Highlights from

CORN PRODUCTION IN THE TEXAS HIGH PLAINS: GAINS IN PRODUCTIVITY AND WATER USE EFFICIENCY

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Executive Summary

The high water demand and the susceptibility to water stress of corn have created an impression of corn being inefficient in water use. However, this high water use is usually more than compensated by increased yields. Moreover, genetic improvements and modern management practices have led to considerable yield and efficiency improvements in corn during the past decade. (Page 4)

Estimates from *Scenario III* indicate that from 1998-2002 to 2010 and 2013 the irrigation amounts decreased by 16.1%, total water applied decreased by 7.6%, corn yield per acre increased by 10.4%, corn yield per inch of irrigation increased by 27.7%, and corn yield per inch of total water applied increased by 18.6% in the region. (Page 4)

Past research attributes about 60% of the historical yield increase in corn to genetic improvement and about 20% to increase in plant population. Irrigation scheduling and conservation tillage practices can reduce corn irrigation by 3 and 2 acre-inches per acre, respectively. The increased adoption of center pivot irrigation system in the Panhandle region from 2000 to 2013 is estimated to reduce the irrigation demand for corn in the region by approximately 3%. (Page 4)

Introduction

High evaporative demand and high water use have made the impression among the general public and policy makers that corn is not an efficient user of irrigation water. However, the high water requirement of corn is more than compensated by its increased productivity relative to other crops. Corn is physiologically more efficient in resource use compared to cotton and soybean. This difference in physiological efficiency makes corn potentially more efficient in the use of water, nitrogen, and CO_2 than crops like cotton, wheat, and soybean. (Page 5)

Irrigated corn yields increased approximately 2.3 bushels/acre/year from 1980 to 2010 in the Northern High Plains. . . . The yield increase was accompanied by improvement in water use efficiency enabling the producers to obtain higher yield with lower irrigation amounts. (Page 5)

The major factors that led to the improvement in yield and water use efficiency were genetic improvements, better irrigation scheduling, adoption of conservation tillage practices, and adoption of more efficient irrigation equipment. (Page 5)

The objective of this study is to determine the benchmark water use by crop for the region from traditional crop production practices and evaluate any improvements over time due to improved technologies. Because of limitations on availability of field-scale data for cotton, sorghum, and wheat, this study focused on evaluating the yield and efficiency gains for corn in the region due to improved technologies. (Page 5)

The water use, yield, and water use efficiency data from the AgriPartners demonstration trials from 1998 to 2002 was used as the baseline. This baseline data was compared with data from different recent demonstrations trials in the region during 2010 to 2013 to evaluate possible yield and efficiency improvements. (Page 6)

Methodology

The large differences in water use, yield, and water use efficiency among center pivot and furrow irrigated fields indicate that the irrigation equipment used in the field can have significant impact on the water use, yield, and water use efficiency. All observations in the recent dataset are from the center pivot irrigated fields and this creates difficulty in having meaningful comparison between the baseline and recent data. Moreover, year to year differences in weather conditions will have significant impact on the yield and water use efficiency of corn. Therefore, controlling the effect of weather is also essential for arriving at reliable estimates of yield and efficiency gains. Considering these multiple confounding factors, the potential yield and efficiency gains were estimated under three different scenarios. (Page 10)

Comparison among scenarios

By comparing the years with similar weather parameters, *Scenario III* provides more reliable estimates of the yield and efficiency gains. Therefore it can be concluded from this analysis that from 1998-2002 to 2010-2013, the amount of irrigation for in the region was reduced by 16.1% and the amount of total water applied was reduced by 7.6%. The corn yield in the region showed an increase of 10.8%. (Page 21)

The most important indicators of the impact of improved technology are the water use efficiency measures (yield per acre-inch irrigation and yield per acre-inch of total water applied). The yield per acre-inch of irrigation improved from 8.78 bushels of corn per acre per acre-inch of irrigation in the baseline period to 11.21 bushels of corn per acre per acre-inch of irrigation in the recent years. This water use efficiency improvement translates to 27.7% increase with respect to the baseline period. This shows that the corn producers in the region are now more efficient in the use of irrigation water. This improvement in the efficiency of irrigation water is very important considering the need for conserving the diminishing water supply in the region. The yield per acre-inch of total water applied also registered an increase from 5.95 to 7.05 bushels per acre per acre-inch of total water applied during this period. This increase in total water use efficiency corresponds to 18.6% increase from the baseline. The yield per unit of total water applied also takes into account the differences in seasonal rainfall and soil profile contribution. This shows that the producers were able to achieve 18.6% increase in the corn yield (bushels/acre) per acre-inch of total water applied by using improved technologies and following better management practices. (Page 21)

Sources of yield and efficiency improvements

Genetic improvements

Almost all of the yield improvement of corn hybrids is due to the increase in the optimal plant population (population under which maximum crop yield is expected). The ability of modern hybrids to better tolerate soil moisture stress also contribute to a large portion of the yield and water use efficiency gains. . . . For hybrids released in 1960s the yield increase was possible only up to 12,000 plants/acre while for the hybrids released in 2000s yield increases up to a plant density of 24,000 plants/acre. (Page 22)

Irrigation scheduling

When irrigation water supply is limited, deficit irrigation is practiced, which aims at reducing the amount of irrigation water applied to a crop with minimal impact on its productivity. Ensuring adequate water supply at critical stages of the crop growth is an essential feature of deficit irrigation. . . . Proper irrigation scheduling is estimated to save 2-3 acre-inches of water per acre for corn without significant yield reduction. (Page 23)

Conservation tillage

Conservation tillage is a term covering a range of tillage practices with the common characteristic of reduced soil and water loss. . . . Considering the different studies, it will be safe to assume that conservation tillage practices in corn can save about 2 acre-inches of water per acre. (Page 25)

Irrigation equipment changes

The corn producers in the Texas High Plains are renowned for the use of efficient irrigation equipment. The percentage of irrigated acreage under center pivot irrigation system increased from about 11% in 1958 to about 72% in 2000 in the Texas High Plains. The current adoption level of center pivot irrigation system in the Panhandle region of Texas is about 87%. Our analysis of the county wise water use data for corn in the 21 counties of the Panhandle region shows that the change in irrigation equipment from 2000 to 2013 has reduced the irrigation in corn by about 3 %. (Page 26)

Summary

This analysis shows considerable reduction in the use of irrigation water and significant gains in water use efficiency by the corn producers in the region. Genetic improvements that led to high yielding varieties and practices that enhanced the efficiency of water use such as advances in irrigation scheduling, adoption of conservation tillage practices, and shifting to more efficient irrigation equipment were the major factors that led to these improvements in yield and water use efficiency.