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Water Saving and Irrigation Water Pricing Approaches in Agriculture

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Abstract

Decreasing available water resources in the face of increasing water demand in the world makes it necessary to prevent excessive water use. As in many countries, most of the water is also used for agriculture in Turkey. Despite the use of excess water in agriculture, high yields cannot be obtained due to high water losses.

Measures can be taken for water saving in agriculture such as application of pressure irrigation methods, establishment of closed water conveyance and distribution systems, use of treated wastewater, harvest of rain water, farmers training. Pricing of irrigation water is the most important tool, especially in preventing excessive water use. In the studies conducted, it was determined that the water is overused than used as needed in the irrigation schemes, which the farmers are given water free of charge. At the 1992 Dublin Conference, it was accepted that water was a commodity and that it should have a price. Since then, the price of irrigation water has been determined in different ways in each country. In this study; Water saving in agriculture and irrigation water pricing approaches are discussed.

Keywords: Water saving, irrgation, wastewater.

Tarımda Su Tasarrufu ve Sulama Suyu Fiyatlandırma Yaklaşımları

Öz

Dünyada artan su talebi karşısında kullanılabilir su kaynaklarının giderek azalması, aşırı su kullanımının önlenmesini zorunlu kılmaktadır. Birçok ülkede olduğu gibi ülkemizde de en fazla su tarımda kullanılmaktadır. Tarımda fazla su kullanılmasına rağmen yüksek su kayıpları nedeniyle yüksek verim alınamamaktadır.

Tarımda su tasarrufu için basınçlı sulama yöntemlerinin uygulanması, kapalı su iletim ve dağıtım sistemlerinin tesis edilmesi, arıtılmış atık suların kullanımı, yağmur suyu hasadı, çiftçilerin eğitimi gibi önlemler alınabilir. Özellikle aşırı su kullanımını önlemede, sulama suyunun fiyatlandırılması en önemli araçtır. Yapılan çalışmalarda, çiftçilere suyun ücretsiz verildiği sulama şebekelerinde, suyun gereğinden fazla ve kullanıldığı saptanmıştır. 1992 Dublin Konferansı'nda suyun bir meta olduğu ve bir fiyatının olması gerektiği kabul edilmiştir. o tarihten beri, her ülkede farklı yöntemlerle sulama suyu fiyatı belirlenmektedir. Bu çalışmada; tarımda su tasarrufu ve sulama suyu fiyatlandırma yaklaşımları tartışılmıştır.

Anahtar Kelimeler: Su tasarrufu, sulama, atık su

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1. Introduction

Water is also the basic element of food production as it is life of the living thing. Despite the increase in food demand with population growth, the quality of water resources is deteriorating for various reasons and the amount of water available is gradually decreasing. In this case, the agriculture sector competes with other water user sectors. In this case, the agriculture sector competes with other water user sectors. The first priority in meeting water demands is for the drinking and domestic water needs of the individual, and the second priority is given to the agricultural sector. Getting limited available water resources, both in terms of quantity and quality, water saving is required. As in developing countries, the most water user sector in our country is agriculture. For this reason, it is required to start with agriculture in order to save water.

Increasing agricultural production and productivity are needed to ensure the sustainability of food supply for the growing population and agricultural production. In the 21st century;this situaition is getting the countries directed new technologies to use water resources in order to increase and utilize effective and sustainable use efforts [1].

The average annual rainfall in our country is 642.6 mm. The amount of underground and surface water that can be consumed economically is 112 billion m^3. In our country, 28.05 million hectares of arable land can be irrigated to 25.75 million hectares. With the available water potential, the amount of land that can be irrigated technically and economically is 8.5 million hectares. As of the end of 2015, the total irrigated area in our country is 6,225 million hectares. 3,935 million hectares, 63% of this area, have been irrigated by DSİ. Under current conditions, approximately 73% of the 8.5 million hectares of land economically irrigable in our country are irrigated [2].

The most important of the water use indicators in irrigation is irrigation efficiency. Irrigation efficiency is approximately 40% for surface irrigation, 70% for sprinkler irrigation and 90% for drip irrigation. In other words, in surface irrigation, only 40% of the water deviating from the water resource is available by the crops and 60% is lost in various ways. With pressurized irrigation methods, the need for irrigation water is reduced and the water used in the irrigation can be saved by 50% [3]. Most of the developing countries where water is used the most in agriculture; measures are taken to ensure water saving in agriculture [3]. These measures include; use of pressurized irrigation methods, treatment of wastewater in irrigation, pricing of irrigation water, water harvesting, desalination. When irrigation water is priced, it is used more consciously and less. Water for agriculture is available for free or low price until the 1990s. For the first time, at the 1992 Dublin Conference, it was accepted as a principle that every drop of water was regarded as a commodity. Since then, water-saving irrigation technologies and water pricing have gained importance all over the world. International organizations such as FAO, IWMI and ICID (United Nations Agriculture and Food Organization, International Water Management Institute, International Irrigation and Drainage Commission) have adopted the principle of "more products for every drop of water".

In this study; water saving in agriculture and pricing of irrigation water was mentioned.

2. Water Resources and Use in Turkey

It is targeted that our country will develop the entire amount of 112 billion m³ water with economical potential until 2023 (Figure 1). 8.5 million hectares of economically irrigable land in our country are projected to be irrigated until 2023. Turkey's goal is to reduce the rate of consumption of irrigation water to 65% using modern irrigation techniques. Thus, 72 billion m³ of water will be used per year in agriculture [3].

Approximately 39% (44 km3) of 112 km^3 water is used in our country, which can be used technically and economically. 32 km^3 of this is in irrigation, 7 km^3 is in domestic and drinking needs and 5 km3 is consumed in the industry. In other words, about 73% of the water resources in our country are used on agricultural irrigation, 11% on industry and 16% on domestic use.

In irrigation networks where water conveyance and distribution are made in open channels and canals, water losses are quite high. To prevent this, piped water distribution network is used in newly constructed irrigation projects. Only friction losses occur in pipe systems. This is at a low enough level to ignore. Therefore, in pipe systems; water losses are minimized, saving water [3].

Modern irrigation techniques are supported through grants with the "Support for Rural Development Investments" project initiated by the Ministry of Food, Agriculture and Livestock in 2006. Since this date, the primary objective is effective use of water, drip irrigation method is used for vegetables, field crops, fruit trees and vineyards without regard to the plant [4]. "Rural Development Investments Support Program" is carried out by the Department of Land Improvement and Irrigation Systems of the Ministry of Food, Agriculture and Livestock. Within the scope of the program; Based on the decision of the Council of Ministers on Agriculture Strategy 2006-2010 Document and Rural Development Investments 2006/10016, Individual Irrigation Machinery and Equipment Supports are implemented in 81 provinces. Credit is given to farmers to establish drip and sprinkler irrigation system under the framework of the program.

Support issues for individual irrigation machinery and equipment are comprised of establishment of in-field drip irrigation system, establishment of in-field sprinkler irrigation system, establishment of in-field micro sprinkler irrigation system, purchasing of a linear system sprinkler irrigation machine, purchasing of center pivot irrigation system, purchasing of sprinkler irrigation system with a drum system, establishment of solar powered irrigation systems [4].

According to the data of the Turkish Statistical Institute, the population of Turkey is estimated to reach 100 million by 2030. In this case, it can be said that the amount of usable water per capita for 2030 will be about 1,100 m^3 / year.

In one country, the most reliable indicator of whether water resources are adequate, is the annual amount of renewable fresh water. Countries that use less than 1000 m^3 per person per year in terms of water are "poor water"; those who use between 1000-3000 m^3 are "water-stress-stressed country"; those who consume more than 10 000 m^3 of water are considered "water rich". According to this, Turkey is in the group of countries suffering from water shortages. In 2030, it can be said that the amount of usable water per capita can be 1120 m^3 / year if the population reaches 100 million. [4] (Figure 1)

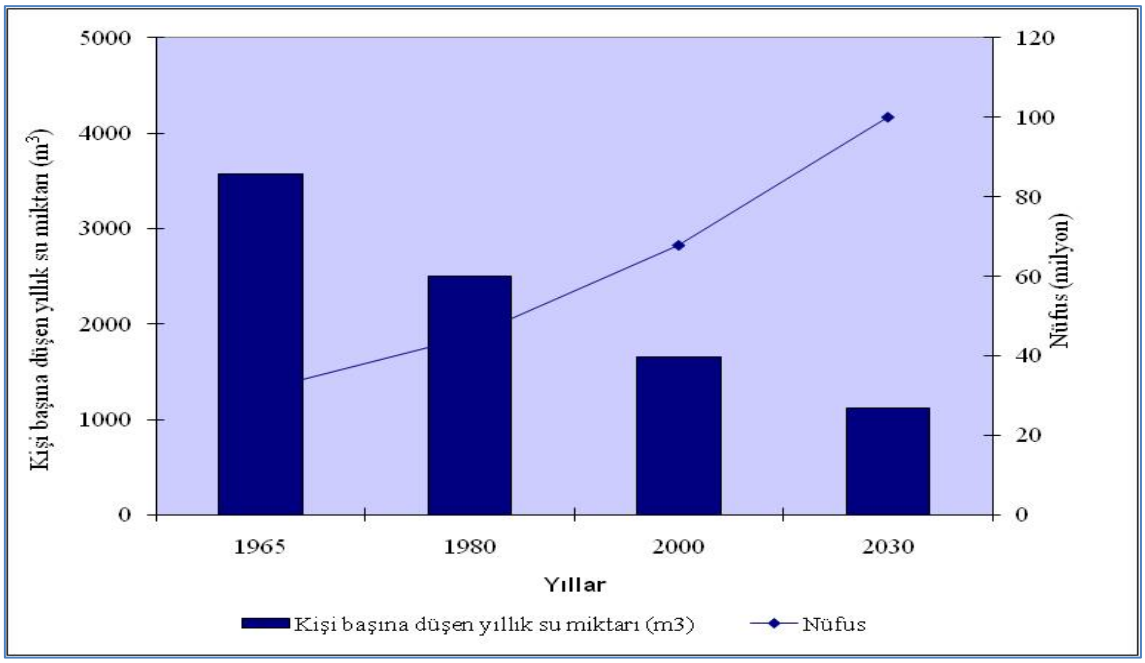

Figure 1. Population and the annual amount of water per capita in Turkey.

3. Irrigation Water Pricing Approaches in Agriculture

Usable water is gradually decreasing due to population increase, climate change, pollution of water resources. Reducing water increases "water shortage risk" day by day. From this point, water pricing have a great importance.

Water is given to farmers in some irrigation schemes at low cost or as a free service. It is stated by the World Bank that water fee cannot be collected even in places where the water fee is low. In such places, farmers receive irrigation water without paying the price. Water saving is not encouraged in countries such as Egypt and Albania where water is provided free of charge. Conversely, volume-based pricing approaches have been introduced to provide water conservation in Israel [5].

Aküzüm et al. [6] stated that the keeping of the water register and the application of the polluter pays principle should be required for the realistic pricing of the water. It is emphasized that national water policy should be established for effective and sustainable management of water resources.

Hazneci et al. [7] performed a study in the provinces of Samsun, Antalya, and Çanakkale in order to find an answer to question whether irrigation water will be left to the free market and proposed a model for pricing. In the study, volume water pricing, product-based pricing and site-based pricing were evaluated. It has been stated that pricing of irrigation water in Turkey cannot be done in free market conditions yet.

Aydoğdu et al. [8] have found out the views of the head of the 22 irrigation associations in Harran Plain on water management, operation and pricing. They conducted questionnaire with the president of the irrigation associations by face-to-face interview. In these surveys; It was determined that the current construction could not respond to the needs at the desired level, the water charges were low and should be increased. It is stated that the percentage of those who think that the Harran Plain farmers need to be priced to use the water efficiently is 55%, the proportion of those who think that the charges are normal, 23%, 15% of those who do not participate and 7% of those who never participate.

Methods used in pricing irrigation water can be grouped into three main groups according to;

• Volume basis

• On a fixed fee basis

• Output pricing and input pricing [9], [5]

Water fee for non-volumetric methods is taken as based on a per output basis, a per input basis, a per area basis, or based on land values.

3.1. Volume-Based Pricing

In volume-based pricing, the amount of water used by farmers is measured and payments are made based on the amount of water used. The amount of water used in the underground water networks is determined by the meters or irrigation duration. However, this method could not be used because water is used without measured in most of the surface irrigation systems. Approximately the amount of water given can be estimated according to the distribution time and the size of the outlet. Advantages of method are as follows; providing effective water use as payment is made according to the amount of water used, prevention of excessive water usage and determination of the amount of water used. Despite these advantages, the application of the method has some disadvantages. These; The cost of installing counters is high, the establishment of every meter and the need for continuous control, the establishment of an irrigation organization responsible for the collection of pricing fees, and the expense of measuring instruments.

3.2. On a Flat Fee Basis

Pricing on a flat fee basis can be done in three different ways depending on the unit area, the benefit obtained and the product based on it. Different forms of fixed charges can be applied in areas where water meters are not available or in plants where the wild flooding method such as rice is applied.

3.2.1. Pricing by Unit Area

It is a widely used the water pricing method in our country. The farmer can take as much water as he wants and makes the payment according to the size of the area being irrigated. In this method, water charges can cover operating and maintenance costs, but effective water use cannot be achieved. This pricing method can be applied in areas where there is plenty of water.

Pricing method by unit area; Can be easily applied. It is not necessary to measure the amount of water used by each farmer. In other words, the product grown for pricing and the width of the irrigated land is sufficient. Method; It does not encourage effective water use. In this method, because there are big differences in the consumption of plant water according to plant varieties, the approach of paying to the unit area of grown crops based on plant type has been adopted. Plants with high plant water consumption are priced as much as the amount of water added to other plants. Another regulation applied in the method is the pricing according to the number of times the farmers have water. Pricing method by unit area can be easily applied. It is not necessary to measure the amount of water used by each farmer. In other words, crop grown and the width of the irrigated area for pricing and is sufficient. This method does not encourage effective water use. In this method, because there are big differences in the consumption of

plant water according to plant varieties, the approach of paying to the unit area of grown crops based on plant type has been adopted. Plants with high crop water consumption are priced as much as the amount of water added to other plants. Another regulation applied in the method is the pricing according to the number of irrigation of farmers

3.2.2. According to The Obtained Benefit Pricing

In this method, land reclamation tax per hectare is collected in irrigation area. The pricing is based on the unit area, although the tax is taken from the gain obtained.

3.2.3. Pricing by Base Product

Irrigation water pricing according to the base crop grown is often used in irrigation schemes. Price is determined by taking into consideration the irrigation water requirements and productivity of crops. The common practice in this method is to set a fixed fee for each crop in hectare and to collect this fee determined at the end of the season. In this method, the prices have the power to increase the cultivation of some plants and to reduce some of them.

3.3. Output Pricing and Input Pricing

3.3.1. Pricing Based on Product (Output) Price

Method, the price of water is paid on the basis of the unit of products the farmers produce. A certain proportion of the gross production value of each production activity (1,00%, 2,00%, 5,00%, etc.) is taken as the irrigation fee. In order to be able to make pricing according to this method, it is necessary to keep records about crop pattern, production amount and costs in irrigation schemes.

3.3.2. Pricing Associated With Input Prices

In this approach, the price of irrigation water is determined by the costs of the inputs used. In other words, farmers pay a water fee for each unit of input (such as seed, chemical fertilizer, agricultural medicine) used.

4. Irrigation Water Pricing Practices in Turkey

Effective use of water resources is important for food safety and sustainable development. "Action Plan for Enabling Water Use in Agriculture" was prepared on the 10^{th} Development Plan. The aim of this Action Plan;is to solve the problems that are caused or probably caused by climatic conditions, unconscious and excessive water use throughout the country together with the improvement of water use in agriculture [10].

The widespread application in Turkey is charged according to the differentiated unit area according to the product. The unit area is taken as hectare. This approach may be appropriate to the current conditions of the irrigation networks. However, although the water source is abundant, it can lead to excessive consumption of water. On the other hand, non-volumetric water pricing can have an adverse effect on the yield of imported products. Effective water use and irrigation water pricing are closely related [11].

Irrigation Associations : In irrigation schemes operated by irrigation associations in Turkey, annual irrigation tariffs are established together with the annual budget [5]. Settled irrigation water tariffs are presented to DSİ Regional Directorates. Operation, maintenance and repair costs of the facilities are collected as irrigation fees from the farmers. Irrigation fee covers depreciation, permanent staff costs, investment repayment installment, temporary worker costs, maintenance costs in the current year, office and stationary costs, energy and fuel costs, maintenance and repair costs.

In irrigation associations, irrigation fees is determined regard to irrigated crops and the size of the land. At the end of the irrigation season, land assets owned by the users with the property and / or with the tenancy are measured and recorded. Land measurement and accrual (invoicing) operations are carried out by water distribution and accrual staff. The fee collection is made by the collectors in 2-3 installments according to the decisions of the irrigation association. In the case of public irrigation, a 10% delinquency is applied once a year to unpaid debts. In the associations, monthly interest is applied. With the transfer of facilities by public associations, collection rates rose from 36-50% to over 90% [12]. With transferring of the irrigation facilities to farmer organizations, collection rates rose from 36-50% to over 90% [12]

Irrigation Cooperatives: In our country, underground water is generally operated by irrigation cooperatives. In cooperatives, the costs of operating the facilities and ensuring the sustainability of the services are taken by the partners under the name irrigation water fee. Irrigation water fees are determined by the board of directors of the irrigation cooperative to meet the management and operating costs of the installation.

In irrigation cooperatives, irrigation fees are taken in cash as a principle. However, when unsuitable economic conditions are reported by the farmers to the cooperative management, the board has the authority to give the farmers the right to give up the crop harvest or sale. The user who does not pay the water price on time is not given any money in accordance with the legal rights of the board of directors until the debts are closed.

These costs are calculated by summing the costs falling in m3, hour or decare, and the irrigation water fees are determined by adding a low profit share, such as 10-15%, to the calculated value in the unit area. The irrigation fees received from the partners in irrigation cooperatives are generally determined as "TL / hour" as hourly basis as irrigation period or m3 / hour as water usage amount. Thus, farmers are prevented from over-watering and water losses are reduced. Therefore water saving is provided.

Local Authorities: In irrigation schemes operated by local administrations, there are not enough regulations regarding operation and maintenance services and irrigation water pricing. Irrigation fees are generally not charged from the users in the transferred irrigation schemes to village legal entities. In the irrigation facilities transferred to the municipalities, the collection of irrigation fees is the responsibility of the municipal administrators. In the municipalities water charges are determined according to the characteristics of the water supply and facilities, and the costs of operation and maintenance are taken from the farmers [12].

5. Conclusions and Recommendations

In developing countries such as Turkey, the largest part of the total annual amount of water consumed is used in agriculture. The biggest problem in water use in agriculture is excessive water use.

There are many reasons for using excessive water. These are as follows; irrigation schemes are old, distributing water by open canal or canal, demanding of farmer for excess water, high water losses at scheme and field level, using of surface irrigation methods.

Effective use of water in agriculture can be achieved by reducing losses from source to reaching the plant. Thus, water saving is also achieved. Water saving in agriculture can be realized using pressurized irrigation methods such as drip irrigation, pricing of irrigation water according to the amount of water used, application of purified wastewater in the water, application of water harvesting techniques and construction of piped systems of water distribution.

Pricing is the most important tool for water-saving and efficient use. When the applications in our country are examined, there are differences between the public institutions / farmer organizations regarding the repayment of the investment made with pricing. Therefore, the debate about how to make irrigation water pricing continues. In terms of effective water use, pricing based on the amount of water used (m^3) is increasingly getting important.

The most important problem in the pricing of irrigation water is the calculation of irrigation water cost. It is proposed to determine the irrigation water price by adding a certain profit share to the sum of fixed and variable costs of irrigation schemes. However, costs such as environmental / social costs that do not participate in the price of irrigation water are becoming more important.

In water pricing, appropriate to who consume pay approaches should be identified and new regulations should be made to implement them. Co-operatives and associations may be provided with compensation for other co-operatives and associations or other sectors when the amount of water allocated to them is saved. For this purpose, legal arrangements should be made and the amount of water given from water storage facilities to irrigation organizations should be regularly measured. Public institutions or irrigation cooperatives operating irrigation networks, irrigation associations, village legal entities and local governments should be informed about water-saving irrigation techniques and effective water use.

In water pricing, apppropriate approaches to the principle of the payer who use should be identified and new regulations should be made to implement them. If cooperatives and associations save water allocated to them, the saved water may be sold to other cooperatives and associations, or other sectors.

For this purpose, legal arrangements should be made and the amount of water given from water storage facilities to irrigation organizations should be regularly measured. Public institutions or irrigation cooperatives operating irrigation schemes, irrigation associations, village legal entities and local administrations should be informed about water-saving irrigation techniques and effective water use.

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