Agricultural productivity and global food scarcity is highly determined by climate conditions and dependent on location, crop type, and irrigation condition (Kukal and Irmak 2018). Concerns over the potential effects of climate change as well as extreme weather on agriculture has driven a substantial amount of research in the past two decades along with the increased severity of climate change. According to Wang et al. (2019), climate change may increase both the intensity and frequency of extreme weather events, particularly drought.

In Marković et al.’s work (2015), irrigation and maize yield showed positive linear correlation in drought conditions and maximum yields were observed in fully irrigated treatment during extremely dry years. Kukal and Irmak’s work (2018) showed the weather and climate were prominent drivers that affect crop yield. Irrigated systems have been producing more consistent yields and irrigation decreased the sensitivity of precipitation rise for all crops. But what is the main contributing factor to irrigation systems?

This paper investigates the impacts of extreme weather on crop yields, focuses on drought. Exams how saturated thickness affects irrigation and then affects irrigated crop yield when there is a drought. To see if saturated thickness can significantly mitigate the negative effects of drought on crop yield.

The Great Plains region in the U.S. (Ogallala aquifer) is selected as the area of our project.  After World War II, Ogallala groundwater started serving large-scale irrigated agriculture, due to improved technologies. Increased access to Ogallala groundwater reduced the Ogallala counties’ sensitivity to drought and increased those agricultural land values (Hoenbeck and Keskin 2014). Nowadays, the High Plain annually irrigates fourteen million acres, which plays the most significant role in the Western Hemisphere in irrigation (Frankel 2018). Its vast geographical extent, substantial spatial, temporal variation, and the region’s significant contribution to national agricultural production also make our research more significant, comprehensive, and robust. (Kukal and Irmak 2018).

The Drought Index used by the U.S. Drought Monitor (Kuwayama 2018) is used in our paper in order to control weather conditions and reflect the severity of drought. We run OLS regression models in four different time periods applying fixed effect and year fixed effect to test the significance of the depth of saturated thickness on irrigated corn and soybeans respectively from 2000 to 2018.

The regression results indicated that four levels of drought (from D1 to D4) significantly impacted on hurting the corn yield. The most severe one happened during the growing season from May to September, with 2.677 units of corn yield loss when one more D4 level drought hits. Although the yields of soybean had less impact of drought than corn, severe drought (D3 and D4) have significant effects on hurting soybean yield. Similarly, the most representative result is also shown during the growing season of May to September but in a D3 level of drought, with 0.695 units of soybean yield loss when one more D3 level drought is added.

The regression results also indicated the saturated thickness of the aquifer plays a significant role in mitigating the impact of drought on crop yield. D4 level and D3 level of drought showed the most significant effects on corn and soybean yields, respectively, which is consistent with the results of the impacts of drought on corn and soybean yields. One unit of saturated thickness increases could mitigate 0.017 unit of the negative impact of D4 level of drought on corn yield and 0.006 unit of negative impact of D3 level of drought on soybean yield.

The negative relationship between drought and crop yield we got in this work is consistent with the previous works (Marković et al. 2015, Kukal and Irmak 2018). A key advantage of our study is we evaluated the function of saturated thickness in irrigation systems, showing that saturated thickness is one of the root causes that make irrigated crops less sensitive to drought. Our results provide a better understanding of the effects of extreme weather on agricultural productivity and demonstrate one of the main contributors to the relatively consistent yields produced by irrigated lands. These may provide some advice in terms of groundwater production and other decision makings in the future.

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