Analysis of Mechanisms for Water Management Improvement from the Viewpoint of Tehran Province Farmers

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Abstract: The purpose of this research is to identify the most important mechanisms for improving management of 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. 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. Based on the results obtained from prioritizing the effective mechanisms influencing water management, the following three items were determined by farmers under study as the most effective mechanisms on management improvement: replacing traditional irrigation methods with modern, high efficiency methods, avoidance of digging wells unnecessarily, and attending educational-extensional classes organized to give instruction on water resources management. Factor analysis shows the following mechanisms to be effective on water management improvement: 1) extension-educational mechanisms, 2) preventive mechanisms, 3) managerial mechanisms, and 4) executive-operational mechanisms. These mechanisms explained collectively 56.49 percent of the total variance.

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Introduction

The growing trend of population increase as well as expansion of urban areas would necessitate supply of drinking water, healthcare, food security, environmental protection for the society, as well as water for agriculture and industry, which are all vital for human beings. However, competition among consumers of drinking, industrial, and agricultural water, as well as competition for watersheds on one hand, and occurrence of crises such as draughts as a result of climatic changes on the other, can lead to new challenges for countries (Kiani, 2010). Today, agriculture is facing crises at different levels: water shortage, water resources contamination, water transfer to other

consumption sectors, low water consumption efficiency, etc. Water management is needed to alleviate the severity of these problems (Jin and Youhg, 2001).

Geographically, Iran is situated in an arid area, so that, according to researchers, water shortage is its main agricultural bottle neck (Keshavarz et al., 2005). The reason is that annual precipitations accumulated as surface water in rivers and water ways are the only source of water this country has access to (Karpisheh, 2011). Statistics show that Iran has an annual rainfall of only one third of the mean global rainfall. As 70% of this evaporates, Iran is ranked as a country with low water reserves (Almasavandi, 2010). Investigation of the cultivated land in Iran shows that out of an area of about 37 million hectares of potential farmland, only 7.8 million hectares are water farmed due to water shortage (Ehsani, 2003). Some researchers believe the agricultural sector to be the greatest consumer of water in Iran, so that more than 95% of usable water is consumed by this sector. Therefore, due to the importance of agriculture in producing strategic products as well as food for the society, planning for optimum water management should be given priority in accordance to every region's potentials. In fact, in the new millennium, preserving water, i.e., more productivity in water consumption, is a key factor in maintaining life and food security in the society, and any activity initiated in this way could be astep forward in economic development, particularly in rural areas (Sharifi, 2008). That is why management of agricultural water should be considered as a systematic approach for controlling water consumption and meeting irrigation and drainage needs on farms (Forest, 2002). From another perspective, water management could be defined as organizing and controlling water in order to utilize it wisely for obtraining better performances (Mohammadi et al., 2009). Some believe that without optimum water management, the third millennium goals of elimination of poverty and hunger, as well as a stable global environment could not be realized (Surendra, 2007). Therefore, a broad comprehensive view with regard to improving water managemen is of great importance and could actually safeguard sustainable development (Dungumaro and Modulu, 2003). This issue can be further clarified if we consider water shortage and its consumption in agriculture in the context of population growth and concerns regarding food shortages (Howarth et al., 2005).

Tehran Province has, due to its climatic and geographic situation, been subject to water shortage and draught. That is why optimum management of water in the agricultural sector is a great challenge facing farmers and planners in this province. No doubt, efficient management that can utilize water resources sustainably would need mechanisms for saving water and increasing the area of cultivated land.

Now, the question is, "What are the most important mechanisms for improving management of water resources in the agricultural sector?" Water resources management improvement mechanisms are a series of timely actions which would alleviate management problems and prepare the ground for control and optimum use of water, i.e., increase the efficiency of water consumption. Obviously, much research is neede to identify these mechanisms.

The present research is aimed at identifying the most important mechanisms in the management of water resources in the agricultural sector, and making them available to farmers and agricultural planners. Different studies have been conducted on mechanisms for water management improvement. For brevity, these cases are listed in Table 1.

Table 1: Mechanisms for Water Management Improvement in Agricultre

Researcher (Year)	Mechanisms
Fazampour (2001)	Raising social awareness, Coordination among organizations, Integration of agricultural land, Protection of water resources.
Alizadeh (2001)	Technical approaches: land leveling, suitable irrigation methods; Managerial approaches: correct irrigation planning, processing soil for water storage capability, better canal and irrigation equipment maintenance; Organizational approaches: development of non-governmental organizations for public participation; Farming approaches: selection of plant types that yield the most crop, cultivation of plants compatible with climatic condistions, selection of hardy plants, combined cultivation to use water most efficiently.
Saadat & Mahdavi(2001)	Artificial Feeding of Subterranean Waterbeds
Jin & Young(2001)	Use of efficient technologies in irrigation (drip and spray methods), recycling lost water, planting of crops that require less water
Preira et al.(2002)	Acceptance and implementation of combined and integrated land-water resources, optimum usage through improving old irrigation systems, recycling waste water, adopting irrigation technologies for reducing water loss, raising awareness on water shortage and participation
Ehsani et al.(2003)	Avoiding mid-day irrigation, using various covers for farmland, destroying weeds, frugal irrigation to increase productivity, mending soil to increase water productivity, recycling waste water, farmers' participation in management of irrigation systems, Paying attention to education, research and extention in increasing productivity.
Tayebi & Jahanbanifar(2004)	Using sewage from refining processes and placing it to enhance subterranean water beds, preventing unlawful operation of wells, Artificial Feeding of Subterranean Waterbeds.
Zehtabian(2005)	Heeding the region's extension and educational activities, change of irrigation system, reviving of traditional systems, integration and leveling of land, determination of plant water requirements, alteration of farming plants, covering of canals, reviving ghanats, bracing of surface water.
Nazemi(2005)	People's participation in planning and management of water, raising public awareness, protection of water resources.
Jahani(2005)	People's active participation in planning management of water, efficient utilization of waste water, recycling unconventional waters.
Davarpanah(2005)	Educating people to bring about change in water consumption, Considering the importance of public participation, implementation of water consumption projects, production of crops that tolerate saltwater, using saltwater for farming.
Rahimi(2005)	Regular inspection of canals, timely dredging, controlling weeds, repair and maintenance of canal linings/cover plates.
Farshi(2005)	Development of modern water transfer systems, implementation of scientific irrigation and modern methods, extension of irrigation/informing farmers, suitable farming models to increase water consumption efficiency, planting crops that tolerate dry conditions.
Osareh et al.(2005)	Regular dredging of canals and destroying weeds, prevention of land division, participation of farmers and people in water distribution and maintenance of water network, round the clock irrigation, implementation of recommended farming models, Teaching modern irrigation techniques to gfarmers.
Heidari et al.(2006)	Management of farming, increasing farmers' efficiency and know-how.
Nikbakhtjahromi(2006)	Increasing water consumption efficiency through mending farming models, cultivation of high efficiency crops.
Nouri(2006)	Improved management and irrigation methods.
Amirkhani et al.(2010)	Increasing farmers' knowledge of optimum water management.
Shahidasht & Abassnejad(2011)	Prevention of surface water loss, protecting subterranean water beds.
Mortazavi et al.(2011)	Raising farmers' awareness, controlling water consumption, sealing unauthorized wells, changing irrigation methods, raising irrigation efficiency, irrigation cooperative companies and integration of canals, transfer of water from well to farm through suitable means, preventing the of expansion of orchards.

Materials and Methods

This study 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. 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. Tehran Province is situated to the north of central Iran. 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.

Conclusions

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.

Prioritizing Effective Mechanisms for Water Management Improvement from the Respondents' Viewpoint

To prioritize effective mechanisms for water management improvement from the respondents' viewpoint, 35 mechanisms were introduced to them in the form of a table. The farmers were then asked to express their views about each mechanism in a Likert 5 Point Scale (from very low to very high). Then the mean and standard deviation of their responses were calculated from the scores assigned to each item, attributing a score to each answer from 1 (very low) to 5 (very high). Coefficient of variation was obtained by dividing the standard deviation to the mean value. The items could subsequently be ranked in terms of the coefficient of variation for each. The less the coefficient of variation of an item, the more important that item would be in the ranking. Table 2 shows the 3 most important items (mechanisms) from the farmers' point of view that could improve water management in their area as: changing traditional irrigation methods into modern techniques, avoiding irregular well digging, and attending educational-extension classes on optimum water management.

Table 2: Prioritizing Effective Mechanisms for Water Management Improvement from the Res pondents' Viewpoint

Items	Mean Value	Standard Deviation	Coefficient of Variation	Rank
Changing traditional irrigation methods into modern techniques	4.687	0.543	0.116	1
Avoiding irregular well digging	4.669	0.574	0.123	2
Attending educational-extension classes on optimum water management.	4.578	0.585	0.128	3

3. Inferential Statistics

In this study, the purpose was to perform factor analysis to summarize the mechanisms that could be used for better management of Tehran Province water resources. So, 35 mechanisms were introduced to farmers in the form of a table. They were then asked to express their views about each mechanism in the form of a Likert 5 Point Scale. The suitability of the data for factor analysis was established through KMO statistics and Bartlett's Test. The obtained KMO value was 0.856 and the significance level of Bartlett's Test was less than 0.01. Both these values indicated that the extracted data were suitable for factor analysis. An important point in factor analysis is the number of extractable factors. In Table 3, these factors are presented along with the corresponding specific value, variance percentage, and accumulated variance percentage values for the effective mechanisms of management improvement.

Table 3: Extracted Factors with their Specific Value, Variance Percentage, and Accumulated Variance Percentage Values

Item	Factors	Specific Value	Variance Percentage	Accumulated Variance Percentage Values
1	Educational-Extension Activities	4.129	18.78	18.78
2	Preventive Measures	3.765	15.56	34.34
3	Managerial Measures	3.345	12.60	46.94
4	Executive Measures	2.558	9.55	56.49

As shown in Table 3, there are four improvement mechanisms (factors) which explain 56.49 % of the total variance. The Educational-Extension mechanisms, as the most important factor with a specific value of 4.129, account for 18.78% of the total variance. The other three factors, namele, Preventive Measures, Managerial Measures, and Executive Measures explicated 15.56, 12.60, and 9.55 percent of the total variance respectively. Table 4 represents each factor with its associated variables and their factor loading.

Table 4:

Mechanism	Item	Factor Loading
Educational-Extension Mechnisms	Attending Educational-Extension Classes on Agricultural Water Management	0.846
	Applting New Irrigation Methods with Higher Efficiency Recommended by Experts	0.790
	Heeding the Educational-Extension Recommendations by Experts on Optimum Utilization and Management of Wells	0.651
	Cooperation with Other Farmers in Utilizing Water and Maintaining Canals	0.612
	Using the Experiences by other Farmers who already Use Modern Irrigation Systems	0.578
	Applying the Cultivation Models Recommended by Experts	0.509
Preventive Mechanisms	Using Irrigation Systems in accordance with Climatic and Topographic Conditions of the Area	0.712
	Avoiding Unnecessary Digging of Wells	0.703
	Making the number of Wells Proportional to each Farmer's Farming Area	0.634
	Observing Distancing and water right for each Well	0.621
	Avoidding to use Well Water that is too Salty/ Using Permits for Displacement and Digging of New Wells	0.587
	Observing Proportion between the amount of Extracted Water and the Farming Area	0.553
	Suitable Canal Design for Carrying the Specified Water Volume	0.539
	Avoiding Day-Time Irrigation to Prevent Direct Evaporation	0.518
	Avoiding Day-Time Operation of the Winch Motor when Evaporation is at its Highest and Waterlevel at its Lowest	0.506
Managerial Mechanisms	Replacing old Irrigation Methods with Modern high efficiency Methods	0.722
	Implementation of Frugal Irrigation Methods to Increase Productivity	0.717
	Implementation of Alternation if Farming to Preserve Soil Moisture	0.693
	Combination of Salt and Fresh Water in Irrigation Irrigation	0.622
	Implementation of Agricultural sewage for Re-Irrigation	0.567
	Irrigation of Plants according to their Water Needs/ Studying Water Requirements for each Plant	0.533
	Controlling Growth of Weeds	0.524
	Using more than one person for Irrigating at night to Prevent Water Loss	0.510
Executive and Operational Mechanisms	Artificial Feeding of Subterranean Waters	0.617
	Regular Inspection of Canals	0.601
	Construction of Concrete Canals with Polyethylene Pipes to Reduce Water Penetration/ Improve Efficiency	0.588
	Dredging of Canals to Prevent Water Loss	0.579
	Using Motor Winches to Increase Efficiency of Pumping Subterranean Water	0.563
	Regular Repair/Maintenance of Canal Linings	0.534
	Land Integration and Leveling to Reduce Water Loss in Farms	0.525
	Eliminating the Bends along Traditional Canal Ways	0.519
	Covering of Waterways in places where Water Loss is evident	0.513
	Installing Flow meters on Wells to determine the amount of Allowable Water for each Farmer	0.507
	Conducting Soil Texture Tests to Determine the type of Soil and the amount of Water Required by it	0.501

Discussion

Today, in many scientific, as well as policy-, and decision-making circles, management of water resources is a hot topic for discussion. This is due to the fact that in many parts of the world, water shortage and problems associated with low productivity water consumption are acute. Among the most important topics discussed are the machanisms that could be used to improve water resources management. In this study, an effort was made to investigate some of these mechanisms which can be categorized as follows: 1) Educational-Extension Mechanisms, which are activities promoted for improving farmers' knowledge, skills, and managerial insight into water consumption in an effort to improve water resources management by the relevant organizations in charge of agriculture, and can include the following items: farmers' attending educational-extension classes held by the agricultural mobilization organization om water management, employing new higher efficiency irrigation techniques recommended by experts and heeding these recommendations, learning from the experiences of other farmers who already use modern irrigation methods, etc. These mechanisms can assist farmers at the time of water shortage or other problems associated with bottle necks of optimum water management. Therefore, these mechanisms can, due to the support they receive from authorities and in particular the management of agricultural mobilization organization, play an important role in improving water resources management in agriculture. 2) Preventive Mechanisms which are the measures taken before the occurrence of accidents or natural disasters in order to prevent their occurrence or alleviate their negative consequences. The cost of such measures is usually far less than the inevitable costs one has to pay if those events actually happen. Some of these preventive mechanisms are as follows: Using Irrigation Systems in accordance with Climatic and Topographic Conditions of the Area, Avoiding Unnecessary Digging of Wells, Making the number of Wells Proportional to each Farmer's Farming Area, Making the number of Wells Proportional to each Farmer's Farming Area, Avoiding to use Well Water that is too Salty/ Using Permits for Displacement and Digging of New Wells, Suitable Canal Design for Carrying the Specified Water Volume, Avoiding Day-Time Irrigation to Prevent Direct Evaporation, Avoiding Day-Time Operation of the Winch Motor when Evaporation is at its Highest and Water level at its Lowest, etc, 3) Managerial Mechanisms which include a series of innovative measures on the farmers' part for better management of water at farm level, such as: Replacing old Irrigation Methods with Modern high efficiency Methods, Implementation of Frugal Irrigation Methods to Increase Productivity, Implementation of Alternation if Farming to Preserve Soil Moisture, Combination of Salt and Fresh Water in Irrigation, Implementation of Agricultural sewage for Re-Irrigation, Irrigation of Plants according to their Water Needs/ Studying Water Requirements for each Plant, Controlling Growth of Weeds, and Using more than one person for Irrigating at night to Prevent Water Loss. And Finally, 4) Executive and Operational Mechanisms which are measures taken at a practical level by farmers to better manage water resources, and include the following: Artificial Feeding of Subterranean Waters, Regular Inspection of Canals, Construction of Concrete Canals with Polyethylene Pipes to Reduce Water Penetration/ Improve Efficiency, Dredging of Canals to Prevent Water Loss, Using Motor Winches to Increase Efficiency of Pumping Subterranean Water, Regular Repair/Maintenance of Canal Linings, Land Integration and Leveling to Reduce Water Loss in Farms, Eliminating the Bends along Traditional Canal Ways, Covering of Waterways in places where Water Loss is evident, Installing Flow meters on Wells to determine the amount of Allowable Water for each Farmer, and Conducting Soil Texture Tests to Determine the type of Soil and the amount of Water Required by it.

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