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Field Water Management for Saving Water in Water-Starved Environments Such As Konya Plain, Türkiye

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Abstract: The main purpose of the present study was to propose applicable water management strategies in agricultural production for water limited ecologies like Konya plain of Türkiye. In accordance of findings obtained from our previous studies in such environment, following necessary efforts could be done for improving water productivity: Newly registered crop cultivars/animals having tolerant to dry climates should be introduced to the farmers; use area of water productive irrigation technologies should be widen; farming areas with low water consuming crops could be expanded by subsidizing farmers producing those crops; deficit irrigation can be applied; regular maintenance-repair works must be done at water delivery systems. Transferring water from neighbour hydro-basins could be also good alternative; and farmers could be informed about high quality irrigation water management with some education activities.

Keywords: proper agro-water management; water productivity; modern irrigation technologies; water saving

1. Introduction

Irrigated agriculture particularly at dry environments is the backbone of the food supply of world. Even it is impossible to get economical incomes particularly from summer crops in such climates like Konya plain of Türkiye without irrigation. In addition, pressurized irrigation systems are highly preferred for obtaining high water saving as well as causing almost little / none labour works during the irrigation events. Enhancing water productivity with those irrigation technologies has yielded reduction the both amount of water use and irrigation energy cost having maximum share among all crop production inputs in Türkiye. In one field research in Konya region region[1] irrigation energy cost for potato plant were found as around 44% within whole production inputs practicing during crop growth stages.

One of the large land size provinces of Türkiye is Konya plain. That city has 1928000 ha farmlands. The cultivated land is around 68% of the total land of Konya. The irrigable land area is about 1653000 ha in accordance of current water resources. The current irrigation area is around 595000 ha in such plain. The region has favorable soil and environmental conditions for various crop farming. The planted area of Konya is about 1305000 ha with 8.3% of Türkiye. Maize, potato, sunflower, sugar beet, and dry bean are common field crops in region, and current productions of sugar beet and carrot are 29% and 60%, respectively.[2] Water shortage is serious environmental limitation affecting sustainability of agro-production in such ecology. The region has only 2.5% of the fresh water supply of Türkiye. Irrigation is maximum share, higher than 80%, in fresh water consumption in Konya plain[3] that is greater than world average of 70%. The reasons behind over water uses in irrigation are increment of cultivated land area with favor of high water consuming crops and areas bringing under irrigation without control.

However, irrigation has focused on mainly particularly at vegetation period July-September, and over water consumption is present from the groundwater reservoir due to none availability or lack of surface water bodies to meet the crop water requirement in most parts of the Konya plain. In accordance of our projection, almost 2 billion m^3/year of water consumption is present from the groundwater reservoir. This situation has negative effects on sustainability of water resources in our region.

The applied water for sugar beet, dry bean and carrot crops were nearly 980 mm, 818 mm, and 1010 mm, respectively.[4] The crop growing cycle of 2020-2021 is possible the most dramatic season in recent years. In rain-fed conditions, we had almost none grains in cereal-cultivated lands, and some yield losses were recorded at irrigated cereal lands. In outcome of those scenarios, climate change is reality and has great effect on rainfall amount, consequently agriculture, as well as distribution of precipitation at time and places. In that regard it is estimated that negative effects of climate change are more than positive effects.[5] Konya plain is one of the maximum inversely affecting places from climate change in Türkiye.

Fig. 1. View of poor development of cereals under serious drought conditions.

The aim of the present study is to propose realistic strategies for better water productivity in water shortage regions particularly for Konya plain of Türkiye.

2. Attempts for improvement of water productivity

2.1. Use of Pressurized Irrigation Systems

The uses of drip and sprinkler irrigation systems are almost 15% worldwide although they have lots of advantages such as well-suited different soil, plant, and field topographies.[6,7] Sprinkler irrigation is well-known irrigation technique in Konya plain. Since this method has been used for a long-time in our region, farmers have high experiences about management of such irrigation system.

Drip irrigation system have used in our region with an increasing popularity for irrigation of some field crops such as maize, sugar beet, and vegetables such as tomato. It is possible to get more than 90% water application productivity in such irrigation technique under good management.[8] Proper design, installation of the irrigation system components with great care, regular maintenance-repair works as well as successful management of pressurized irrigation systems are very important role to play for resulting maximal water saving.[9]

2.2. Deficit Irrigation Practices

The main of target in irrigation particularly at water shortage environments is to get maximum benefit from unit applied water. One of the practical ways to reach such target is deficit irrigation application at farm level. In that technique, water is applied to the crops less than crop water requirement.[10] Crops are exposed to certain water stress conditions resulting minimum yield losses.[11] In findings of some field experiments at our region relevant to the deficit irrigation, 75% of the full irrigation led to none significant yield reduction for drip-irrigated sugar beet, sunflower, dry bean and potato so it could be highly recommended particularly in regions with water scarcity problem.[12] In study conducted in Italy[13] about different water applications as 100% (A), 70% (B), and 50% (C) of ETC (Evapotranspiration or Crop Water Use) on grain yield of drip-irrigated local dry bean cultivar namely fogiolo rosso scritto' (*Phaseolus vulgaris* L.) the grain yields for A, B, and C treatments were found as 1401 kg/ha, 1307 kg/ha, and 1257 kg/ha, respectively.

Table 1. Some yield performances of main crops in region (t/ha)

Year	Wheat Farming System		Sugar beet	Alfalfa
	Irrigated	Rain-fed		
2020	10.0	3.0-3.5	90.0	7.0-7.5
2021	7.5-8.0	0.75-1.0	85.0	5.5-6.0

The difference between A and B treatments were found not significant statistically. Therefore, B treatment was recommended for obtaining maximal water productivity from unit applied water in environments having arid and semi-arid climate. The result obtained this study is conformity with our previous study findings.

2.3. Minimizing Stress on Over Water Consumption from Groundwater Reservoir

Unfortunately over water use is present from groundwater supplies for meeting current crop water demand due to the insufficient surface water bodies in most parts of the Konya plain at irrigation season. High water consumptive crops such as maize, sugar beet and alfalfa are growth in some areas due to the resulting well economical returns for farmers. If this trend continues water level will reduce gradually to the critical level. This situation will raise irrigation energy cost as well as environmental problems. It is possible to see some sinkholes in region resulting from over water pumping from groundwater reservoir. In the light of such information, current crop pattern is responsible for groundwater depletion. Increasing areas with low water use crops will reduce water-taken from groundwater supplies. In that regard, sunflower, dry bean, lentil and chickpea could be planted more for sustainable groundwater utilization.

2.4. Obtaining Additional Water from Neighbour Hydrological Basins

There is no doubt that droughts are resulted from low-average rainfall than normal amount of water recorded. It causes reduction in surface and sub-surface water resources consequently both the crop yield and livestock watering. In addition, period of above-average temperatures, may increase hydrological and biophysical stress, is reason of the droughts.[14]

In 2021, Beyşehir water storage, surface water source of Konya, reached up to critical level. Therefore, some agro-fields had no received enough irrigation water from that storage. Crops suffered from insufficient water supply. The solution should be introducing water from neighbour hydro-basins to our region to minimize or complete ignorance negative effects of drought on agro-production.

2.5. Drought Impacts on Agro-Productions and Sustainability of Natural Resources

In general drought has negative effects on both the yield and quality of the farm productions consequently economical return of farmers. In the lights of our information obtained from research areas such as Konya-Karapınar province of Türkiye, crop yield was highly influenced particularly at rain-fed farming areas and moderately at irrigated lands during periods 2020-2021 crop growth cycle. In such environment, the yield-reduction of wheat was determined as around 75% under rain-fed farming system (Fig. 1).

It was varied from 5 to 25% at irrigated farms depending on the crop types (Table 1). In sugar beet, not only fresh root yield is important but also polar value is very important role to play for

incomes of farmers. Those values were 17.5 and 16.0 for 2020 and 2021 production season, respectively so there could be around 10% reduction in farmer's income in 2021 by comparison to the 2020-growing season. On the other hand, over water extraction from the groundwater resources was witnessed to minimize the yield losses at irrigation areas in 2021. That case led to important groundwater depletion in some parts of the Konya plain such as Karapınar province, such water level drop reached up to the 10-12 m in 2021. This situation has inverse effect on sustainable utilization of the groundwater supplies in region.

The drought is environmental problem leading to reducing water resources consequently dramatic yield losses. In accordance of a research [15] the groundwater level depletions at northwest and southeast parts of Iran were predicted as 10 m and 30 m during the periods 2010-2014, respectively.

3. Conclusions

Proper agro-water management is vital important particularly water - starved zones worldwide. Following solutions could be beneficial for maximum profit from unit-applied water. In first, crop patterns should be organized in accordance of current water resources. For example; cultivated land size of cereals can be increased. Even areas with rain-fed farming systems can be widen. In second, modern irrigation systems with high water saving should be applied with an increasing rate. Not only irrigation methods are important but also quality of water management at farm level is very important role to play for enhancing water productivity in irrigated areas. In third, deficit irrigation is an applicable way for water saving so up to 25% water deficiency can be applied. Finally, education program with rich visual documents or organizing field demonstrations related to irrigation and environmental sustainability for farmers could be very beneficial to accomplish efficient irrigation.

Conflicts of Interest

The authors declare no conflict of interest.

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