Analysis of Cattle Grazing Effects on Profitability in a Dryland Wheat-Sorghum-Fallow Rotation with an El Nino-La Nina Decision Variable

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Introduction

In the Texas High Plains irrigated land has decreased by 0.55 million ha from 1974 to 2000, partially due to the decline of the Ogallala Aquifer (Figure 1). The lack of sufficient water resources for continued irrigation may begin to impact profitability of operations. In order to enhance profitability, producers incorporate cattle grazing. It has been shown that grazing wheat for forage or dual purpose forage and grain production increased profitability over the corresponding grain-only system. Although cattle grazing intensifies production of the dryland wheat, sorghum, fallow (WSF) rotation (Figure 2) in the United States Southern High Plains, the level of risk associated also intensifies when cattle are introduced. In an attempt to aid producers in their decision making processes, a consistent and thorough analysis of the El Nino-La Nina Decision Variable, and the typically wet or dry weather patterns that accompany them is merited (Figure 3). As forecasts have come to predict the oncoming El Nino-La Nina years, producers can use the information to make more informed dryland management decisions.

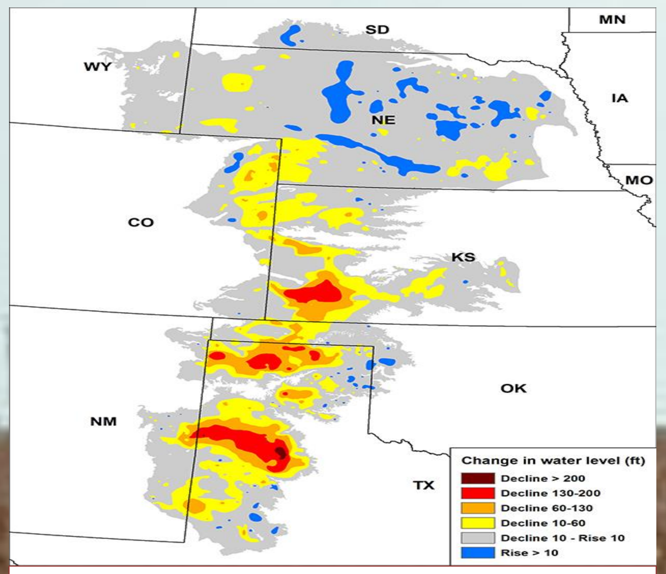

Figure 1. Aquifer Water Level Change

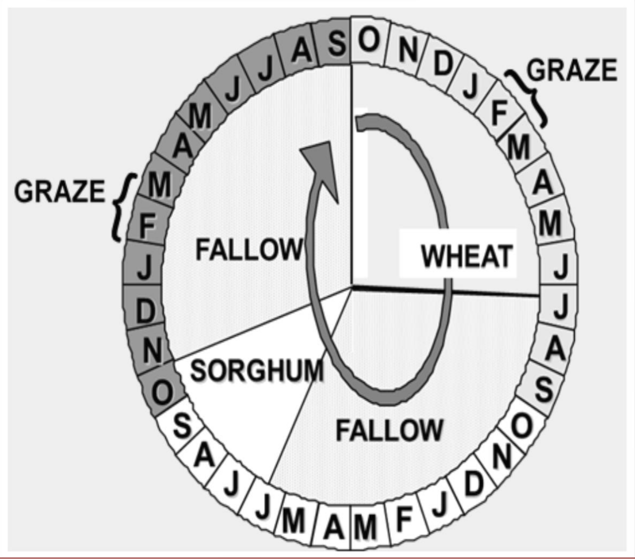

Figure 2. Wheat-Sorghum-Fallow Rotation

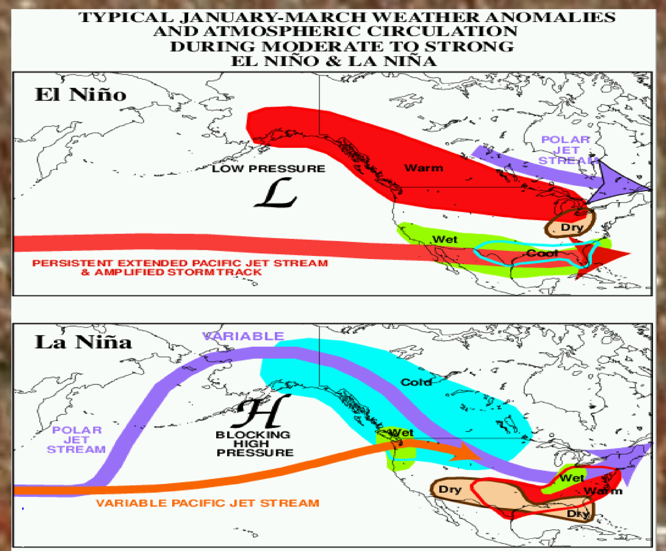

Figure 3. El Nino Southern Oscillation Pattern

Objectives

- To provide a consistent and thorough analysis of the incorporation of El Nino-La Nina years as information when deciding to graze or not graze the dryland WSF rotation in the Southern High Plains.
- To evaluate the viability and subsequent deviation of profitability when cattle grazed are owned as opposed to a more risk-averse approach of leasing out the grazing to another producer.

Materials and Methods

From 1999-2009, the WSF rotation phases were established in duplicate ungrazed and grazed plots in three replicated paddocks in Bushland, Texas. Blocks were randomly assigned to each of the three phases. Each block contained randomly assigned grazed or ungrazed treatments in two 165 meter wide paddocks. Paddocks were then divided into three 55 meter wide plots that were assigned one of three phases in the WSF rotation (Figure 4). Cattle were bought in the first quarter of the year and were contained with electric fences. The target stocking rate for each acre was 1,600 pounds, depending on available forage, this yielded an approximate .95 head per acre (Figure 5). Cattle gain was calculated as the difference between stocking and pull off weights, determined after 1-d shrinkage.

Enterprise budgets generated by the Texas A&M Agrilife Extension Service were used to determine variable and fixed costs for each enterprise. Average monthly cattle prices for the purchase and sale date were generated by collecting sales data from 2014-2017 for the Amarillo, Dalhart, and Tulia Livestock Auctions. Wheat and sorghum grain prices were obtained from the National Agricultural Statistics Service (2017) for the years 2014-2017 and then averaged. The Decision Variable of El Nino-La Nina years was then incorporated into the model. It was determined that grazing would be done in the El Nino years, and no grazing would be done in the typically dryer La Nina years. The phase years were determined from NOAA Research (2017), with the years '00, '01, '08 and '09 being La Nina, and '02-'07 being El Nino. Once incorporated, the profitability of the separate decisions was determined.

Figure 4. Sorghum – Wheat Transition

Figure 5. Cattle on Sorghum Stover

Profit Functions

- Sorghum
  - $\text{Profit} = (\text{Price}_{\text{Per Bushel}} * \text{Yield}_{\text{Per Acre}}) - \text{Fixed Cost}_{\text{Per Acre}} - \text{Variable Cost}_{\text{Per Acre}}$
- Wheat
  - $\text{Profit} = (\text{Price}_{\text{Per Bushel}} * \text{Yield}_{\text{Per Acre}}) - \text{Fixed Cost}_{\text{Per Acre}} - \text{Variable Cost}_{\text{Per Acre}}$
- Stocker Cattle
  - $\text{Profit} = (\text{Sell Price}_{\text{Per Pound}} * \text{Sell Weight}_{\text{Per Pound}}) - (\text{Purchase Price}_{\text{Per Pound}} * \text{Purchase Weight}_{\text{Per Pound}}) - \text{Variable Cost}_{\text{Per Head}}) / \text{Total Acres}$
- Ungrazed System
  - $\text{Profit}_{\text{Ungrazed Sorghum}} + \text{Profit}_{\text{Ungrazed Wheat}}$
- Owning Grazed System
  - $\text{Profit} = \text{Profit}_{\text{Grazed Sorghum}} + \text{Profit}_{\text{Grazed Wheat}} + \text{Profit}_{\text{Stocker Cattle}}$
- Contracting Grazed System
  - $\text{Profit} = \text{Profit}_{\text{Grazed Sorghum}} + \text{Profit}_{\text{Grazed Wheat}} + (\text{Total Gain} * \text{Contract}_{\text{Price}})$
- Decision Variable System
  - $\text{Profit Own} = \text{Profit}_{\text{Ungrazed: 00, 01, 08, 09}} + \text{Profit}_{\text{Grazed Own: 02, 03, 04, 05, 06, 07}}$
  - $\text{Profit Con} = \text{Profit}_{\text{Ungrazed: 00, 01, 08, 09}} + \text{Profit}_{\text{Grazed Contract: 02, 03, 04, 05, 06, 07}}$

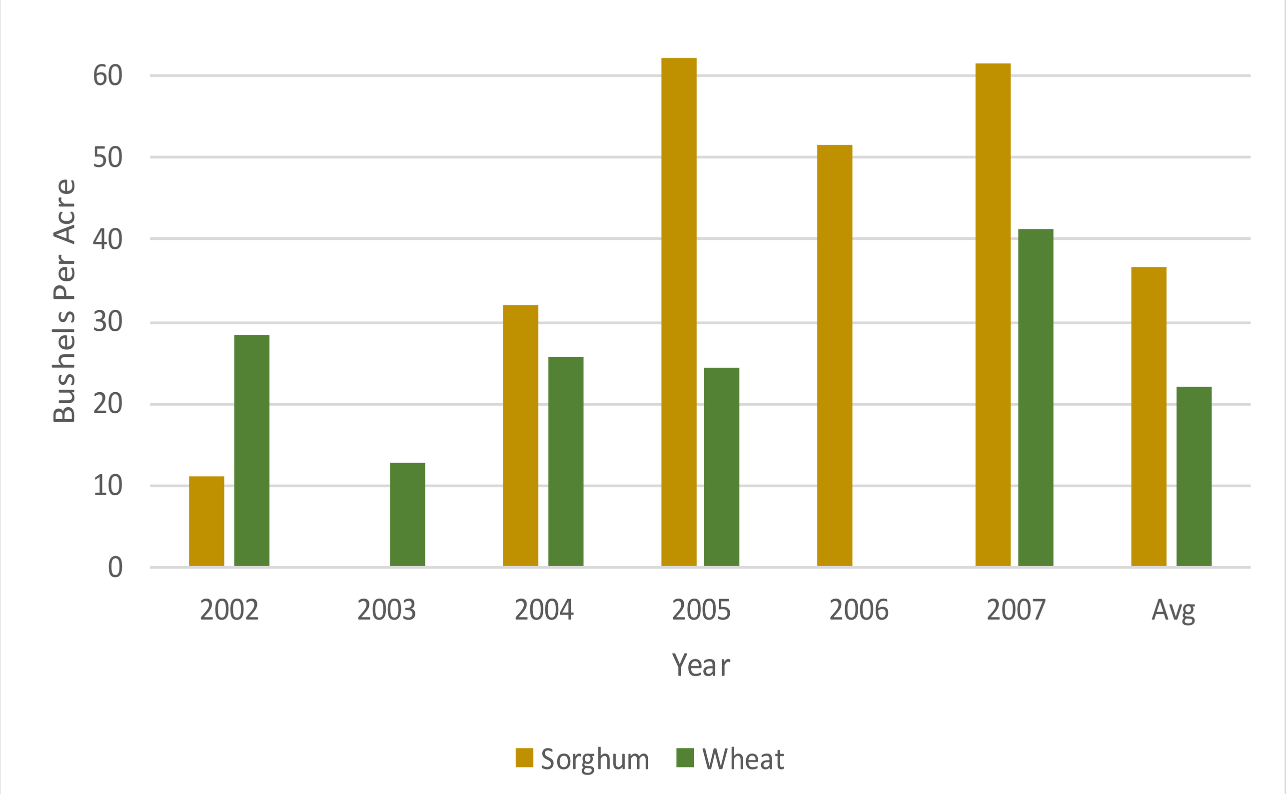

Figure 6. Wheat-Sorghum-Fallow Crop Yield in El Nino Years

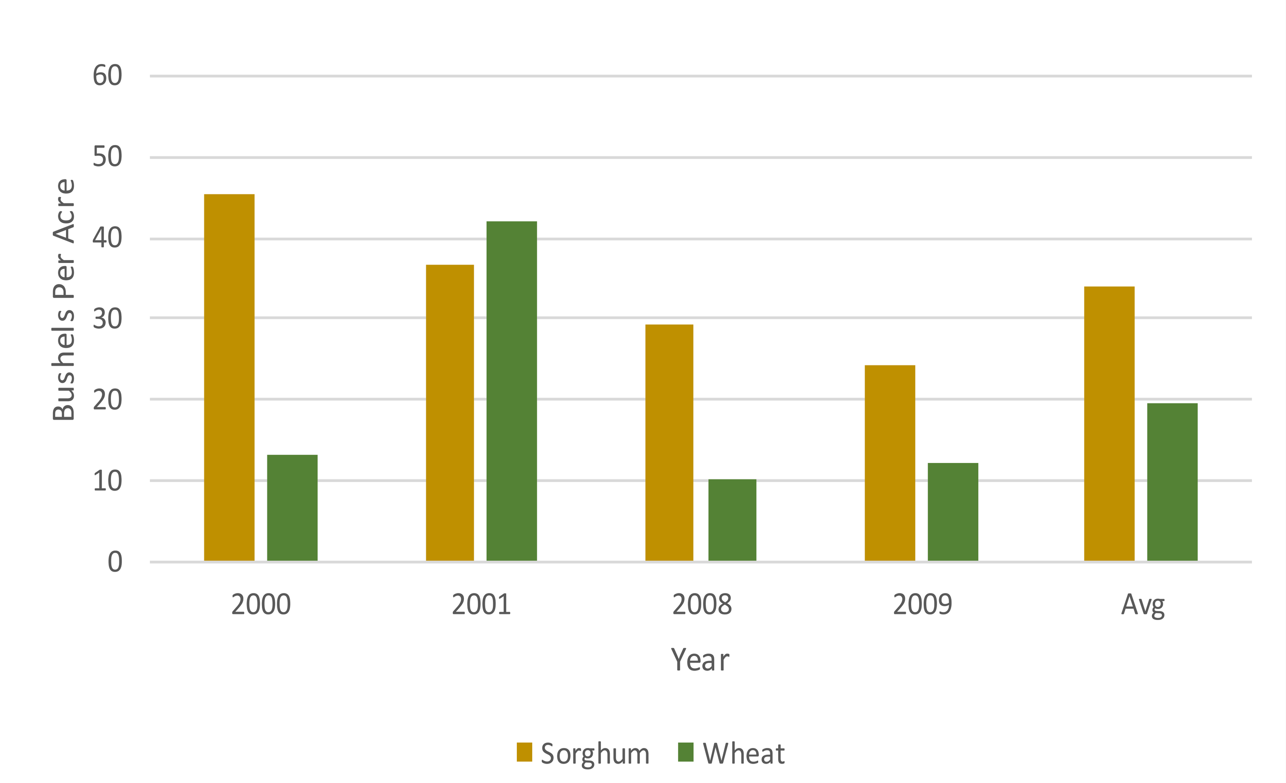

Figure 7. Wheat-Sorghum-Fallow Crop Yield in La Nina Years

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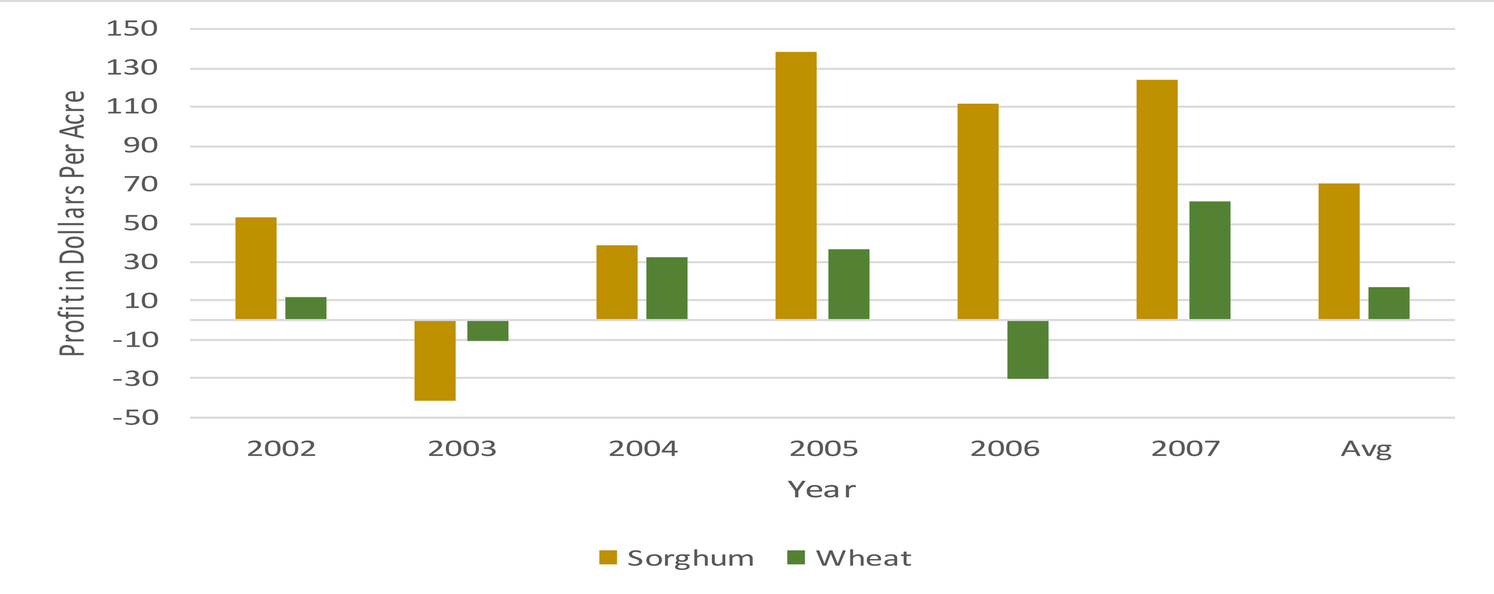

Figure 8. Wheat-Sorghum-Fallow Crop Profit in El Nino Years

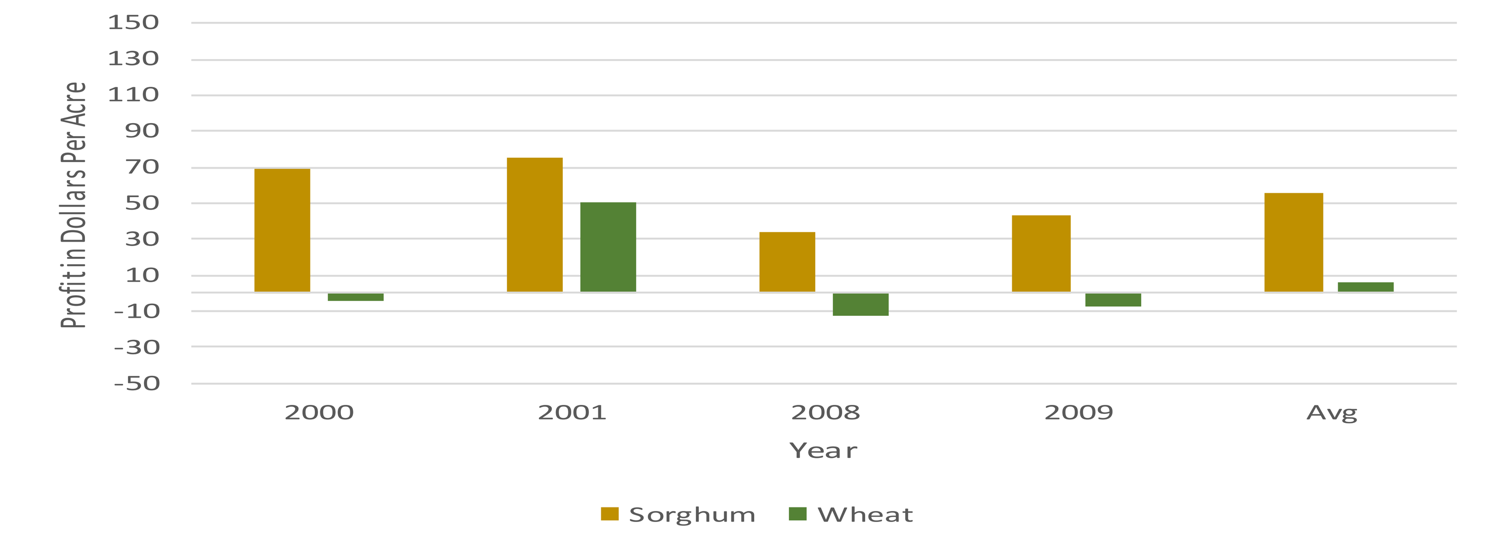

Figure 9. Wheat-Sorghum-Fallow Crop Profit in La Nina Years

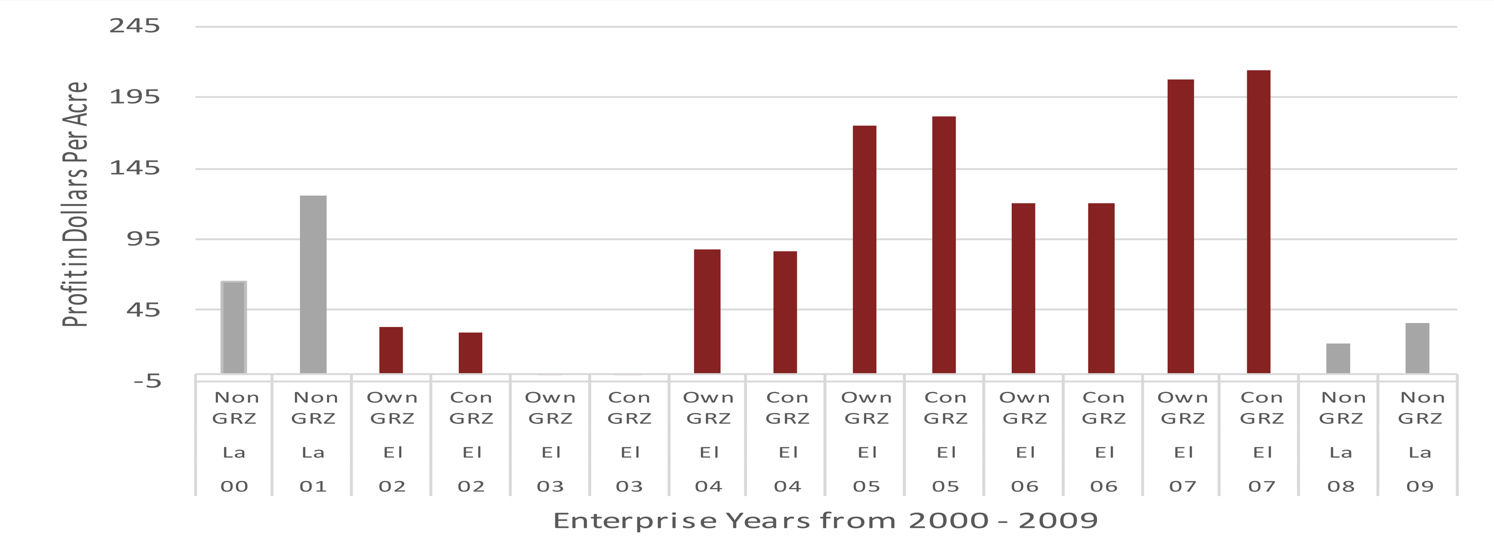

Figure 10. Profit by Enterprise with Decision Variable

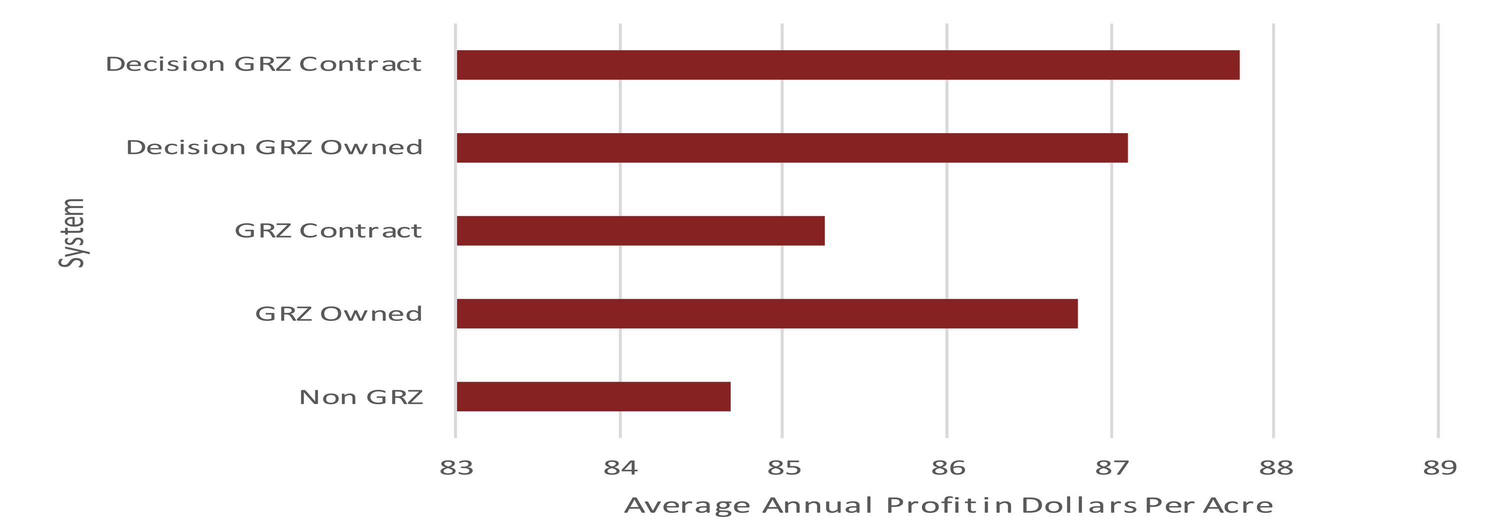

Figure 11. Profit Summary by System, 2000-2009

Results and Conclusion

Over the study period, 2000-2009, crop yields when using the El Nino-La Nina decision variable were higher for both sorghum and wheat during the El Nino years. On average, the yields for sorghum were 2.61 bushels per acre greater than the La Nina years, and the wheat was 2.60 bushels greater. (Figure 6 & 7). The crop profit during the El Nino years was also greater than the La Nina years, with sorghum being greater by $15.46 per acre and wheat $10.75 per acre (Figure 8 & 9). Both of these differences, in yield and profit were significant ($P < .05$). Using the decision variable was also found to negate some level of risk, as there was only one year in which producers lost money (Figure 9). The profit by system also showed that the largest profit per acre came when the decision variable was incorporated on whether or not to graze. Using the variable and contracting the cattle to negate risk proved to have the highest per acre profit at $87.79 per acre (Figure 11). The next highest was the system in which the decision variable was used again, but the cattle were owned, with a profit of $87.10 per acre (Figure 11). Overall, grazing the WSF rotation was more profitable in every scenario than non-grazing, and using the decision variable, whether owning or contracting cattle, increased profit over every other system.

Ogallala Aquifer Program. A research consortium between USDA-Agricultural Research Service, Kansas State University, Texas A&M AgriLife Research and Extension, Texas Tech University, and West Texas A&M University.