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Identification and Prioritization of Factors Influencing Agricultural Water Price Index from Farmers' Viewpoint in Charkhab Village, Yazd Province

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Abstract

Arid and desert lands in terms of specific environmental characteristics such as low annual precipitation, sequential droughts, huge drop in ground water levels or the like, have always faced strict limitations in water resources. In the shadow of these characteristics and many other factors, Water Price Index (WPI) is significantly affected. This study set out with the aim of identifying and determining the priority of factors influencing Agricultural Water Price Index (AWPI) in arid and desert lands from farmers' point of view. The Charkhab village in Yazd province was selected for this study. Detailed field surveys using structured questionnaires were considered with the statistical society comprising the whole of the farmers of the village. The identification of the influential factors is done by means of reviewing the literatures and eliciting experts' opinions. We implicated the factor reduction and analyzing frequency distribution and CV correlation methods. Data interpretation was carried out by using SPSS software. The results of the factor analysis method have revealed 9 important factors being accounted for 92.06% of the variance. From 26 detected variables, "constructing and expanding greenhouses" are the most influential factors according to the farmers' responses. Moreover, from other cases investigated lower ranks are assigned to the role of well costs, water supply costs and agricultural input costs.

Keywords: Water pricing index; Farmers' viewpoint; constructing and expanding greenhouses; water supply costs; Charkhab village

1. Introduction

Mankind has always been in struggle with nature for survival amongst which challenging for water is first and foremost. Population growth and accordingly escalation in water demand in agricultural, industrial and domestic sections have made us incapable to fill the need for fresh water. The trend in renewable water amount per capita in Iran shows a serious increment from 5500 m^3 in 1961 to 2100 m^3 in 1997 and it is estimated that the amount would reach 1750 m^3 in 2006 and 1300 m^3 in 2021 respectively (The National Committee of Irrigation and Drainage, 2000). This trend, in the case of agriculture which is accounted for 90% of potential consumption of the current amount of water, would raise a serious trouble (The Scientific Council of Investigation of Iran, 2002). With respect to the status quo of water consumption ratio and the current population growth rate, it is estimated that the water demand of the country would stretch up to 1260 billion m^3 and 1400 billion m^3 in 2011 and 2021, respectively, which is 15% greater than the current capability of renewable water resources (The National Committee of Irrigation and Drainage, 2000). In spite of these limitations, no commitment for a better exploitation of water resources in this country is reported to date and each year a huge volume of water is wasted away from the ground and underground reservoirs. Water shortage and

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many other factors get water price increased. This situation could be partially associated with direct factors influencing water price and sometimes with specific environmental conditions and unknown factors. Readers may have come across literatures studying water price index from many aspects and by many different methods; for example, in some cases, WPI is calculated by mathematical approaches and in some other cases WPI is calculated in terms of final cost.

The shared dimensions with the aforementioned studies consist of methods and techniques in water pricing (volumetric and non-volumetric methods) - pricing with the objective of a better water allocation- water pricing with respect to supply and demand- water tariff and tax and finally the assessment of pricing tool as a water consumption controller. However, far too little attention has been paid to the description of the issue from farmers' point of view. Farmers as the major beneficiaries of water, who provide the society with its rudimentary need viz. food, play a vital role in water pricing. This paper seeks to identify different factors influencing WPI. Secondly, identification and investigation of the factors in an arid and desert situation is considered.

In deserts and Kavirs, the milieu itself gives an account of the must-be-considered factors which indirectly, while interconnected, impose changes to water price. The region of study was selected Charkhab village in Yazd province, Iran. Yazd province owing to its location in central Iran plateau in the vicinity of Kavirs, is regarded as a water stressed region. Alongside water shortages, this province faces nature constraints like sequential droughts and so forth. Investigating water price in such an environment is mostly neglected. Moreover, national priorities to achieve self-sufficiency of food grains and stable food prices are influencing the political will of many governments in setting realistic irrigation water prices demonstrating its true value. Therefore, greater effort is needed to upgrade farmers' appreciation of the need and necessity to pay for irrigation water and acceptance of the modified situation if they wish to receive the services on a sustained basis (Sindhu, 2010).

The objective followed, is to prioritize extracted factors from farmers' point of view. As noted, with regarding to the vital role of water pricing in the context in and out of the country, however, rarely have literatures been involved with the important factors forming agricultural water pricing from farmers' pint of view. The various methods included in the pricing process and the critical ones are identified. Then extracted factors from farmers' viewpoint will be categorized and prioritized according to statistical methods. In a study named "identifying best method in agricultural water pricing" the ways of gaining water price is classified into volumetric and non-volumetric methods and non-volumetric method itself is further sub-divided into tiered pricing and double tariff (multi tariff) pricing. In volumetric method, water price is calculated regarding water volume, so the consumed water for every farmer is estimated whereupon various facilities for accurate measurement of water volume is required and the costs of water purvey and transmition should be included. Volumetric tiered pricing is calculated, when water flow is constant by some reasons, by measuring water volume per time (Hosein zad, 2004). Comparative cases are found in Maharashtra (India), Morocco, Spain and Columbia (Easter et al., 1997). In a study about losses, limitations and agricultural water price, it is expressed that the water price coverage doesn't include harvested crop, cost of water and social costs. The author claims that the only way to reduce losses is to apply proper volumetric methods or measure with water meter (Zafar nejad, 1996). Multi tariff method is applying in order to adjust volumetric method and here water price is determined when consumption surpasses the threshold. In addition to the calculation of water price according to consumed volume, when the costs is lower than average, a constant price is received from beneficiaries because of branching rights (Laffant and Tirol, 1994). This is due to capital costs in long run. In Turkey and Spain the method is being applied (Mohammadi Nejad, 2001). In cases where volumetric method is not feasible, non-volumetric methods are introduced. Deferent methods are popular in the context such as, output pricing, input pricing and goods quality. After determining water price and farmers' share, the shares would be gained considering common characteristics of agriculture in the region (e.g. the crop, irrigation methods, cropping pattern; and yield) (Laffant and Tirol, 1994).

The most common non-volumetric method is areal method. In this method different prices are regarded according to farm's area for each crop (i.e. different water prices are set for each crop) by which farmers are tended toward feasible crops (resistant to drought) and in response, the consequent demand would decrease (Mohammadi Nejad, 2001). In a study about agricultural water pricing, the volumetric methods or marketing is highlighted when we want to decrease the demand in agriculture section (Bosworth et al. 2002). In dams facilities the price is calculated regarding net costs or in underground waters (wells and Qanats) the pricing is done considering extraction and distribution costs (Hosein zad, 2004). In sarvestan, fars province the same method is applied where pricing is taken into account water purvey (investment and current costs), total costs of wells, average water volume in every well, capital return, water unit price (Marvdashti and Farhood, 1996). One outcome of Sadr (1996) research is water pricing algorithm and as the author says, water pricing will be fair if all water-based output marketing considers water added value, wherein the price is determined regarding water scarcity or production cost. In another paper named The effects of spot water markets on the economics risk derived, they assert that water pricing according to marketing is optimum, means that for a suitable pricing and to form economical price, market is necessary (Calatrava and Garrido, 2003). The substance of Bohloulvand‘s (2006) could be summarized that even in Jordan or Morocco suffering strict water scarcity, water pricing is associated with the capital return and also water market and transfering water rights.

2. Materials and methods

This research was implicated on a region, 7 km away from Yazd city between 229704.4–236247.1N and 3536794.5 – 354508.7E. (Fig. 1). This region has 1195m altitude and the climate is defined as arid and semi-arid. The method used here according to the stated goals is practical. Methods such as questionnaire survey, interviews with stakeholders, interview with interested groups and expert consultation will be adopted to analyze and evaluate farmer's viewpoint. The sampling being carried out in this study is based on census. Questionnaires have been applied here in which statistical society covers all of the farmers in Charkhab village. The aim of choosing the whole of society is to gain precise data. Determining all of the factors influencing agricultural water price has been possible doing direct interview with a group of deans in the village. 26 influential indicators from non-important (0) to completely important (5) have been elicited. The participants filled the questionnaires. The experts of the department of natural resources tested the validity of the indicators. Some suggestions came from them that were taken into account. Presented paper uses Koronbach alpha test to test the validity. In 30 questionnaires, the coefficient was determined to be 0.92 showing a good conclusion. In order to categorize the factors, factor analyzing was applied. The aim of this test is to elicit some important factors among a confusing set so the missing data would be negligible. This is a test where all of the factors are taking into account altogether and each one is regarded as an independent factor (Kalantari, 2006). If the value is smaller than correlation of variation (CV), value the inherent effect on water price escalation will be higher (Kalantary, 2006). Aforementioned statistical analysis has been carried out with SPSS. Factor analysis, frequency distribution analysis (Correlation of variation) has been included in Moradnejad et al. (2007), Akbari and Asadi (2007).

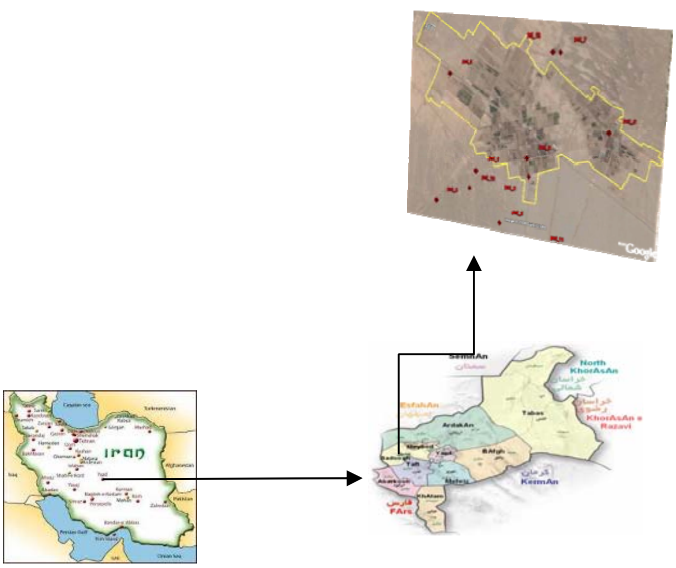

Fig. 1. Map of the study area with the target community indicated in the upper part of the inset

3. Results

In order to clarify the suitability of data for factor analyzing, KMO correlation and Bartlet test are applied. If KMO exceeds 0.7, the data is suitable. Bartlet test examines current correlation in such a way that these are belong to an independent society (Kalantary, 2006). The KMO and Bartlet measures are presented in Table 1 in which KMO shows the suitability of the data for factor analyzing and the Bartlet shows that the test is meaningful in 1% probability.

Table 1. KMO measure – Bartlet test

Factor analysis	KMO	Bartlet test	SIG
Indicators influencing AWPI	0.86	358.456	0.000

Table 2 shows the number of identified factors besides the related measures, variance percentage and cumulative factors' variance. The measures explain the share of each factor versus total variance. The all measures are greater than one so they all seem to be meaningful. The first factor with a share of 16.94% has the highest effect and the ninth factor with a share of 6.46% has the lowest measure among all and totally 9 factors could be accounted for a share of about 92.06% of total variance influencing Charkhab's water price index (Table 3).

Table 2. The number of identified factors along with specific measures, variance percentage, and cumulative variance percentage

Factors	Specific measures	variance percentage	cumulative variance percentage
Acceptance of new modern culture	2.880	16.940	16.940
Hydrological characteristics of the village	2.305	13.558	30.498
Special and infrastructural characteristics of the village	2.240	13.171	43.669
Mismatch between area under cultivation and available water	1.879	11.054	54.723
Agricultural water costs	1.440	8.467	63.190
The role of institutions authorized to manage water	1.363	8.017	71.207
Irrigation factors	1.321	7.767	78.974
Well costs	1.127	6.626	85.6
Agricultural inputs costs	1.100	6.468	92.068

Table 3. Related Indicators and factor weights according to Verimax method

Extracted factors	indicators	Factors' weight
Acceptance of modern cultures	Acceptance of greenhouses and developing them	0.983
	Type of products cultivated in the village being low in water consumer	0.960
	Farmers high operation	0.846
Hydrological characteristics of the village	High quality of water of the wells	0.880
	High discharge of the wells	0.865
	Continued discharge of well throughout the year (availability of water throughout the year)	0.850
Spatial and infrastructural characteristics of the village	Vicinity of the village to markets	0.772
	The role of water channels in decreasing losses	0.754
	Fertility and quality of soil in the village	0.744
Disproportion of cultivated area and water	Increasing cultivated area beside constant well discharge	0.778
	Fragmentation of cultivated areas (Long way for water to be transported)	0.773
	Decrease in water supplies during drought period and the related effects on irrigation of cultivated areas	0.770
Agricultural water costs	Final costs	0.780
	Month to month constant lease's rent	0.738
Institutional role in water management	The role of Mirab	0.745
	The role of Manager and Accountant	0.530
Irrigation factors	The role of the type of irrigation circle comparing with other villages	0.733
	The role of the number of irrigation for different crops	0.720
	The role of irrigation duration time	0.698
	The role of modern irrigation techniques	0.680
Well's costs	Cost of water transportation from well to farm	0.720
	Initial investments	0.588
	Depreciation costs and annual maintenance costs (current annual)	0.535
Agricultural input costs	Labor and human force costs	0.515
	Costs of machines and agricultural gears	0.480
	Pest management, fertilizer and seed's costs	0.444

Factor analyzing results (Table 3) result in 9 factors as the main factors influencing AWP in Charkhab village. In this classification, some indicators fall into one factor. The highest factor weight is accordant with “Acceptance of greenhouses and developing them”. In other words, the role and impact of greenhouses construction on water price in Charkhab, is in the first place. The question is, despite other important and influential factors (which considered by local relevant organization) why does this factor shows the utmost importance? The answer is, in deserts, water is a rare gem and farmers with appreciation of this factoid use it as sufficient as it could be. High performance of crops in greenhouses and respective water efficiency causes great acceptance in recent years by producers. Results of comparing net income (net profit) for three crops include cucumber, pistachio and pomegranate stating that one-hectare greenhouse cultivation worth 10.5 hectares pistachio and 15 hectares pomegranate for farmers (Islami, 2008). The author also believes that the water needed for each kilogram pistachio equals 4 times and 125 times greater than pomegranate and cucumber respectively. Nevertheless, one should bear in mind that hydrological characteristics play an important role either. High discharge of wells (110 liter/sec) beside other characteristics such as low EC (according to author) which is suitable potable water for local people make cultivation go on even in drought and this little dilemma at first, finally result in a huge drop in water tables. The potential of this village along with good geographic location and vicinity to markets, fertile soil and infrastructures like water channels lead to an sharp increase in water value in recent years. Clarifying the matter, we point out to some interchanges during 10 years in Charkhab village. In 1998, 10 Ghafiz (1000 m^2) and 1 hour water was exchanged for 3200 $ (taking 1 dollar equal to 10000 Rials (Iran monetary unit). In 2002, 25 Ghafiz pistachio orchards with 0.5 hour water were exchanged for 18000 $, hence, in 2005 the price became 110000 $. It means that during 3 years, the price is tripled. In 2008, 45 Ghafiz pomegranate and pistachio orchard with 2 hours water were exchanged for 360000 $ from which 120000 could be excluded for water price. Water price equal to 60000 $ each year is obvious. The exchange of water hour is rare but hour renting is common among local people. Unlike selling water, constant water rent for each hour is low about 2.4 $ (Adopted from direct interviews with local people and Mirab of Charkhab’s wells). This shows unfair pricing. These cases cause water cost to be neglected. One of the main reasons why water pricing is not fair is the lack of proper authorized organization to do the pricing. A powerful and independent organization must be included for making a competitive marketing for balancing water’s supply and demand (Bohloulvand, 2006). The lack of such an organization leads to put the inherent factors in water pricing in lower places than the subsidiary factors. For example, the role of water cost, irrigation factors (number of shares, irrigation duration time and …), capital costs (depreciation cost, annual maintenance, water transportation cost), are discerned obscurely among nine other factors. However, in a torrent of literature these factors distinguished as the main ones. For instance, it is argued that for extracted water (from well and Qanat), the price is based on the costs of extraction and transportation from well to farm (Hoseinzad, 2004). However, among effective factors influencing water price, a relationship between water input and other inputs is established. The prioritization is summarized in Table 4.

As explained earlier, in this study we use correlation of variation (CV) as a means for prioritization process. Increasing one to 26 in CV shows the reduction of effectiveness. The foundation of the prioritization is upon farmers’ opinion. The order of importance from one to 26 shows that farmers do not consider them as the main factors and the closer to the end of table, the less important they are. The total arrangement of the indicators confirms Table 3 results. In some cases, some factors with respect to farmers’ opinion are more important. In this table constructing greenhouses and developing them is considered as a unique one. The high discharge of the wells and high quality water of the village are in the following order of importance. The role of Mirab in Charkhab village is highlighted in this prioritization. Ownership of water, measuring water, allocation and distribution of water rights, rent, water buy and sell are in the point of focus for Mirab in the village. At the bottom of the table the role of agricultural input costs and investment are brought.

4. Discussion and Conclusion

The aim of this study is to classify and prioritize the influential factors on AWP. It seems that according to climate characteristics dominated desert regions, factors determined by farmers are a twisted set. The final goal is to help sustainability of farmers’ life against restrict condition of nature. In the middle of water limitation, the focus is on crops having low water demand. According to high performance of modern cultures, constructing greenhouses and developing them in Charkhab village is intensified. Mohammadi Nejad (2001) in his study explains that water distribution organizations can pursue farmers to alter their crops into drought resistant ones. This approach is in line with keeping efficiency in water supplies exploitation.

Table 4. Prioritization of the effective factors influencing AWPI from perspective of Charkhab's farmers

	The prioritization	Mean	Correlation of variation
1	Constructing and developing greenhouses	4.78	0.11
2	High discharge of wells	3.98	0.22
3	High quality of water	3.88	0.24
4	Field capability and high quality crops of the region (Performance)	3.75	0.24
5	Water shortages due to drought in Yazd province	3.51	0.25
6	Kind of crops cultivated in the region according to water consumption	3.49	0.30
7	Continued discharge of well throughout the year	3.47	0.30
8	The role of Mirab of the well	3.44	0.31
9	The role of vicinity to local markets	3.40	0.34
10	The role of water channels in decreasing water losses	3.38	0.36
11	Fertility and quality of soil in the village	3.37	0.37
12	Effect of irrigation duration time	3.40	0.37
13	Increasing cultivated area beside constant well discharge	3.31	0.38
14	Cost of water transportation from well to farm	2.78	0.38
15	The role of the multiplicity of irrigation for different crops	2.85	0.39
16	The role of water extraction costs from wells and Qanats	2.70	0.39
17	The role of modern irrigation techniques	2.68	0.39
18	Total water costs	2.43	0.42
19	The role of the type of irrigation circle comparing with other villages	2.38	0.44
20	The effect of different types of cultivation	2.40	0.48
21	The role of number of irrigation	2.12	0.48
22	Month-to-Month lease's rent	1.82	0.56
23	The role of labor costs	1.74	0.57
24	The role of capital costs and current annual costs	1.66	0.57
25	The effects of pest management, fertilizer and seed costs	1.54	0.58
26	The role of Manager and Accountant	1.50	0.58

For farmer, crop without ease of access to markets have no merit. The geographic situation of the village (vicinity to local markets) beside fertility and diversity of soils for different cultures are among other factors make water and farm customers' attention to the village and for this reason, we face unmitigated increasing trend in price. This is consistent with Safi Nejdad (1996). According to the author, Mirab have an important role in irrigation system since have a great part in fair allocation of water, supervision and regulation of water distribution. Table three shows different factors such as transportation from well to farm, water extraction and other ones like final cost of water and month-to-month rent which are in lower order of consideration. The results of present paper are completely consistent with Zafar Nejad (1996). While it seems that water price comes from water cost, but farmers have less emphasized it. So we suggest that the price should be determined in a manner that showing water scarcity. Marketing mechanism has a greater potential in effective water pricing (Bohloulvand, 2006). However, in Charkhab village, water is exchanged traditionally. Some authors (Sadr, 1996; Calatrava & Garrido, 2003; Bohloulvand, 2006) have emphasized the importance of market in effective water pricing and in Charkhab village, establishing and organizing an institute ordering water distribution seems necessary. The role of irrigation duration time is put after other indicators like vicinity to local markets, the role of water channels, fertility and proper quality of soil and before some indicators like water transportation. In charkhab village, the rent of water is determined according to irrigation duration time. According to Mohammadi Nejad (2001), water pricing regarding irrigation duration time is one of the non-volumetric methods in agricultural water pricing. The mismatch between cultivated area under constant discharge from wells is among indicators which has a positive effect according to farmers' opinion. Definitely, along with decrease or increase in cultivated area, transportation way, drought occurrences and related reduction in water supplies, water price is affected positively or negatively which regulate irrigation consequently. In a study carried out by Behbahani (1994), the author explain that pricing according to cultivated area is of no use, which itself need further investigations. From other cases investigated in this study, the role of well costs (transportation, initial investments and annual current costs) is noteworthy. Our work show that the role of transportation from farmers' perspective has less important. In Marvdashti and Farhoud's research (1996), water supply cost is evinced useful in water pricing per cubic meter. Not to be tangible, the effects are considered of low importance, hereupon, further investigation seems essential. Given farmers opinion, the role of subsidiary factors is slight in water pricing. For gaining more precise results, supply and demand function, which is available in most econometrics ways, might be useful in handling mutual relationships between different kinds of agricultural inputs such as fertilizer, gears, water and so forth (Hosein zad, 2004). For example, the analysis of the results indicates in the Hamadan-Bahar plain show that water pricing by itself can considerably reduce the agricultural demand for exploitation from aquifers (Balali et al., 2011)

With respect to farmers' perspective in Charkhab village, the authorities can take into account their opinions into decision making and orientating. As we learned our lessons from experiences, considering people opinion into policy-making and decision-making, leads to a more sustainable result. In this context, present study is derived from hard worker farmers in agriculture section and main stakeholders of agricultural water and yet hope remains, that our consequences would be inspirational for authorities.

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