Investigation of the Effects of Extension Factors on Improving Water Resources Management in Tehran Province

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Abstract: The purpose of this research is to identify the effect of extension factors on improving the management of agricultural water resources in Tehran Province agricultural sector. This is an applied research in terms of its objective, a field research in terms of the degree of control it exerts on variables, and a descriptive (non-experimental) research in terms of its method of gathering information. Therefore, it could be termed a "descriptive-correlational" research. The statistical population for this research was Tehran Province water farmers (45652 persons), and the statistical sample size was calculated as 243 from the Cochran Formula. Due to the uneven distribution of farmers in the 14 counties of Tehran Province, in the first step only 5 counties were selected: Shemiranat on the north, Varamin on the south, Firouzkouh on the east, Shahriar on the west, and Tehran in the center of the province. Then, in the second step, in proportion to each county's farmer population percentage in the whole statistical population, the selected sample sizes for each county were determined as fractions of the total sample size (243 persons). The randomly selected farmers in each county were consequently interviewed and the required information was obtained from them through questionnaires. The stability of the scale used for the present research was confirmed by a Cronbach's alpha value of greater than 0.70, and the validity of the questionnaires was ascertained through seeking the opinion of academic advisors. Ultimately, the obtained data was analyzed by using the SPSS software. The obtained correlation results point to the fact that there exists a significant relationship between the "water resources management improvement" variable and the following variables: the number of times farmers participate in training-extension courses, the quality of the organized educational- extension courses, the number of times farmers seek advice at the local agricultural extension service, the performance of the local agricultural extension service in the areas where farmers work, the farmers' education level, the farmers' workforce, the farmers' annual income, the degree of participation exhibited by each farmer in cooperating with other farmers for better management of water resources, the total land area owned by each farmer, and the number of plots of land allocated to each farmer. According to the results obtained from the Regression Method, the following seven variables which together explicated 77.5 percent of variations of the dependent variable, were identified as the effective extension factors in improving water resources management.

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Introduction

Although most of the earth's surface is covered with water, only 2.5 percent of its available water is fresh. Moreover, due to their being in the form of glaciers and permanent snow on mountains, large parts of the existing fresh water could not be utilized (Asgari, 1999). In addition, renewable water resources are on the decline, not only in dry arid areas, but also in areas with large amounts of annual rainfall (Panda et al., 2004). One of the important factors pinpointed as responsible for deterioration of water quality is population growth and concentration. This factor is among the greatest stress factors on water resources in dry areas (Mortazavi et al., 2011). In 1990, about twenty countries with an annual water consumption of less than 1000 cubic meter per capita were faced with water shortages. It is estimated that by 2020, 30 to 35 countries will have come to face the same problem, and by 2025, one third of the developing countries, mainly in the arid and semi-arid regions of the African Continent, will have been affected by water shortage (IWMI, 1999). As a developing country situated in the arid and semi-arid region of the globe, Iran is also confronted with the fundamental problem of water shortage (Foroughi et al., 2006; Shabani et al, 2006) since annual precipitations accumulated as surface water in rivers and canals form its only source of water (Karpisheh, 2011). Therefore, preservation of this vital resource and optimum utilization thereof would be among the greatest challenges the country would have to come to terms with in the present century (Shabani et al., 2006). Iran, having an annual rainfall equal to one third of the world average, below-average renewable water resources (equal to only 36 percent of the world average), and one percent of the world population, would be taking its fare share in overcoming water shortage. Consuming 94% of available water resources, the agricultural sector plays a crucial role in promoting optimum and productive methods for transportation and utilization of water (Shayanfar, 2003). However, it is observed that, due to farmers' insufficient knowledge about optimum methods of water consumption in agriculture and the subsequent inappropriate ways of utilizing water by them, there has been a steep fall in production, efficiency, and income levels in the agricultural sector, causing disillusionment among farmers and preventing further advances in the country's drive towards development (Ranganijahromi and Mohammadi, 2007). To address this problem, in this study we present management of agricultural water as a systematic approach for controlling water consumption, which would bring about suitable techniques for meeting irrigation and drainage needs on farms (Forest, 2002). Management of water resources to supply water efficiently for human needs as well as to reduce the damage caused by irregular consumption, is a complicated subject which will become more significant in the coming years with the growth of population and demand (Shahidasht and Abbasnejad, 2011). In fact, improving the management of agricultural water, aimed at achieving the environmental, economic, and social goals of sustainable agriculture, is an important step in optimum consumption of water and efficient increase of irrigation as well as in agricultural production.

The fundamental questions that could be asked here would be: "What factors affect such an important and vital issue as water management improvement?", "To what extent can educational-extension factors affect the way water resources are managed?"

Undoubtedly, different factors influence the management of water resources, and once these factors have been identified, we can use them correctly in order to bring about positive improvements in the control of water resources. Taking up the level of farmers' knowledge, insight, and skills through arrangement of educational-extension activities by organizations in charge of agriculture would be a positive step in the betterment of water management. Such educational-extension programs on optimum management of water resources can greatly help to alleviate the water shortage problem. Of course, this would need comprehensive knowledge of the nature of these programs and activities. That is why the present research was conducted with the purpose of identifying the effects of extension factors on improving water resources management in Tehran Province. Today, many reports are aimed at water resources management, but there are few studies that directly investigate the agricultural extension factors affecting water resources management improvement. For example, the research conducted by Ehsani and Khaledi (2003), Zehtabian (2005), and Heidari et al. (2005), focuses on the role of training in the betterment of agricultural water management. Results obtained from such research show that

farmers are in dire need of learning modern methods and techniques for optimum water consumption and appropriate farming patterns as well as irrigation systems, and that farmers expect the trainers to help them in improving water consumption through holding classes and providing agricultural extension material in the form of publications, brochures, etc (Mohammadi et al., 2007). Other studies show that the most important reason for low productivity and irrigation deficiency is lack of technical knowledge and agricultural extension in teaching farmers how to apply water management optimally (Keshavarz and Sadeghzadeh, 2000; Ehsani and Khaledi, 2003; Pourzand, 2003; Afshar, 2004; Hasheminia, 2004; Mohammadinikpour and Parastar, 2006). Obviously, promoting farmers' knowledge would, among other things, lead to appropriate and timely use by farmers of new technologies for the purpose of achieving a favorable level of production (Omani and Chizari, 2002). For this reason, experience and knowledge of farming could be the best way of planning for optimum management of water as well as the training programs involved (Kaupila and Pelsue, 2003). In fact, a fundamental yet simple approach for optimum water management is to make use of the experiences gained by farmers themselves (Steven et al., 2003). For this reason, examining farmers' level of technical knowledge and the factors influencing it would be of particular interest. Karami (1999) believes farmers have different levels of technical knowledge and that their degree of putting this knowledge into practice depends on numerous factors including the support and the tools they require. There is no doubt that observance of the principles of optimum management would require the necessary training associated with it. In other words, through educational means, the effective approaches for correct management can be made available to farmers. The results of Paul's (1998) work show that agricultural extension services and non-governmental organizations play a role in farmers' improved performance in coping with natural disasters. Zareidastgerde et al. (2007) also refer to the importance of education, research, and promotion in raising awareness and introduction of modern science and technologies to farmers, which would result in betterment of management of water used in agriculture. Heidari et al. (2006) have also pointed to the importance of taking up farmers' level of knowledge for better managing the water used in farming. Preira et al.(2002) believe farmers' increased knowledge would result in optimum management of water resources used in farming. In his investigation in Kenya, Rees (2000) announced that between 40 and 70 percent of the farmers under study had recognized the training received from state agricultural extension services to be the most important source of know-how transfer to them. In Desalegn et al. study (2006), education and capacity-building were introduced as key elements in the development of skills and know-how, and the right tool for optimum management of water resources. They enumerate training, sustainable use of resources, development and application of economic systems as essential elements for integrated optimum management of water resources. Amirkhani et al. (2010) also showed that lack of know-how and generally poor education of farmers on implementing optimum water management methods,were responsible for low productivity and inefficient water consumption.

As could be seen from the above studies, educational/training and extension services are effective factors on the improvement of water resources management. For this reason, such activities cannot be ignored if management of water resources is to be improved, and that is why research should be conducted to investigate the role and significance of these activities.

Materials and Methods

This is an applied research in terms of its objective, a field research in terms of the degree of control exerted by it on variables, and a descriptive (non-experimental) research in terms of its method of gathering information. Moreover, since it investigates the relationship among different variables, this research describes a correlation. Therefore, the best way of describing the present research would be to call it a descriptive-correlated study. The dependent variable is the degree of improvement in management of water resources used for agriculture, and is measured through implementation of effective mechanisms by farmers for bringing about this improvement. In other words, the more the farmers use such mechanisms, the better water resources could be managed. To measure the dependent variable, 35 mechanisms were used in the form of a Likert Spectrum scale. Independent variables consist of extension factors that influence the improvement of water resources management including: number of times farmers participate in educational-

extension courses (ratio variable), number of times farmers seek advice at local agricultural extension services (ratio variable), farmers' use of modern irrigation technologies (nominal variable), farmers' use of optimum farming patterns (nominal variable), watching educational films (nominal variable), farmers' visiting model farms (nominal variable), farmers' reading extension literature (nominal variable), farmers' reading extension brochures (nominal variable), farmers' using educational posters (nominal variable), and performance of the local agricultural mobilization centers regarding optimum management of water resources (interval variable). Eleven mechanisms were used in the form of the Likert Spectrum to measure the performance of local agricultural mobilization centers. The statistical population for this research consisted of 45652 water farmers in Tehran Province. The statistical sample size was calculated as 243 from the Cochran Formula.

Tehran Province where Iran's capital, Tehran, is situated lies between the northern and central part of Iran. Due to the uneven distribution of farmers in this province, at the outset of the study, 5 out of the overall 14 counties were chosen as follows: Shemiranat on the north, Varamin on the south, Firouzkouh on the east, Shahriar on the west, and Tehran in the center of the Province. Then, in the second step, in proportion to each county's farmer population percentage in the whole statistical population, the number of selected samples for each county was determined as a fraction of the total sample size (243 persons). Then, randomly selected farmers in each county were interviewed and the required information was obtained from them through questionnaires. The stability of the scale used for the present research was confirmed by a Cronbach's alpha value of greater than 0.70, and the validity of the questionnaires was ascertained through seeking the opinion of academic advisors. Ultimately, the obtained data was analyzed by using the SPSS software.

Results

1. Descriptive Statistical Results

The descriptive statistical results concerning personal particulars of the farmers showed the average age of the farmers to be 43 years old and the age group of the majority of farmers (35.8 %) to be between 50 and 60 years old. Their average working experience was 20 years with a 32% majority aged between 10 and 20 years old. A 31.7% majority had secondary school education. The mean dimension for farmers' households was 5.30 persons and a 49.8% majority consisted of households with 6 or more persons. The mean farming workforce was 3.77 with a 48.2 % majority having fewer than 3 working persons. The average annual income for a farmer was 7.805 million tomans (1 toman=10 rials. Rial is the official monetary unit of Iran), with a 32.5% majority earning between 9 and 12 million tomans a year. The mean total cultivated area per farmer was 2.555 hectares with a 46.9% majority being in possession of less than 2 hectares of farmland. The mean number of farmed land plots was 4.94 per farmer with a 41.6% majority having 6 or more plots for farming. The farmers were mostly small landowners (42.4%) or had acquired ownership of their own land and water rights (51.8%). The water for irrigation of their land was supplied through a combination of several sources (35%) and a 48.2 % majority transferred water via earth canals to their farmland. The 48.2% majority used traditional irrigation techniques. The majority of traditional farmers (53.4%) implemented the flood irrigation system, and the majority of farmers (69%) implementing pressurized irrigation techniques used the spray irrigation system. The degree of social participation demonstrated by most farmers (32.9%) with respect to better water management for agriculture was low: a 32% majority had never taken part in training courses related to water management, and 39.6% had never sought advice at agricultural extension centers. Other obtained results about the farmers under study are as follows: 69.6% had never taken part in the Farm Day ceremonies, 58.4% had never seen educational films on water management, 76.1% had never visited model farms, 75.3% and 73.7% had never read extension literature and brochures respectively, and 81.1% and 70.4% of the farmers had not utilized the optimum farming patterns and the new irrigation systems recommended by agricultural experts respectively.

2. Inferential Statistics Results

2.1) Relationship between Water Management Improvement and other Variables

In this section, the relationship between water resources management improvement variable, the ordinal variable, and the ratio variable was

investigated through the Spearman's and the Pearson's correlation tests, respectively. The results are shown in Table 1.

Table 1: Relationship between Water Management Improvement and other Variables

Primary Variable	Secondary Variables	Test	r	Sig
Degree of Improvement in Management of Water Resources (P)	Number of Participation in Agricultural Extension-Training Courses (A)	Pearson	0.493**	0.001
	Quality of the Organized Agricultural Extension Courses (B)	Spearman	0.618**	0.000
	Number of Occasions Farmer Sought Advice at the Agricultural Extension Services (C)	Pearson	0.169*	0.041
	Performance of Agricultural Extension Sector on Managing Water Resources Optimally (D)	Pearson	0.713**	0.000
	Degree of Participation Demonstrated by Farmers on Improved Management of Water Resourced (E)	Spearman	0.723**	0.000

*Significant at the one percent level **Significant at the five percent level

It could be seen that there is a significant relationship between the variable P, "Degree of Improvement in Management of Water Resources", and the variables A, B, D, and E (see Table 1) with a 99% probability, and there is a significant relationship between P and C with a 95% probability. In other words, the more the number of occurrences for the variables A to E, the more the degree of improvement in water resources management.

2.2) Comparison of Mean Values obtained for Degree of Improvement in Management of Water Resources in Different Farming Groups

The Independent Two-Sided T-Test was used to compare the Degree of Improvement in Management of Water Resources in two different groups of farmers. The results are shown in Table 2.

Table 2: Comparison of the Degree of Water Resources Management in Different Two-Sided T-Test Groups

Dependent Variable	No.	Categorizing Variable	Groups	Mean Value	Standard Deviation	t	Sig
Degree of Improvement in Management of Water Resources	1	Use of Modern Irrigation Technologies	Y	112.71	29.43	6.87**	0.000
			N	56.63	12.76		
	2	Use of Optimum Farming Patterns	Y	91.52	21.34	2.35*	0.040
			N	77.87	15.94		
	3	Use of New Irrigation Systems Introduced by Persons In Charge	Y	118.88	31.31	6.11**	0.000
			N	58.54	12.40		
	4	Participation in Farm Day Ceremonies	Y	86.44	18.47	1.17	0.127
			N	82.96	18.05		
	5	Watching Educational Films	Y	118.82	34.84	7.70**	0.000
			N	50.51	11.73		
	6	Visiting Model Farms	Y	108.11	32.68	5.94**	0.001
			N	61.20	17.57		
	7	Using Agricultural extension Lterature	Y	96.59	20.90	2.69*	0.024
			N	72.83	13.56		
	8	Using Agricultural extensional Brochures	Y	93.21	19.87	2.44*	0.031
			N	76.11	15.15		
	9	Using Educational Posters	Y	85.03	18.23	0.97	0.234
			N	84.32	16.32		

*Significant at the one percent level **Significant at the five percent level Y=yes N=no

According to the obtained results, the mean difference obtained for Degree of Improvement in Management of Water Resources is significant with a 99 percent probability in groups 1, 3, and 5, and with a 95 percent probability in groups 2, 7, and 8. Also, this difference is not significant in groups 4 and 9. This means that, as compared to farmers who did not use these resources, farmers using modern irrigation technologies, optimum farming patterns, new irrigation systems introduced by the persons in charge, extension literature and extension brochures, implemented to a greater extent the effective mechanisms for improving water resources management, so that the degree of water resources management improvement was significantly higher in these groups. Moreover, the mean improvement in the degree of water resources management was higher in a significant manner among farmers who had seen films on the subject or visited the model farms, as compared to farmers who had not participated in such activities.

2.3) Investigation of the Effective Extension Factors for Improving Water Resources Management

In this section, the simultaneous effects of extension variables on the degree of water resources management improvement were studied by making use of multiple regression and stepwise methods. As could be seen in Table 3, the results indicate that 7 variables (X1 to X7) were entered into the equation, for which the coefficients of determination (R^2) were obtained. Collectively, these variables could explain 77.5% of the dependent variable's variations. The positive standard coefficients (β) obtained for analyzed

variables indicate that a change equal to one standard deviation in each of these variables would produce a corresponding change in management improvement equal to 0.789, 0.613, 0.567, 0.402, 0.237. 0.187, and 0.115 of the standard deviation, respectively.

Table 3: Effect of Variables on Water Resources Management Improvement

Variable Name	Coefficient of Determination (R^2)	"B" Coefficients	Standard Error	Standard Coefficients (β)	Statistic "t"
C: Constant Coefficient	---	12.966	3.285	---	19.76**
X1: performance of the local agricultural extension service	0.446	18.327	6.445	0.789	5.76*
X2: quality of the organized educational-agricultural extension courses	0.560	1.578	0.778	0.613	3.33**
X3: participation exhibited by each farmer in cooperating with other farmers for better management of water resources	0.659	1.076	0.650	0.567	2.48**
X4: use of modern irrigation technologies by farmers	0.704	2.654	1.239	0.402	2.57**
Number of Participation in agricultural extension - Training Courses	0.736	0.790	0.236	0.237	1.67*
X6: Watching Educational Films about Water Consumption Management	0.757	3.401	1.880	0.187	1.50*
X7: Number of Times Farmer Sought Advice at the local Agricultural Extension Service	0.775	1.107	0.991	0.115	1.32*
F=45.176**	Df= 7	R=0.809	R^2=0.775		

*Significant at the one percent level **Significant at the five percent level

With due regard to what was said before and the information given in Table 3, the linear equation from the regression analysis is obtained as:

$Y = 12.996 + 18.327\ X_1 + 1.578X_2 + 1.076\ X_3 + 2.654\ X_4 + 0.790\ X_5 + 3.401X_6 + 1.107\ X_7$ (Eq. 1)

Discussion

Many factors are effective on the way water resources are managed. That is why much research has been aimed at identifying these factors in order to better manage water consumption in the agricultural sector. However, so far few studies in Iran have been directed at investigating the agricultural extension factors that can result in improved management of water resources. In this article, an effort is made to identify the effective factors that can improve water resources management in Tehran Province agricultural sector. Performance of the agricultural extension centers for water management in the agricultural organizations was recognized as the most effective factor on better management of water. This is no surprise since better extension activities in any field would lead to improvement and finding of better solutions for problems, and water management is no exception. A successful agricultural extension service for water management in any region should do the following to help farmers to optimally manage their water consumption: introduce advanced technologies for irrigation and optimum farming models, organize educational-extension courses, provide educational posters, publish agricultural extension literature, brochures, etc., observe Farm Day, distribute educational films on water management, and establish model farms. The second important factor in improving water management was the quality of the organized educational-extension courses. The obtained results showed that the higher the quality of these courses, the better farmers can manage water consumption. This result also offers no surprise since the quality of these courses would act as a guarantee for raising awareness among and introduce knowledge to the farmers, and for this reason, this is classified as a significant test. The third important factor in improving water management is the level of participation shown by individual farmers for improving water management schemes as a social activity. This factor would also be logically expected. Group participation in utilization and management of water resources in arid areas has been and will be one of the reasons why these

areas can withstand the harsh conditions associated with water shortage. Encouraging farmers to participate as groups in the following activities can improve management of water resources: dredging canals, utilizing water from canals as well as maintaining the canals, paying their share for motor-driven pumping of water from adjacent wells, buying pipes for common water transfer paths, asking for the advice of those farmers who are already utilizing modern irrigation systems through establishment of cooperative companies, supplying funds for digging aqueducts (ghanats) as well as solving technical problems thereof, dredging of ghanats, arriving at agreement and group resolution with regard to the right of way in water canals, wells, and fillings (ridges), installing systems for drawing water from rivers, digging catch basins and diversion canals for optimum utilization of rain and flood water as well as maintaining these structures, prevention of water pollution in rivers and stagnant waters, reducing the length of water canals to a minimum, purchasing of polyethylene pipes for reducing water loss, controlling the growth of weeds in canals, preventing irresponsible draining of industrial and agricultural sewage into irrigation canals, integration and leveling of land, recycling agricultural waste, and many other similar cooperative activities. The fourth important factor in improving water resources management was application by farmers of modern irrigation techniques. The ICID (International Committee on Irrigation and Drainage) evaluates as 30% the efficiency of irrigation in Iran (Ashgartousi and Mohammadinikpour, 1995), while the efficiency of modern pressurized irrigation systems is more than 70% which is a marked improvement on traditional irrigation systems (Mousavi, 2005). If the current trend of population increase as well as the critical decrease of already diminishing water resources continues, in the near future, the mere feeding of the Iranian population would be a huge challenge. Therefore, it would be essential to improve water consumption efficiency in farms via replacing traditional irrigation methods with modern irrigation systems (e.g., spray method, drip method, etc.). The fifth important factor in water management improvement was increased farmers' participation in educational-extension courses, i.e., the more the farmers participate, the better they can manage their water resources. This is another logical conclusion in this article. Naturally, these classes would increase the farmers' knowledge and skill for utilizing mechanisms aimed at increasing water consumption efficiency. The significance of this relationship is indicative of the positive role agricultural extension activities play in improving water resources management. The sixth important factor in the betterment of water management was the watching of educational films by farmers. This is a useful and yet inexpensive way of encouraging farmers to manage water more efficiently. It would be better if farmers watched such films in groups and in the presence of an expert (educator), so that they ask their questions on the spot. Another way, of course, is to make CD's available to farmers for watching as they wish. Finally, the seventh (and the last) effective factor in improving water management was the number of times farmers would seek advice (with regard to water resources management) at their local agricultural extension services. Naturally, such sessions would be beneficial only if: 1) experienced and knowledgeable experts are present in such centers to help farmers, and 2)These experts expend sufficient time and effort in solving the farmers' problems. Obviously, the farmers would be reluctant to go to these centers again if they do not receive appropriate answers to their demands.

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