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Farmers' perception of water scarcity and components influencing on this challenge in Fars province

Yaser Mohammadi*, Hussein Shabanali Fami and Ali Asadi

Department of Agricultural Development and Management, College of Agricultural Development and Economic, University of Tehran, Tehran, Iran.

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As water scarcity is alarmingly on the increase in national and international level especially in agriculture and due to the importance of examination of components influencing how water scarcity is dealt with by farmers, this research was carried out to analyze the situation of water scarcity by farmers of Zarindasht County and to examine influencing components on this challenge. A questionnaire was used for the collection of data which its reliability was confirmed through computing Cronbach's Alpha coefficient which was above 0.80. About 150 farmers were selected as a sample population through calculating Cochran's formula among 4648 farmers in this County and were sampled using multi-stage sampling technique. Findings revealed that more than 70% of farmers were highly faced with water scarcity, and there was a significant relationship but negative between farmers' perception of water scarcity (FPWS) and variables such as "the depth of water in the well", "income", and a positive significant relationship between this challenge and variables such as "length of water transmission canal" and "the volume of water decrease". In addition, the older farmers, the ones without a second job, the ones using soil canals for water transmission, and the ones with salty water irrigation were faced with water scarcity challenge more often. Also, geographical situation was recognized significant as there was a significant difference among villages and states. Finally, the results showed that, among all the examined components, the decrease of used water volume, having a second job and, the length of water transmission canal were the most important factors, explaining 40% of the variance, influencing on FPWS in Zarindasht County. It is suggested that to decrease the rate of water scarcity, farmers should be supported financially to change their irrigation method or transmission canals as the efficiency of irrigation be improved.

Key words: Water scarcity, influencing factors, water transmission canals, Zarindasht County, Iran.

INTRODUCTION

Water has been the most important factor in the development of the world for a very long time (Khalilian and Zare-Mehrjardi, 2005; Azizi, 2001). Ninety seven percent (97%) of the world's water resources are salty, and a very limited amount of it is directly being used by human beings. Almost 1.76% of the water on the planet is crystallized or has changed into frozen rivers and whatever left is stored in the underground. Increasing demands for water by industrial and urban users will intensify the competition to get it. At the same time, water scarcity is increasing in several important agricultural areas (Fraiture and Wichelns, 2010). According to the scientists' prediction, in the following decades water scarcity in the global scale will be experienced more than

*Corresponding author. E-mail: ymohammadi@ut.ac.ir. Tel: +98-261-2818709. Fax: +98-261-2206824.

before, and the necessity of this vital substance will become more obvious (Sayer and O'Riordan, 2000). Nowadays, water crisis has become one of the controversial issues among all countries' scientists, researchers and politicians. As Frank Rager Berman one of the managers of International Water Institute said, about one fourth of the world are faced with water scarcity because of physical factors including natural disasters, overuse of water resources and, poor management in agriculture which cause rivers and underground water resources to dry up early (Sistan and Baluchestan Regional Water Company, 2007). Iran is located in the arid and semi-arid area in the world, and as a result, water scarcity is a big problem (Forooghi et al., 2006). Generally, water scarcity happens when the rate of water users' pressure is more than water supply, and increasing demands of different parts of the environment like agriculture, industry and urban users are not answered completely (FAO, 2007). Water scarcity, can broadly be understood as the lack of access to adequate quantities of water for human and environmental uses. The term 'water scarcity' is regularly used by the media, government reports, non-governmental organizations (NGOs), international organizations such as the United Nations (UN) and Organisation for Economic Cooperation and Development (OECD), as well as in the academic literature, to highlight areas where water resources are under pressure (White, 2012).

Zarindasht County is one of the 13 counties of Fars province in Iran faced with water scarcity which is due to the persistence of drought and overuse of the underground resources (Ansarifar, 2006). This County with an area of 4626 km^2 and the population of about 65000 people is located in the Southeast of Fars province of Iran. With an average amount of 236 mm rainfall and the average temperature of 22.7°C, Zarindasht is a hot and semi-arid County of Iran and in recent years, water scarcity has been highly increasing due to continuum droughts which has made the farmers leave their unproductive farms behind and migrate to big cities (Jihad-E-Agriculture Management of Zarindasht County, 2010). While agriculture in this County is of great importance, the main source of supplying agricultural water is groundwater. However, due to overexploitation of groundwater, the annual decrease of the water level from this resource is considerable. Decreasing number of agricultural water wells from 915 in years 2004 to 2005 to 870 wells in years 2008 to 2009 and decreasing average of discharge from 12 to 9 L_S prove that groundwater, as the main source of supplying agricultural water, signifies an alarming case of water supply (Jihad-E-Agriculture Management of Zarindasht County, 2010). In fact, both sequential droughts and lack of groundwater optimal use in Zarindasht County have caused water scarcity problem which has ended in agricultural yield loss in this County (Asadi et al., 2009). Considering the importance of water scarcity problem in this County, this research aimed to investigate how water scarcity is dealt with by farmers and to find out factors influencing this challenge. Scientists believed that different factors can cause water scarcity. Pereira et al. (2002) stated that overexploitation of water resources and water quality degradation is associated with water shortage. Also, overexploitation and poor management of groundwater threaten the resources (Fraiture and Wichelns, 2010). Luquet et al. (2005) showed that traditional irrigation methods are a big challenge in countries facing water scarcity. Research carried out in Rafsanjan County by Abdollahi and Soltani (1998) revealed that the land ownership and topography are the factors causing waste of water which results in water scarcity. Kardovani (2000) also believed that the long length of irrigation canals as well as their turns and twists are the factors causing water loss and water scarcity. Zehtabiyan (2005) referred to three points that is the fact that irrigation canals are made of soil, the farms are not leveled, and the long length of water canals. He believes that these factors result in decreasing irrigation productivity and water scarcity. Davarpanah (2005) concluded that agricultural product insurance against water scarcity and government supportive policies are the managerial components to overcome water scarcity and drought. Furthermore, studying water scarcity in Darab County (located in Fars province, Iran) and determining components leading to water scarcity, Forooghi et al. (2006) stated that turning soil irrigation canals into polyethylene pipes, and improving water consumption in the farm by hydroflom pipes are the best managerial strategies to tackle water scarcity.

RESEARCH METHODS

This study was based on survey study. A number of 4648 households from Zarindasht County (with 2 divisions, 5 rural districts and 23 villages from Fars province) were selected as statistical population 150 of which were selected as sample population using Cochran's formula (Figure 1). This formula estimates the sample size using standard deviation of a main variable in pretest stage. Sampling was done in two phases, first by using stratified sampling method and in the second phase by random sampling. A questionnaire was used to gather data and information which was included of farmers' characteristics, agronomy information, water and land data, and farmers' perception from water scarcity. Pilot study revealed statistically acceptable reliability of the questionnaire by estimating the Cronbach's Alpha which was above 0.80. Validity of the questionnaire was also confirmed by expert opinions like Fars water organization experts, power ministry experts. As the dependent variable, that is farmers' perception of water scarcity (FPWS) with an ordinal scale, Mann-Whitney test was used to compare the average of FPWS of farmers between dummy variables and for more than two levels, Kruskal-Wallis test were exploited.

RESULTS

Personal and professional characteristics

The results of this research showed that most of the farmers were middle aged (30 to 60 years old) with the

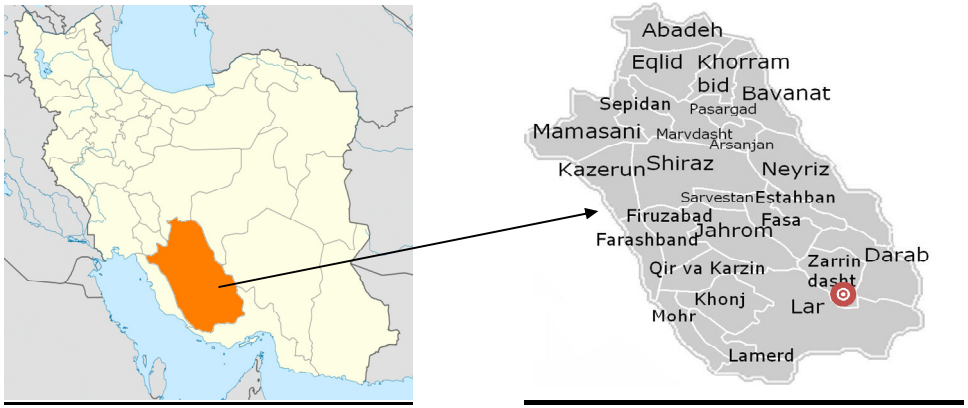

Figure 1. The position of Zarindasht County in Fars province and Iran Country.

Table 1. The average situation of farmers' information and their agricultural characteristics.

Variable	Age	Agri-exp-years	Literacy	Cultivated lands	Topography	S oil quality	Source of irrigation	Length of water canals	Water ownership	Irrigation method	Type of water canal	Water quality
Mean / mode	42	16	Read and write	6.5	Not flat (hilly)	Salty	Deep wells	>1 km	Joint	Traditional	Made by soil	Semi-salty

Source: Research findings (2011).

average age of 42, and the average years of their agricultural experience was 16. Most of them were able to read and write. Also, the average cultivated lands were 6.5 ha, and the average number of their lands' plots was three. About 50% of their farms were not flat (hilly) and the soil was salty with white spots on it. Furthermore, 95% of farmers use a deep well with pipes with an average diameter of 4 inches to irrigate their farms. In addition, 62% of the wells were located farther than 1 km away from farms. Moreover, most of the farmers had a joint ownership regarding the water resources, and more than 90% of them used the traditional deepwater irrigation method to irrigate the farms. Also, most of them use soil canals to transmit water to the farms with an average length of 1.5 km. About 61% of the farmers used governmental credits to improve their irrigation systems. Water quality for most of the farms was semi-salty, and more than 97% of them did not have drainage system for their farms (Table 1).

Farmers' perception of water scarcity (FPWS)

It was established that 41.3% of the farmers believed that they faced very severe water scarcity, 32.7% of them faced severe scarcity, 21.3% faced average scarcity, 4% described it as being low, and just 0.7% of them believed that they had faced water scarcity very low (Table 2).

As it is observed in Table 2, water scarcity is a very serious problem in Zarindasht because farmers faced water scarcity of above average were more than 70%, then the necessity to find out and pay attention to the factors influencing water scarcity is completely inevitable.

Relationship between FPWS, and personal and agricultural characteristics

Research findings in Table 2 show that there is a positive and significant relationship between how

Table 2. Farmers' perception of water scarcity (FPWS).

Intensity of FPWS	Frequently	Percent	Cumulative percent
Very low	1	0.7	0.7
Low	6	4.0	4.7
Average	32	21.3	26.0
Severe	49	32.7	58.7
Very severe	62	41.3	100
Total	150	100	

Source: Research findings (2011).

Table 3. The relationship between facing water scarcity with independent variables.

Variable 1	Variable 2	r	Significance
Facing water scarcity	Age	0.176*	0.032
	Literacy level	-0.021	0.801
	Agricultural experience	-0.070	0.397
	Water discharge (liter/S)	-0.446**	0.000
	Water depth in the well	-0.362**	0.000
	Income	-0.161*	0.050
	The length of irrigation canal	0.218**	0.007
	Amount of water decreasing	0.569**	0.000
	Amount of water consumption	0.006	0.946

**, P ≤ 0.01. *, P ≤ 0.05.

often farmers are faced with water scarcity, the length of irrigation canal in the level of 1% and the variable of age in the level of 5%. Also, there is a negative and significant relationship between the variable of the amount of water resource, water depth in the well, and income with facing water scarcity in the levels of 1 and 5% (Table 3).

According to the results in Table 3, as the age increases, the rate of FPWS increases which could be due to the fact that farmers pay more attention to their old principles and do not use new irrigation methods. In addition, the rate of water scarcity increases with increasing the length of irrigation canal. This seems to be due to the fact that increasing the length of the route causes over evaporation considering high penetration of canals. Decreasing the depth of water in the well and considered water also cause the problem of water scarcity. But increasing income causes a decrease in water scarcity which could be the result of purchase of new irrigation systems like polyethylene pipes, electro pumps. This is what farmers agreed with that when they have been asked. These help farmers to use water much better, and to face water scarcity less often.

Comparing the ranked mean of the FPWS between dummy variables

The results of comparing ranked mean of the FPWS between two different levels of Dummy Variables could be observed using Mann-Whitney Test (Table 4).

As shown in Table 4, farmers with a second job face water scarcity less often. This could be to the fact that farmers with a second job have a higher income, and consequently are more financially empowered to buy water than the other group. Also, farmers who use product insurance have fewer problems than those without because, they are not worried about draught and water scarcity and use water better. However, those who do not have insurance try to exploit water more to compensate for the problems caused by water scarcity. As a result, they face a decrease in the level of water in the well.

There is a significant difference between the farmers who use modern irrigation method and the ones who use conventional irrigation. Therefore, the second group faces water scarcity more often than the first group. This is understandable considering how more water in deep water irrigation method is wasted compared with sprinkler irrigation methods.

Also, the results showed that the rate of facing water scarcity is high among people who use diesel pumps compared with the ones who use electro pumps, and people who have soil canals as compared to the ones with polyethylene or cement pipes. This could be because of the fact that soil canals are penetrable, and weeds grow along these canals.

Table 4. Ranked mean of the FPWS between virtual parameters.

Dependent variable	Grouped variable	Levels	Ranked mean	U	Significance
The rate of facing water scarcity	Second job	Have	70.48	2160.00**	0.050
		Don't have	83.93		
	Insurance	Use	72.17	1179.50*	0.040
		Don't use	90.82		
	Irrigation method	Modern	34.00	65.00*	0.201
		Conventional	76.06		
	Water extracting tool	Electro pump	66.01	2136.00**	0.008
		Diesel pumps	83.80		
	Soil canals	Use	83.29	2118.00**	0.008
		Don't use	65.59		
	Drainage	Yes	74.67	171.500	0.135
		No	105.63		
	Location of wells	<1 km	65.24	2076.00*	0.018
		>1 km	81.68		
	Water quality	Salty	19.60	75.50*	0.096
		Sweet	13.39		
	Land topography	Not-flat	54.53	758.00*	0.061
		Flat	42.65		

** Difference is significant at the 0.01 level. * Difference is significant at the 0.05 level.

Others results also showed that the farmers whose pumps were more than 1 km away from their farms compared to the ones with a distance less than 1 km, and farmers who had salty water and not flat agricultural farms compared with the ones with sweet water and flat farm face water scarcity more often.

Comparing the ranked mean of FPWS among variables with more than two levels

In order to compare the ranked mean of FPWS among different levels of non-virtual parameters, Kruskal-Wallis test was used. The results are observable in the Table 5.

Table 5 results show that there is a significant difference among different districts and villages of Zarindasht County regarding the rate of facing water scarcity. The least and the highest rate of water scarcity were related to Khossuyeh and Izad Khast districts, respectively. This could be because of salty water in West Izad Khast district. Among villages, the least and the highest rate of those facing water scarcity were observed in Miandeh and Darreshoor villages. This could also be because of salty water in Darreshoor farms and the shortage of rain and low level of underground water. In addition, there is a significant difference among farmers with different ownerships of water resource regarding facing with water scarcity which means that the least and the highest rate of water scarcity belong to personal and rental ownerships, respectively. The farmers who use polyethylene pipes to transmit water and the ones, who use soil canals, face with the least and the most rate of water scarcity respectively.

Also, the results showed that there is a significant difference among different topographies of the farms regarding the rate of facing water scarcity. The highest rate of facing water scarcity was observed in hilly farms and the least of it in flat farms. It can be related to amount of water wasted in hilly farms in comparison to flat farms.

The discriminant analysis of the components influencing the challenge of FPWS

There were definitely certain characteristics that could separate farmers who faced water scarcity more often compared to farmers who did less often. These

Table 5. Ranked mean of the FPWS among non-virtual parameters.

Dependent variable	Grouped variables	Levels	Ranked mean	Chi-square	Significance
The rate of facing water scarcity	Districts	East Izad Khast	95.17	17.557**	0.002
		West Izad Khast	98.05		
		Khossuyeh	63.24		
		Dabiran	73.86		
		Zirab	73.00		
	Villages	Mazijan	95.17	26.518**	0.001
		Darreshoor	98.05		
		Khossuyeh	71.73		
		Sachoon	74.85		
		Tajabad	60.36		
		Miandeh	36.40		
		Dehno	73.86		
		Chahsabz	74.69		
		Galugah	71.77		
	Water ownerships	Joint	79.12	6.567*	0.037
		Personal	80.99		
		Rental	58.82		
	Water transmission canals	Polyethylene pipes (1)	63.07	12.342*	0.030
		Cement canals (2)	69.00		
		Soil canals (3)	83.59		
		(1) + (3)	81.52		
		(2) + (1)	119.50		
		(3) + (2)	119.51		
	Land topography	With up and down (1)	79.45	11.407*	0.044
		Smooth and flat (2)	61.52		
		Smooth and gradient (3)	71.66		
		(1) + (2)	119.50		
		(1) + (3)	68.50		
		(2) + (3)	75.10		

** Difference is significant at the 0.01 level. * Difference is significant at the 0.05 level.

characteristics are the factors really influencing the challenge of facing water scarcity. To find out these factors, one has to find out what characteristics differentiate these groups regarding how they face water scarcity. Discriminant analysis is a technique that shows the discriminant characteristics of these two groups. Using estimated discriminant equation, we could identify the components affecting the challenge of water scarcity, and how important each factor is.

Considering the two groups of compared farmers, one discriminate equation with the Eigenvalue of 0.616 and canonical correlation of 0.617 was gained which explained about 40% of the discrimination between the two groups because the square root of canonical correlation coefficient indicate the percentage of explained discriminations by linear combination of independent variables (Table 6). Another criterion for the assessment of the function is referring to Eigenvalue which in this function also showed that the gained function was very powerful in discriminating the groups.

The results of Table 7 also showed a significant level for the discriminant function. Considering the value of Chi-square and Wilks' Lambda, the discriminating equation was significant and could discriminate groups well. The estimated equation from discriminant analysis can be written as:

$$D = -2.308 + 0.082x_1 + 0.264x_2 - 0.765x_3$$

According to Table 8 and discriminant equation, it was showed that between 13 components in discriminant analysis, during two stages, three came to be the

Table 6. Eigen values and canonical correlation of discriminant functions.

Function	Eigenvalue	% of variance	Cumulative %	Canonical correlation
1	.616[(a)]	100.0	100.0	.617

[a] First 1 canonical discriminant functions were used in the analysis.

Table 7. Wilks' Lambda.

Test of function (s)	Wilks' Lambda	Chi-square	df	Significance
1	0.619	68.863	3	.000

Table 8. Standardized canonical discriminant function coefficients.

Variable	Function
	1
Percent of water decrease	0.898
Length of irrigation canal	0.352
Having a second job	-0.364

significant components influencing the rate of facing water scarcity most by farmers. Of these three components, the percentage of water decrease was the most important component, having a second job comes next, and then the length of irrigation canal.

DISCUSSION

According to the results gained in this study, most of the studied farmers were older than 40 years, and had a low level of literacy. More than half of their farms were not flat and their soil was salty. In addition, the distance from their farms to their water resource was also a lot considering that most of them transmit water through soil canals, and that the canals were very long too. As a result, most of them face water scarcity a lot which is also observable in Table 1. Also, the method of conventional irrigation and lack of drainage system in farms worsen the situation as more than 90% of farmers had farms without drainage which explained why more than 74% of the farmers are faced water scarcity much or very much. The relationship between mentioned characteristics with the rate of facing the challenge of water scarcity was proved which means increasing age, increasing the length of irrigation canal and decreasing the depth of water in the well make farmers face water scarcity more often. The older a farmer is, the less able he is in maintenance and management of canals. The longer the canals are from the wells to the farm, and the fact that they use soil canals, the more water is wasted, and the productivity of water transmission decreases, too. Therefore, the farmer faces water scarcity more often.

Although, the more people's income increases, or the deeper their well water is, the less often they face water scarcity. Since they have more water, and they could also use their money to employ some workers, or, they could buy polyethylene pipes and increase the productivity of water transmission, so, the farmers who had a second job as compared with those without a second job faced water scarcity less often because having a second job means another source of income that the farmer can use to buy new equipment of irrigation, turn soil canals into polyethylene pipes, and change his pipes and irrigation pumps to increase the productivity of water transmission and consumption. Poor farmers who had to use the traditional irrigation method instead of sprinkler irrigation, use soil canals to transmit water, utilize diesel pumps instead of electro pumps definitely faced water scarcity more often as these farmers wasted more water, and they had low water productivity.

Other components for example, land topography, the quality of agricultural water and the place of water resource also decrease the productivity of water consumption. The farmers who did not have flat farms, with agricultural salty water and those whose farms were more than 1 km away from the pump, usually faced water scarcity more often because the farms that are not flat use lots of water, while the amount of water penetrating the earth is also less than flat farms. Salty water is also more penetrating and gets into the soil very quickly. Many weeds preferring salt grow there, and use most of the water. This results in less water productivity and more water scarcity. The longer the distance is between water pump and the farm, the more evaporation into the air, and more penetration into the land is. This decreases the transmission productivity dramatically.

Moreover, the kind of water resource ownership influenced how the farmers felt toward water scarcity. Those who owned water resources personally felt water scarcity more than the ones who had rented the resources. It seems that those who rented the resources considered the condition of water just at the moment, while the owners were worried about the water condition now and in the future.

The place where farmers lived was also a component that influenced the rate of facing water scarcity. The rate

of facing the challenge of water scarcity between different districts and villages of Zarindasht County had significant differences. It can be concluded that different districts and villages are different considering the amount of rain, land topography, the amount of water in the wells, the quality of agricultural water, the amount of the farmers' income, and so on and all these components had a significant impacts on facing water scarcity.

All in all, of all these components, the rate of water decrease in wells (which is caused by draught or overuse), having or not having a second job (which could provide a financial support for farmers to increase the productivity of water transmission), the length of the irrigation canals were the most influencing components considering the results of discriminant analysis. This means that enough attention should be paid to these components to tackle water scarcity.

Conclusion

To sum up, the results showed that water scarcity in Zarindasht County is a serious problem and more than 70% of the farmers faced water scarcity. This challenge of facing water scarcity was influenced by farmers' age, their income, having a second job, water depth in well, decrease in the amount of consumed water, the length of irrigation canal, the kind of irrigation canal being made of soil, irrigation method, the quality of irrigation water, the place of settling water pump, and the farms of improper topography. Of these components, the decrease of the amount of the consumed water, having or not having a second job and the length of irrigation canal were known as the most important ones. This means that to tackle this challenge, and improve the condition of irrigation water in Zarindasht County, it is imperative to pay due attention to these components. Operational strategies should be taken to remove these obstacles. For instance, considering the fact that long length of water canal and soil canals increase the rate of facing water scarcity, it is suggested that we use new methods of water transmission like polyethylene pipes or concrete canals in order to prevent waste of water (Jin and Yong, 2001; Berim-nejad and Paykani, 2004; Foroghi et al., 2006). Considering the positive effect of a second job and high income in decreasing the rate of facing water scarcity, it is suggested that the government provide financial or credit support in order to improve farmers' financial situation (Alizadeh, 2001; Farzampour, 2001; Zehtabiyan, 2005; Mahdavi, 2005; Assare et al., 2005; Arjomandi et al., 2000).

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