COMPARISON OF PRODUCTIVITY AND PROFITABILITY TRENDS OF MAJOR CROPS IN THE TEXAS NORTHERN HIGH PLAINS

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Abstract

The Northern High Plains of Texas is a major crop growing area, where irrigated corn production dominates other major crops, in both acreage planted and water used. Cotton, grain sorghum, and wheat are produced to a lesser extent, although each are significant crops in the region. This study compared productivity changes, as well as changes in both nominal and real Returns Above Variable Cost (RAVC), for the four irrigated crops between 1970 and 2014. As expected, productivity (yield per acre, expressed as a percent of average yield over the study period) increased for all crops studied, although cotton had substantially higher yield increases that the other three. Productivity increases, however, do not necessarily lead to higher profitability. Using Extension budgets to calculate revenue and variable costs per acre, RAVC was calculated for each crop each year. Nominal RAVC increased for corn and cotton, but decreased for sorghum and wheat across the years. When converted to real returns using the Farm Machinery Price Index (2011 base), all four crops showed negative trend in real RAVC over the study period.

Introduction

The Northern High Plains (NHP) of Texas is an important agricultural region in the state. Corn dominates the agricultural water use in the region, consuming about 60% of annual irrigation water (Freese and Nichols Inc., 2015). Corn also occupies the largest share of irrigated acreage in the summer cropping season, with cotton and grain sorghum being its major competitors. The average irrigated acreage over the last 40 years for corn, cotton, and grain sorghum were 716,000, 550,000, and 402,000 acres, respectively. The predominant share of irrigated acreage in the winter cropping season is planted to wheat. The average irrigated acreage planted to winter wheat over the last 40 years was on the order of 844,000 acres in NHP (USDA NASS, 2015). Since NHP is a low-rainfall region without any significant surface water sources, the Ogallala Aquifer is the principal source of irrigation water in the region. Dwindling water supplies from the Ogallala Aquifer (McGuire et al., 2003) and increasing cost of production make improvements in water use efficiency and productivity important concerns for producers.

Crop productivity (yield/acre) tends to rise over time for most of the agricultural crops. For example, the average corn yields in the United States increased from less than 30 bushels per acre in 1900 to more than 150 bushels per acre in the first decade of 2000 (Egli, 2008). Several factors contributed to such a dramatic gain in productivity. Corn, being a C_4 plant, is genetically more efficient in the use of resources because of its C_4 photosynthetic pathway (Jones, 1983; Pearcy and Ehleringer, 1984). Most of the yield improvement in corn can be attributed to improved hybrids such as the introduction of double crossed hybrids around the 1930s and single cross hybrids in the 1960s (Hallauer, 2008). It is also interesting to note that 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 typical plant density was 12,000 plants per acre in the 1930s, and it was increased to 31,600 plants per acre by the 1990s (Duvick and Cassman 1999). Similarly, cotton yields also showed considerable increase, with an annual increase of 5.99 lbs. per acre for the US. This increase has been attributed to better insect management, agronomic improvements, and the introduction of newer varieties with higher yield potential (Meredith, 2000). However, there are considerable differences in the rate of yield increase among crops and among different geographical regions in the US. The variations among crops are mainly due to differences in crop characteristics and the economic importance of the crop, which determines the research and development efforts for that crop. The geographical differences are due to differences in technology adoption, management practices, water availability and the influence of climatic conditions.

Although technological advances and higher adoption of advanced practices by producers have greatly improved input use efficiency and productivity of these crops over time, these productivity trends may not align with profitability because of fluctuations in commodity prices and production costs. Hence, estimating profitability of

various crops and analyzing profitability trends will provide us more information on profitability of major crop enterprises in the region. However, comparing nominal profits may not provide the actual trends in profitability because of the role of inflation on costs and prices. Hence, it is important to adjust for inflation and compare real profits. Therefore, the objectives of this study were to estimate and compare annual increase in productivity (yield/acre) for irrigated corn, cotton, winter wheat, and grain sorghum in NHP of Texas and to analyze the trends in profitability (returns above total variable cost) of irrigated corn, cotton, grain sorghum, and wheat in terms of both nominal and real returns.

Materials and Methods

Historic productivity for corn, cotton, grain sorghum and winter wheat under both irrigated and dryland conditions were collected (USDA NASS, 2015). Simple linear regressions (OLS) were used to estimate yearly productivity increase for each crop under each condition. This allowed us to compare the yield improvements of the same crop under irrigated and dryland conditions.

In making the comparisons, it is important to note that cotton productivity is reported in lbs. per acre whereas the productivity of grains is in bu. per acre. Moreover, the bushel weight is also different for small and large grains. Hence, crop yields were converted to relative yields to have meaningful comparisons. Relative yield was calculated for each crop in each year as the percentage yield relative to the average yield of that crop from 1975 to 2015. Simple Linear Regression was then used to estimate the yield trend line over time for each crop.

The productivity data for irrigated cotton, corn, winter wheat, and grain sorghum for NHP of Texas was used along with their corresponding prices (USDA NASS, 2015) and cost of production data (Texas A&M AgriLife, 2015) to calculate Returns Above Variable Cost (RAVC) for the crops. The cotton lint-seed ratio for each year was used to calculate cottonseed yield, and the revenue from wheat grazing were drawn from the estimates reported in the respective crop budgets (Texas A&M AgriLife, 2015). The farm machinery price index (USDA NASS, 2015) was used to convert nominal profit to real profit for the four crops from 1990 to 2014. Simple Linear Regressions were then used to estimate trends in profitability (both nominal and real) for each crop.

Results and Discussion

The analysis of productivity trends of individual crops indicated that the average increase in corn yield was 1.74 bu. /acre /year from 1972 to 2014. However, if we discard 2011 yield data (2011 was an extreme drought year which resulted in many acres not harvested or with extremely low yield), then the average annual yield increase of corn was 2.23 bu. / acre. Irrigated cotton showed an annual yield increase of 18 lbs. /acre, while dryland cotton yields increased by only 5.2 lbs. /acre /year. Grain sorghum and wheat yields were essentially stagnant over the years studied. Grain sorghum yields decreased by 0.08 bu./acre/year for irrigated acres, and increased by 0.16 bu./acre/year for dryland acreage. The average annual wheat yield increase was 0.38 and 0.25 bu./acre for irrigated and dryland crops, respectively.

Since corn is cultivated only under irrigation in the region, the yield and profitability of the four crops were compared under irrigated conditions. The descriptive statistics of the yield and Returns Above Variable Cost (RAVC) data for irrigated cotton, corn, sorghum, and wheat are presented in Table 1.

Table 1. Descriptive Statistics of irrigated yield and profit data for cotton (lint only), corn, wheat, and sorghum

Statistic	Yield/acre (lbs. for cotton and bu. for the rest)				Returns above variable cost ($/acre)			
	Cotton	Corn	Sorghum	Wheat	Cotton	Corn	Sorghum	Wheat
Mean	669.46	173.15	86.31	38.86	$74.62	$115.94	-$21.71	-$21.82
Minimum	260.00	135.40	68.40	25.00	-$174.12	-$88.52	-$185.30	-$131.65
Maximum	1188.00	213.10	102.60	61.90	$383.59	$418.60	$123.93	$60.79
Standard Deviation	253.54	22.31	8.89	7.84	$111.84	$114.36	$63.04	$48.80

It can be observed from Table 1 that cotton yields showed very high year to year variability. Among the grains, productivity of corn was much higher than wheat and sorghum. However, sorghum and wheat yields were more stable compared to corn yields. Average RAVC was the highest for corn ($115.94/acre), followed by cotton ($74.62/acre). The variability in profits was also similar for corn and cotton (Table 1). The average RAVC was

negative for both grain sorghum and wheat. It should be noted that the RAVC was calculated based on productivity and price only, and any available government payments were not taken into consideration.

The relative yields of the four crops under irrigated condition are presented in Figure 1. This analysis indicated that cotton had the largest annual productivity increase (2.77%), followed by corn (1.29%). Winter wheat showed 0.53% yield increase per year while grain sorghum showed only 0.45% annual yield increase (Figure 1). Many researchers attribute the high level of productivity increase in cotton to genetic potential of newer varieties and widespread adoption of better management practices including insect management programs.

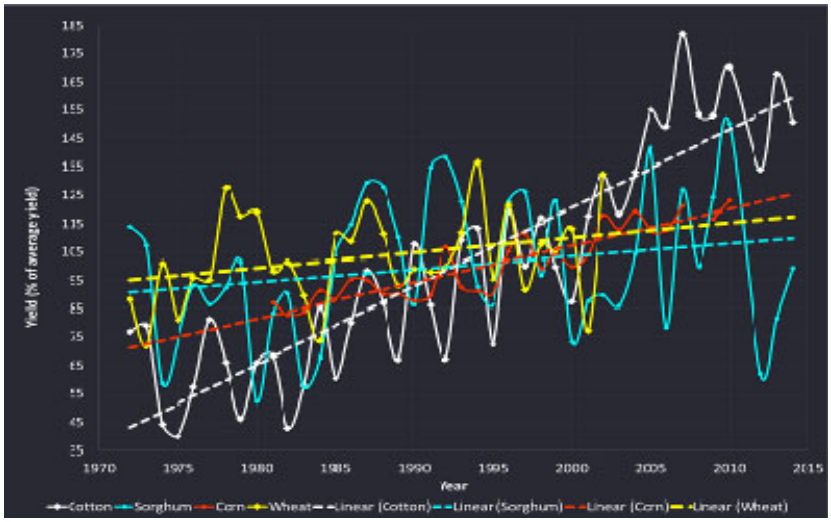

Figure 1. Relative yield (% of mean yield) of irrigated crops in NHP of Texas.

Yearly returns above variable cost (RAVC) for the four irrigated crops for each year are presented in Figure 2. Cotton and corn showed a positive time trend in nominal profit (RAVC) while grain sorghum and winter wheat showed a decrease in nominal profit over time. Nominal RAVC increased by $2.33 and $1.68 per year for cotton and corn, respectively. Nominal profit for sorghum decreased by $2.89 per year, while the annual decrease in nominal profits was $2.29 for wheat (Figure 2). The yearly RAVC also indicate that corn and cotton had positive nominal profits for majority of the years, whereas grain sorghum and wheat recorded a loss in many (21 and 23 years, respectively) of the 36 years in the study.

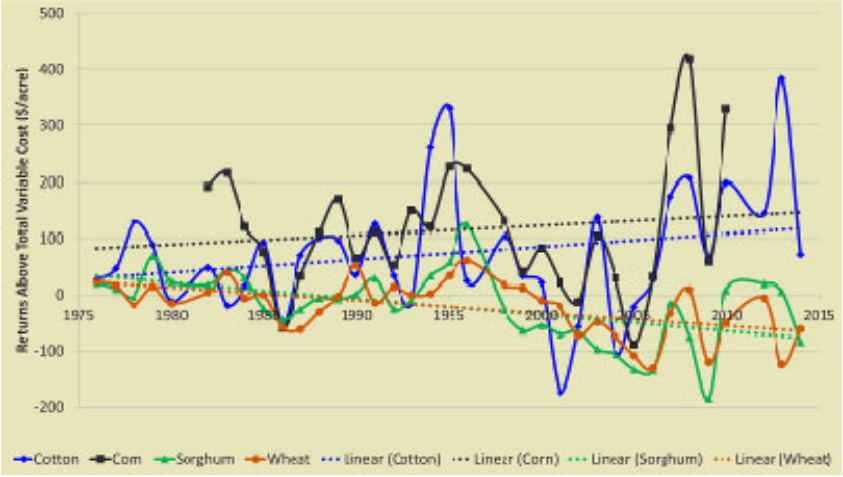

Figure 2. Returns above total variable cost (nominal) for irrigated crops in NHP

The real profits (RAVC adjusted for inflation) for the 4 crops were calculated only from 1990 onwards due to limitations in data availability. The real RAVC (2011 = base) for irrigated cotton, corn, grain sorghum, and wheat are presented in Figure 3. It is interesting to note that the real profits decreased over time for all four crops. The average annual decrease in real RAVC was $3.19, $4.30, $5.48, and $6.64 for irrigated cotton, corn, grain sorghum, and wheat, respectively. This shows that, even though profitability of corn and cotton are increasing over the years in nominal terms, the increase is not large enough to offset the inflation (as measured by increase in farm machinery price) during that time period.

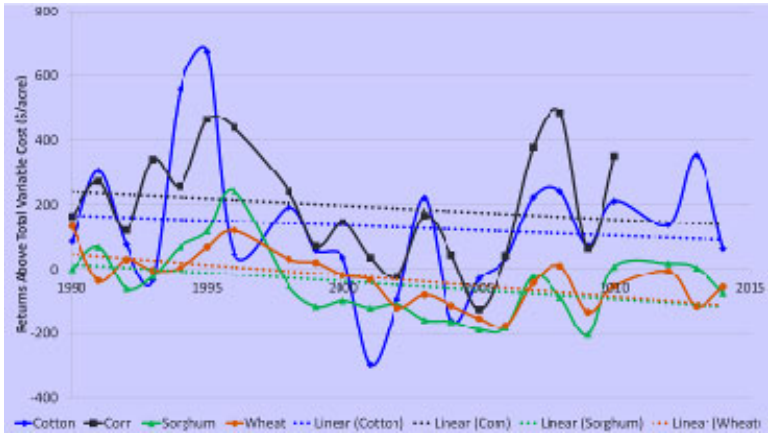

Figure 3. Returns above total variable cost (real) for irrigated crops in NHP

Summary

Irrigated crops continue to be a major agricultural endeavor in the Northern High Plains of Texas. Over 2.5 million acres of irrigated corn, cotton, grain sorghum, and wheat are planted each year in the region. As technology advances and crop management techniques are refined, increases in physical productivity are evident. Each of the four crops studied increased in yield, as measured by the percent difference from the average yield for each crop over the three-decade study period. Cotton had the highest percentage yield increase, with a 2.77% average annual increase. Corn was a relatively distant second, increasing by less than half of the cotton rate, at 1.29%. While both grain sorghum and wheat showed numerical increases, each only grew by about one half of a percent, with 0.45% and 0.53%, respectively.

Farmers would generally expect that increases in yield would lead to increases in profitability, but that has not shown to be the case. In nominal terms, only corn and cotton demonstrated a trend of higher revenues than variable costs over time, when using Extension budget price and cost data to calculate. The results revealed that crop revenues did not cover variable costs for grain sorghum and wheat in more than half of the years studied, and the trend over time was negative. Of particular interest for practitioners is that not only did the revenues frequently not cover variable costs, fixed costs were not considered, but of course must be when the farmer goes to balance the books and determine the success each year.

Furthermore, these nominal profits do not indicate the effect of price inflation on the values, and so are not comparable year-to-year. The data were subsequently translated from nominal to real values using the farm machinery price index (using 2011 as base year), allowing comparisons to be made among years. In real terms, the outlook is even grimmer. All four crops showed decreasing real returns over variable costs over the study period. For corn and cotton, the real profits remained mostly positive while showing a negative time trend. However, for both sorghum and wheat, the trend line has not been in positive territory since the late 1990s.

Finally, the variability of the returns should be considered. Both corn and cotton were much more highly variable than sorghum and wheat. Although their returns were higher, variability in return is considered a measure of risk, so irrigated corn and cotton production are more risky endeavors than sorghum and wheat production.

Acknowledgements

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