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The agricultural perspective on water conservation in Turkey

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ABSTRACT

This study focused on the effects of agricultural practices on water conservation in Turkey. Currently, about 75% of Turkey's available water resources are used for agricultural purposes. In this study, possible solutions for water shortage were analyzed in the light of the research and statistics studies conducted on agricultural irrigation in Turkey and the world.

The objectives of this paper are: (1) to evaluate the water losses due to the irrigation system, (2) discuss the effects of improved WUE on water conservation, (3) examine the amount of water lost due to the wastage of foodstuffs, (4) discuss water conservation by applying appropriate crop pattern for the region and (5) other issues.

The result of the study, it was understood that if applications above described are fulfilled, ratio of water used for agricultural purposes can be reduced about 50% or more.

1. Introduction

Access to clean water, with increasing water demands of fast-growing population, is becoming more and more difficult due to the industrial revolution and global warming, climate changes and droughts. Therefore, new strategies on agricultural water saving are required. All over the world, the most important factor limiting agricultural development is amount of water. To meet the food requirements and to ensure its security for future generations, there is a need of studies on sustainable use of water resources. Within these studies, water conservation from various aspects is the most important issue.

Food and agriculture are the largest consumers of water, requiring one hundred times more than we use for personal needs. Up to 70% of the water we take from rivers and groundwater goes into irrigation, about 10% is used in domestic applications and 20% in industry. Currently, about 3600 km^3 of freshwater are withdrawn for human use. Of these, roughly half is really consumed as a result of evaporation, incorporation into crops and transpiration from crops. The other half recharges groundwater or surface flows or is lost in unproductive evaporation. Up to 90% of the water withdrawn for domestic use is returned to rivers and aquifers as wastewater and industries typically consume only about 5% of the water they withdraw (Anon., 2013a).

The world's population is growing by roughly 80 million people each year (Anon, 2013b). Water is an important natural resource and its increasing scarcity has resulted into the emergence of various issues for its efficient use, management and sustainability. Only 2.7% of the global water is available as fresh water, out of which only 30% can be used for meeting the demand for humans and livestock. The demand for water (of an appropriate quality) is expected to rise manifold owing to ever increasing population, rising demands for food, urbanization and industrialization and may even exceed its supply (Kaur et al., 2010). As the population keeps increasing more food and livestock feed need to be produced in the future and more water applied to this purpose. Irrigated agriculture will have to claim large quantities of water to produce the food required to feed the world. The main source of food for the population of the world is agriculture (Anon., 2013a). The development and use of land and water resources has a great importance and can bring a solution to economic and social problems of a country. Because of the growth of population, industrialization and global warming, agricultural water allocation is decreasing steadily. In the short run, agriculture will be highly affected as it will have to produce more products on less water usage due to increasing needs of the populations.

Irrigated agriculture is a vital component of total agriculture and supplies water to produce fruit, vegetables and cereal food consumed by humans; the grains fed to animals are used as human food and the feed to sustain animals in many parts of the world (Howell, 2001). Drought is one of the greatest limitations to crop expansion outside the present-day agricultural areas. It will become increasingly important in regions of the globe where, in the past, the

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problem was negligible, due to the recognized changes in global climate. Today the concern is with improving cultural practices and crop genotypes for drought-prone areas; therefore, understanding the mechanisms behind drought resistance and the efficient use of water by the plants is fundamental for the achievement of those goals (Chaves and Oliveira, 2004).

Better irrigation can dramatically improve crop yield as about 40% of the world's food supply comes currently from irrigated land. However, the water used in irrigation is often sourced unsustainably, through boreholes sunk into poorly managed aquifers. In some cases government development programs and international aid interventions exacerbate this problem. In addition, producers continue to use wasteful systems, such as flood or overhead spray, which are difficult to control and lose much of the water to evaporation. Although the drip or trickle irrigation methods are more expensive to install, they can be as much as 33% more efficient in water use as well as being able to carry fertilizers directly to the root (Anon, 2013c). High water savings can be achieved through promoting water use efficient techniques, adopting efficient on-farm water management, selecting proper cropping patterns and cultural practices and developing more efficient crop varieties (ICARDA, 2001).

Today, about 19% of the total agriculture land (26 million hectares) in Turkey can be watered. Moreover, 60% of surface water resources and 27% of groundwater potential is not currently used. Owing to the factors outlined previously, Turkey's water resources (112 km^3/yr), in today's conditions will not be sufficient for irrigable land and the country will suffer from a severe water shortage in the near future, also water resources will become increasingly saline (Kanber and Unlu, 2008). Therefore, the necessary measures in this regard must be taken in advance.

In this study, we will discuss the measures to be taken in order to conserve water resources in terms of agriculture and some recommendations will be presented.

2. Material and method

The material of study consists of the Food and Agriculture Organization (FAO) and the Turkey Statistical Institute (TSI) data, scientific research studies conducted on the subject, reports and of periodical publications. The study uses equations obtained from previous researches. Thus, necessary calculations related to water conservation were made and interpreted.

In this study, water conservation in Turkey has been analyzed from an agricultural perspective. For this purpose, the following topics have been analyzed and discussed providing solutions on water conservation; (1) water losses due to the irrigation system, (2) effects of enhanced *WUE* on water conservation, (3) water losses due to the wastage of foodstuffs, (4) water conservation by applying appropriate crop pattern and production planning and (5) other issues.

The first most commonly perceived option is that of increasing efficiency of water use by reducing water losses in the process of production. Technically, 'water use efficiency' is a dimensionless ratio that can be calculated at any scale, from the irrigation system to the point of consumption in the field. It is generally applied to any management that reduces the non-beneficial use of water (i.e. reducing leakage or evaporative losses in water conveyance and application) (FAO, 2012). In the study, the water use efficiency (WUE) was calculated via Eqs. (1) and (2) (Howell et al., 1990; Ertek et al., 2006).

$$\mathrm{WUE} = (E_y/E_t) \quad (1)$$

$$\mathrm{WUE} = (E_y/E_t)x100 \quad (2)$$

where, WUE—the water use efficiency ($t\,ha^{-1}\,mm^{-1}$ or %), E_y—the marketable yield ($t\,ha^{-1}$), Et—plant water consumption or evapotranspiration (mm).

3. Result and discussion

3.1. Reduce water losses due to the irrigation system

Irrigation is the controlled application of water for agricultural purposes through man-made systems to supply water requirements not satisfied by rainfall. Crop irrigation is vital throughout the world in order to provide the world's ever-growing populations with enough food. Many different irrigation methods are used worldwide (Anon., 2013d).

One of the most extensively used terms to evaluate the performance of an irrigation system is "water efficiency". In general terms, water efficiency is defined as the ratio between the amount of water that is used for an intended purpose and the total amount of water input within a spatial domain of interest. Clearly, to increase the efficiency of a domain of interest, it is important to identify losses and minimize them. Depending on the intended purpose and the domain of interest, many "efficiency" concepts are involved, such as crop water use efficiency, water-application efficiency and others (Guerra et al., 1998).

Irrigation-water management has a long way to adapt to the increasing production requirements; however water-saving technologies are already available and can significantly reduce the waste of water. If incentives are in place, as increasing the price of irrigation water, farmers will adopt water-saving irrigation technologies. The main technologies likely to be used in developing countries, where labor is normally abundant, but capital scarce, are underground and drip irrigation. Both technologies depend on the frequent application of small amounts of water as directly as possible to the roots of crops. Reducing the pollution loads of water used by farms, industries and urban areas would enable much more of it to be re-used in irrigation. There are enormous potential benefits to be had from the use of wastewater for irrigation (Anon., 2013a).

In conventional irrigation, water is applied to maximize crop yield (*maximizing production per unit of land*). In the dry areas, land is not any more the most limiting factor of production; rather water is increasingly becoming the limiting factor. Therefore, it is logical to conclude that since water is a more limiting factor, then the objective should be to maximize the return per unit of water not per unit of land. This should lead to higher overall production, since the saved water can be used to irrigate new land with higher production prospects (ICARDA, 2001).

Drip irrigation is the most efficient method of irrigation. While sprinkler systems are roughly 75–85% efficient, drip systems typically are 90% or higher (Stryker, 2013). For this reason drip irrigation is the preferred method of irrigation in the arid and semi-arid regions of the world. Moreover, drip irrigation has other benefits which make it useful almost everywhere. It is easy to install and design and it can reduce disease problems associated with high levels of moisture on some plants. Drip irrigation uses tubes to deliver small quantities of water and nutrients straight to the plants' roots, leading to less wastage and evaporation than systems such as overhead and furrow irrigation. Drip irrigation also helps create improved growing conditions. It can significantly reduce the spread of fungal diseases and because the soil does not become soaked through, it also helps to prevent bacterial diseases. In humid conditions the use of fungicide can be reduced by as much as 50% (Anon., 2013e).

Amount of water used for agricultural purposes is varying between 70% and 80% depending on the state of development of a country. India, for instance, uses three times more water than