INSTITUTIONAL AND AGRONOMIC APPROACHES ON DROUGHT MANAGEMENT AND SOME MAIN CROPS CULTIVATED IN TURKEY

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ABSTRACT

Drought is caused due to a prolonged shortage of water, usually of precipitation. Turkey is located in the Mediterranean region and experiences widespread droughts of various intensities. Turkish Cabinet decided on ‘Procedures and principles to combat agricultural drought in 2007. The aim of this decision is to help lessen the impacts of a possible drought with the participation of related ministries, universities, governorships, local governments and NGOs under the coordination of Ministry of Food, Agriculture and Livestock. However, lack of cooperation among the stakeholders still affects inappropriately drought and water management. On the other hand, climate variability is one of the most significant factors influencing year to year crop production. Cotton and winter wheat are the main crops cultivated in Turkey. Drip irrigation is the most effective method in terms of both maximum yield and water conservation for cotton. Sprinkler irrigation results in a lower yield than furrow irrigation in the South eastern Region of Turkey. The reasons for a lower cotton yield with sprinkler irrigation might be attributed to high temperature and irrigation during the day time, very low relative humidity, relatively high wind speed in summer as well as the impact of sprinkler drops on cotton flowers and leaves. For winter wheat, as the economic maximum fertilizer nitrogen, the rates of 70 kg N/ha under non-irrigation conditions and 170 kg N/ha under irrigated conditions can be recommended. However, in case of drought occurrence, the rate of 120-130 kg N/ha may be used under irrigated conditions. If the farmers get information and/or data about climatic and drought, the farmers should be avoided full fertilization as occurred normal amount of rainfall and distribution. The farmers should be, thus, used yield-response curve pertaining each region to get an economical yield. Knowing impacts of climate variables on the crops could enable to use efficient irrigation scheduling and to avoid excessive fertilizers. In this article, the institutional approaches of drought management and the effects of irrigation and climate variables on some main crops cultivated in Turkey have been discussed.

Keywords: Drought, climate, action plan, irrigation, cotton, wheat, Turkey.

1. INTRODUCTION

Drought occurs when the precipitation is significantly less than normal, causing severe hydrological imbalances that negatively affect land resources and production systems (Turkes 2010; Wallander et al. 2013).

The duration and timing of drought are often key determinants of drought impacts. Droughts vary by timing, duration, severity, and geographic extent (Wallander et al., 2013). Drought risk adaptation is the variation in drought preparedness that is due to differences in drought risk and is a form of climate adaptation. Climate change is already affecting the agricultural sector (Hatfield et al. 2008)

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Trends in drought intensity and crop growth are related to climate changes. The results suggest more frequent, intense and long-lasting droughts in the country particularly along the western and southern coasts under future climate conditions. A shift of climate classes towards drier conditions is also projected for the western, southern and central regions during the 21st century. Evaluating the role of the climate change in crop production reveals significant decreases in yield and shortened growth seasons for first- and second-crop of corn; a likely result of high temperatures and water stresses. In addition to rising temperatures and declining precipitation, increasing frequency, severity and duration of drought may significantly affect food production and socio-economic conditions in Turkey (Sen et al. 2012).

Drought risk management seeks to increase the capacity of individuals, organizations and society as a whole to better cope with the impacts of drought, by focusing on drought preparedness plans and related measures that should be planned proactively and implemented before, during and after droughts (FAO 2014).

On the other hand, agricultural land in Turkey suffered drought. It means that the longest and most severe droughts in the past 40 years occurred in 1971-1974, 1983-1984, 1989-1990, 1996-2001 and 2007-2008. The longest of these droughts began as meteorological drought and later developed into agricultural and hydrological drought (Kurnaz 2014). Recently, severe drought has occurred in 2007 in Turkey. This natural event affected agricultural production and hydrological flow. While the wheat production, a basic crop of Turkey, was 21.5 million tons in the year of 2005, it was 17.2 million tons in 2007 and 17.8 million tons in 2008. Imports were made during the last two years since domestic production was not able to meet the demand. Severe drought of 2007-2008 agricultural year experienced in Southeastern Anatolia Region caused series yield loses in common crops of the region. For instance, while red lentil production was 0.5 million tons in the year 2005, it decreased to 111 502 tons in 2008. Normally, Turkey exporting red lentil had to import lentil in the year 2008. Cotton production also decreased from 2.2 million tons to 1.9 million tons and Turkey had to import much more cotton (Simsek et al. 2010).

Since the drought impacts in 2007, the Turkish government has taken several decisions to tackle the impact of droughts. Modern irrigation systems are being promoted, provincial drought commissions have been established in the region, and drought action plans have been prepared (Anonymous 2016).

In this article, one part of it covers institutional approaches on drought management in Turkey. The other is agronomic approaches for some main crops, cotton and winter wheat, grown commonly in Turkey under the drought and some extreme climate conditions.

2. DROUGHT MANAGEMENT and INSTITUTIONAL APPROACH in TURKEY

Drought is a prolonged shortage of water, usually of precipitation. The duration and timing of drought are often key determinants of drought impacts. Since Turkey is located in the Mediterranean macroclimate region, this causes regional and widespread droughts in various intensities. Agricultural land in Turkey suffered also drought. Turkish Cabinet decided on ‘Procedures and Principles of Combat Agricultural Drought and of Drought Management Operations’ in 2007. The aim of this decision is to help lessen the impacts of a possible drought in the country and to regulate procedures and principles related to the tasks, authority and responsibilities in operations which will be undertaken with the participation of related ministries,
universities, governorships, local governments and NGOs under the coordination of Ministry of Food, Agriculture and Livestock.

The development of a drought plan requires at least three components: (1) a monitoring and early warning system; (2) vulnerability and impacts assessment; and (3) mitigation and response actions.

With the Cabinet decision mentioned above, it was decided that “Agricultural Drought Management” will be executed by Central and Provincial Management units under the coordination of Ministry of Agriculture and Rural Affairs.

Central management is made up of the units below:

(a) Agricultural Drought Management Coordination Committee (ADMCC)
(b) Observation, Early Warning and Prediction Committee
(c) Risk Assessment Committee
(d) Data Flow Unit
(e) Working Group

Agricultural Drought Management Coordination Committee (ADMCC – Work Force) at national level and related Monitoring and Early Warning and Risk Assessment Committees were founded along with Data Collection Unit. In addition to that organizational structure, a National Drought Data Center has been created. Affiliated with this center, the Provincial Agricultural Drought Crisis Centers started their activities on drought management at provincial levels. However, the modern management structure at the national level is still carrying the marks and signs of the prior reactive approaches.

The regional water authorities in Turkey like State Hydraulic Works (DSI) and Farmers Associations have gained experience in network level water management under drought conditions. In order to prevent the water loss which is the most important problem and to have more efficient irrigation systems, it is imperative to develop the physical infrastructure and technical capacity. As a result of this development in these areas the vulnerability of agricultural systems towards drought can be decreased. One of most effective ways to overcome agricultural drought is to manage and/or use water resources efficiently. For this, irrigation must be applied according to the volumetric basis (Kayam & Cetin 2012).

In countries such as Turkey where drought management is new and in a developing stage, comparatively simple and graded applications related to prevention of drought and impact lessening will create more successful results with organizational structures that are appropriate for regional conditions instead of more difficult and complex drought organizations (Kayam & Cetin 2012). On the other hand, ad-hoc emergency measures are often implemented in response to drought conditions. It has been found that these measures often result in ineffective, poorly coordinated, and untimely outcomes and do little to reduce the underlying vulnerabilities that cause drought impacts (Wilhite et al. 2005).

Although some institutional approaches were created for the drought management in Turkey, institutional drought management is depending on continuity and effectiveness of it. Because all the shareholders related to drought must be realized their responsibilities.

Although there is an “Agricultural Drought Management Coordination Committee” in Turkey, it is difficult to say that it works properly since there is no appropriately
collaboration between the institutions. Another problem is to use irrigation water without based on volumetric measurement and this cause excess water use for irrigation. As a result, the cooperation weakness among stakeholders affects inappropriately drought and water management.

3. EFFECTS OF CLIMATE AND DROUGHT ON SOME IRRIGATED CROPS

Climate variability is one of the most significant factors influencing year to year crop production, even in high yield and high-technology agricultural areas. With temperature increasing and precipitation fluctuating, water availability and crop production will decrease in the future. Improving water productivity and keeping stable relations with global food suppliers will be vital for food security (Kang et al. 2009). Thus, irrigation is the prime means of intensification and will remain a keystone of food security policies in the face of climatic variability (Turral et al. 2011).

Cotton and winter wheat are the main crops cultivated in Turkey. Cotton cannot be mainly grown without irrigation and it needs much more irrigation water. Irrigation is also important for winter wheat and precipitation and its distribution significantly affects yield. Considering these conditions, the impacts of climate variables and irrigation on cotton and winter wheat are discussed in below.

3.1 Cotton

In this critical discussion, the results of the study carried out by Cetin et al. (1996) for irrigated-cotton with different irrigation methods for a 4-year were considered. According to this study, drip irrigation is the most effective method in terms of both maximum yield and water conservation for cotton. Sprinkler irrigation uses more water than furrow irrigation in order to obtain the same yield. Moreover, sprinkler irrigation results in a lower yield than furrow irrigation in this research area. The reasons for a lower cotton yield with sprinkler irrigation in the study region might be attributed to high temperature and having irrigation during the day time, very low relative humidity relatively high wind speed in summer as well as the impact of sprinkler drops on both the flowers and leaves of the plants. High temperature and dry wind during the irrigation season resulted in increased evaporation.

Considering some climate variables, the averaged maximum temperature for the growing season varied from 33.2 through 36.1 °C. In addition, monthly averaged temperature in the growing season was the highest in 1994 (Fig. 1). In addition, relative humidity was the lowest during the period of the flowering and boll formation in 1993 and 1994 (Fig. 2). It is, thus, possible to link temperature and relative humidity to the yield and/or boll number. On the other hand, the yields were not lower except under sprinkler irrigation although the averaged maximum temperature was the highest in 1994 compared to the other experimental years. The reason of this observation could be due to the sowing date. Thus, earlier sowing date in 1994 was provided to get the higher yield even if the maximum temperatures were higher in the growing season (Cetin & Basbag 2010). However, drought and high temperatures during the flowering and fruit-set might cause heavy flower and fruit drops and reduce yield. If abnormal drought and high temperatures occur often, measures for prevention of these problems should be taken.

Considering the irrigation methods, a considerable decrease in yield was observed when the maximum temperature was increased under sprinkler irrigation. However, the yields observed for furrow and drip irrigation did not follow the same pattern as under sprinkler irrigation (Cetin & Bilgel, 2002). The reasons for this lower yield,
besides the high shedding ratio, include the high temperatures, high evaporation and low relative humidity. In addition, both leaves and flowers of the plants are damaged by sprinkler irrigation, particularly in the daytime. Because the physical impacts of sprinkled water and the physiological effects of the higher temperature on leaves and flowers during the day could be more efficient or powerful (Cetin & Basbag 2010).

The maximum seed cotton yield was obtained for all the irrigation methods in the experimental year of 1993 where the lowest the wind speed was recorded (Fig. 3). The yields obtained under different irrigation methods were not significantly different except for sprinkler irrigation with an increase in wind speed. There is a significant impact of wind on the yield under sprinkler irrigation. These results could be due to integrated impact of the wind on the flowers and spatial water distribution that is varied by wind during the sprinkling. The wind effects of the other irrigation methods are not having such major impacts as sprinklers have (Cetin & Basbag 2010).

As a result, irrigation methods and climate parameters significantly affect cotton yield. Thus, use of sprinkler irrigation should be used in the early morning, late day or night time to protect loss of evaporation. In order to obtain a maximum cotton yield, amount of irrigation water should be adapted to the irrigation methods. The appropriate amount of irrigation water and method of irrigation depends on the farmers’ situation, his technical facilities and skills, and price of water (Cetin & Bilgel 2002).

### 3.2 Winter Wheat

The results of the study carried out by Cetin (1993) are discussed to criticize the effects of the drought on winter wheat. According to the study, irrigation and nitrogen increased the grain yield of wheat. Generally, grain yield increased as the levels of irrigation and rates of fertilizer nitrogen increased. When normal distribution of the precipitation and drought occurred, only irrigation independently increased grain yield 76 to 136 % and 420 %, respectively. On the other hand, nitrogen independently increased the yield 81-81 % under the normal distribution of the precipitation and 32 % under the drought conditions. However under the same conditions together with irrigation and nitrogen increased the grain yield 198 to 209 and 590 % respectively (Cetin 1993). Thus, higher temperatures and inappropriate distribution of the rainfall caused the lower yield. In addition, as the economic maximum fertilizer nitrogen for winter wheat, the rates of 70 kg N/ha under non-irrigation conditions and 170 kg N/ha under irrigated conditions can be recommended. However, in case of drought occurrence, the rate of 120- 130 kg N /ha may be used under irrigated conditions. When a drought occurs, then extra N may diminish yield. Management of nitrogen is,
thus, part of a balanced fertility program. If the farmers get information and/or data about climatic and drought, the farmers should be avoided full fertilization as occurred normal amount of rainfall and distribution. The farmers should be, thus, used yield-response curve pertaining each region to get an economical yield.

In addition, Hossain et al. (2012) reported that there was a relation between phenological variation and growth and development of wheat: high temperature stress, when combined with drought during growing period decreased the days to visible awns, days to heading and days to ripe harvest, finally negatively affecting the growth and development of plants and resulting in a lower plant population, plant height and dry matter production. Thus, less rain and more droughts can bring crop failure and economic losses. Occurring in tandem with significant drought events, water shortages for all water-using sectors have reached their critical points, and up to 100% yield losses have also been reported in Turkey (Turkes & Erlat 2005).

In the case of dry years winter wheat production cannot be maintained at satisfactory level. Nitrogen use efficiency is also lowered and this increases the probability for nitrogen loss to ecosystems and also to negative economic results in winter wheat production (Cetin & Akinci 2015).

4. CONCLUSION

In the future, food security strategies will be more complex. Higher temperatures will increase water demand, and where rainfall declines, many will seek more irrigation to ensure food security and maintain livelihoods.

Drought is natural event and agricultural land in Turkey suffered drought. In order to decrease the risks of the drought and/or to overcome the negative effects of it, collaboration among the stakeholders used water are significantly important. Thus, institutional and agronomic approaches on drought will reduce the negative impacts of the drought.

Soil moisture can be enhanced by practices such as zero and minimum tillage. Irrigation has been a propelling power in terms of economic and social development in the country. Irrigation scheduling and soil moisture monitoring, precision farming and fertigation, piped distribution systems for local farmers, water measurement and
control, farm consolidation, water user and marketing groups for national level must be paid attention. More efficient irrigation technologies such as drip irrigation system that reduce unproductive evaporation losses should be supported and/or subsidized.

The use of improved practices is critical for the sustainability of irrigation in Turkey. This could enable saving water, thus this allow energy savings and reduce waste of fertilizers. The farmers could be introduced new forms of irrigation, or diversified to varieties that are higher yielding or have greater tolerance for drought or salty conditions.

Lastly, use of irrigation water based on volumetric measurement must be mandatory.

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