Declining Ogallala Aquifer and Texas Panhandle Economy

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Abstract:

The Texas Panhandle is one of the most unique and diversified agricultural areas in the world. Production agriculture contributes $3.41 billion in value-added production and more than $6.32 billion in economic activity annually. Eighty-five percent of the state's fed beef, 45.8 percent of the wheat, 61.9 percent of the corn, and 23.0 percent of the sorghum are produced in the region. The growing livestock industry has accelerated the demand for feed grains in the area and has increased irrigation water demand. The Ogallala Aquifer is the primary source of irrigation water in the region. The depletion of the Ogallala by the excessive pumping of water is threatening the rural economy of the area.   There is a critical need for developing sound water management policies that may result in balancing utilization and extending the life of the Ogallala to sustain the rural economies.

Greater efficiency from the application of irrigation water through effective water management strategies and reallocation to higher value products can greatly reduce the rate of decline of the rural community and stabilize the availability of services in the area. The development of value added industries and transportation and distribution centers, and the expansion of medical and retirement facilities could significantly increase job availability and add stability to the rural communities.

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Introduction:

The Texas Panhandle is a typical semiarid area with little rainfall and hot summer weather. It comprises of the northern twenty-six counties of Texas. The Texas Panhandle is one of the most unique and diversified agricultural areas in the world. Production agriculture in the Texas Panhandle is a major component of Texas agriculture. The area consists of approximately 14 million acres of agricultural land. Out of this total, more than 5 million acres are devoted to cropland, while the remaining acres are used for pasture. Approximately 40 percent of the cropland is in irrigated production. More than 25 crops are grown commercially with corn, grain sorghum and wheat being the major crops in the area.

The region is also often referred to as the cattle feeding capital of the world. In 1998, cattle fed for slaughter in the Texas High Plains topped 6.2 million head (Bilbrey et. al., 1999), 85 percent of the state's total. The fed cattle industry plays a vital role in the economy of the area. The cattle feeding satellite industries have attracted such national firms as IBP, ConAgra Inc. and Excel, which are all major employers in the area. The favorable conditions that brought the cattle industry to the area are now attracting the hog industry. The growing livestock industry has accelerated the demand of feed grains in the area. This expanding demand has attracted area producers to commit more inputs to these crops. As a result water demand for irrigated agriculture has increased.

The agricultural industry has a significant impact on the economy of the area. According to Amosson (1999), production agriculture contributes $3.41 billion in value-added production and more than $6.32 billion in economic activity annually in the Texas Panhandle area. An estimated 46,875 agribusiness jobs are contributed to the regional economy by the agriculture in

3

the area. Twenty-five percent of all cash receipts for crops and livestock in Texas come from the Texas Panhandle. Eighty-five percent of the state's fed beef, 45.8 percent of the wheat, 61.9 percent of the corn, and 23.0 percent of the sorghum are produced in the region.

The Texas Panhandle is a semi-arid region with a great deal of year-to-year variation in precipitation. This leads to a great deal of variation in the year-to-year production of agricultural products under natural precipitation. Therefore the Texas Panhandle relies on irrigation to both increase and stabilize production. The Ogallala Aquifer, which underlies the Panhandle and portion of seven states, is the primary source of irrigation water in the Texas Panhandle region. Due to very limited recharge, continued pumping from the Ogallala Aquifer has resulted in a declining water table. As agricultural production expanded, the rural infrastructure developed, rural communities grew and local governments provided increased services for the small town and rural residents. The continued requirements of the agricultural, municipal, and industrial sectors emphasize the critical need for alternative water management plans. It is theorized that the decline in irrigation will result in lower revenue from agriculture, reduced demand for goods and services in the rural communities, and less tax revenue to maintain the infrastructure and provide health, education, police, and fire protection services.

Objectives:

The economic development of the top 26 counties in the Texas Panhandle has been impacted by the development of water sources from the Ogallala Aquifer. As the water level in the Ogallala declines, agriculture and the rural communities must adjust to the new economic realities of reduced agricultural production, reduced revenue, lower tax revenues, and reduction in the availability of community services. The objectives of this study are:

4

1) To document the relationship between the development of water sources from the Ogallala Aquifer and the growth and development of rural communities and agricultural production in the top 26 counties in the Texas Panhandle

2) To address the impact of the declining water availability from the Ogallala Aquifer on the viability of the rural communities in the area.

Study Area and Data Collection:

This research focuses on analyzing the change in water availability and use on the production of grains and on the rural economy. The study performs an analysis of the water conditions and it's influence on the production of grains, which include wheat, sorghum, and corn in different counties. It focuses on the 26 counties in the Texas Panhandle--- Armstrong, Briscoe, Carson, Castro, Childress, Collingsworth, Dallam, Deaf Smith, Donley, Gray, Hall, Hansford, Harley, Hemphill, Hutchinson, Lipscomb, Moore, Ochiltree, Oldham, Parmer, Potter, Randall, Roberts, Sherman, Swisher and Wheeler, Figure 1.

To estimate the economic implications of the depletion of the Ogallala Aquifer for the study area, the data from the census of business pattern and Census of Agriculture are used to analyze the economic impact resulting from changes in grain production in the Texas Panhandle as the availability of irrigation water declines. Production of crops and livestock information is collected from the various issues of Census of Agriculture and state agricultural statistic from 1900 to 1997. Trends of production are analyzed to show how the changes in water resources and irrigation development affect the yield of different kinds of crops and livestock.

County population and business development data were extracted from the US Bureau of Census and the Census of Business and Industry from 1900 to 2000. The trends in population provide the development pattern for each of the 26 counties in the Texas Panhandle. Historical

records of employment and payroll were collected from 1964 to 1997. This information was used to analyze the impact of agriculture on the business and economy of different counties. The economic impacts of agricultural production and the expansion of the cattle feeding industry on the establishment of infrastructure, the expansion of rural communities and rural services were assessed in the light of declining availability of water from Ogallala Aquifer.

Results and Discussion:

In the Texas Panhandle, the Ogallala Aquifer is the major water resource for agriculture, industry and human society. The current statues of ground water utilization reflect the current economy, and social condition in the Texas Panhandle. Since the 1950s, irrigation has played an important role in agricultural development in this area. As the Ogallala is the only major water resource for irrigation in the Texas Panhandle, the availability of groundwater for irrigation has been an important factor in the economic growth of the Texas Panhandle's economy. In the 26 counties that make up the Texas Panhandle, the cattle feeding industry, and the grain crops including corn, wheat, and sorghum are the most important agricultural production in this region.

The historical data revealed that the corn was grown under dry land conditions in the 1920s, Figure 2. There were more than 100,000 acres of dry land corn in the 26 counties in the 1920s and 1930s, but production was poor and corn disappeared as a grain crop for several decades until the late 1960s when it returned as an irrigated crop. Corn production has increased rapidly and now accounts for about 60% of all grain produced in the 26 northern counties in Texas Panhandle. Irrigated corn is presently grown on about 650,000 acres in the 26 counties, Figure 2.

Grain sorghum production grew rapidly beginning in the 1950s as a result of the development of hybrid grain sorghum, irrigation and expansion of nitrogen fertilization.

Production peaked in the 1960s and has decreased significantly although production appears to be stabilizing in recent years. Dry land acres of grain sorghum accounted for about 60% of the grain sorghum acres in 1997, Figure 3.

Historical records collected from the U. S. Census of Agriculture indicate that before 1950s, most of the wheat was grown under dryland conditions, but dryland wheat acreage dropped from more than three million acres in the 1940s to about one million acres in 1990s, Figure 4. Irrigated wheat acreage has remained relatively stable at about 550,000 acres since the late 1950s. Historical records of grain production indicate that, in the Texas Panhandle, it is higher today than it has ever been in history. This has occurred even though the Aquifer level has decreased significantly and less irrigation water is being used. The total grain production has increased significantly reflecting an increase in water use efficiency. The continuation of this trend in the future as the Ogallala Aquifer level continues to decline is questionable.

The livestock industry plays a vital role in the regional economy. The number of cattle and calves sold in this region has significantly increased from 0.47 million 1940 to 6.1 million in 1997. The value of cattle and calves sold has also increased from $64.926 million in 1949 to $4.086 billion in 1997, Figure 5. Historical records from 1940 to 1997 of estimated market value of agricultural products sold have revealed that prior to 1960, the market value of agricultural products sold increased slowly from $51.736 million in 1940 to $268.944 million in 1959, Figure 5. This is an 8.76% compound rate of growth. Largely in response to the application of irrigation, the market value of agricultural products sold in the Texas Panhandle has increased significantly from $310.438 million in 1964 to $4.956 billion in 1997. This represents a 9.06% compound rate of growth. Estimated market value of livestock, poultry and their products has

7

also increased rapidly with a 11.23% compound growth rate since 1964. The market value

increased from $124.631 million in 1964 to $4.175 billion in 1997.

The growing livestock industry in the region has increased the demand for feed grains. In

fact, the area has become a grain deficit production region resulting in premiums to be paid for

feed grains. This expanding demand for feed grain has enticed area producers to increase

irrigation resulting increased water demand for irrigated agriculture. Simple correlation analyses

presented in Table 1 indicated that irrigated corn acres, market value of agricultural products

sold, market value of livestock products sold, employment and payroll expenses in the region are

highly correlated. Correlation coefficient between irrigated corn and value of agricultural

products is 0.85 and it is 0.83 between irrigated corn and employment. The coefficients for

employment and payroll expenses with respect to market value of agricultural products are 0.91

and 0.97, respectively. This explains the significance of agriculture in the area. Grain production

depends on availability of groundwater for irrigation. The availability of grains has been an

important input for livestock industry that in turn provides an incentive for economic growth in

the Texas Panhandle economy.

Encouraged by the local agricultural industry, population shows a positive change in the

Texas Panhandle as a whole, Figure 6.   The population records from 1900 to 2000 revealed a

rapid increasing trend. In 1900, there were only 21,274 reported residents living in the Texas

Panhandle. By 2000, population in this area has reached 402,862. This increase mainly reflects

the increase in Potter, Randall and Moore counties. The population increase in Randall County

is largely due to Amarillo's southwestern expansion beyond the Potter county line, and the

emergence of Canyon as a virtual suburb of Amarillo. Potter and Randall counties almost

accounted for 53% of the population in the Texas Panhandle in 1997, Figure 7. However, in

most of the counties, there has been a negative change in population from 1990 to 2000, shaded area in Figure 7. Regression analysis indicates that population change is directly related to county population with the smaller counties decreasing and the larger counties gaining, Table 2. More than 7,000 residents were lost from the fifteen low populations, mostly rural counties during 1990-2000 period. This reflects the consolidation of farm operations and limited employment opportunities available in those rural counties.

The analyses indicated that the major north-south highways have significant positive impact on population change associated with the Denver-Dallas trade and development of the Canada-Mexico business corridor. Interstate 40, which is the main east-west, limited access highway, has no significant effect on population change indicating that traffic on the interstate does not contribute much to the small businesses and towns on its route.

It has been estimated that compared to the baseline growth in population, the region would expect decrease in population by 81,000 in 2030 and 261,000 in 2050 (PWPG, 2001). The expected 2050 population under the severe water shortage conditions would be 47 percent lower than the projected population in the most likely growth forecast. The forecasted population growth of the region would be economically restricted by reduction in job creation. This will cause both an out-migration of some current population and an expected curtailment of future population growth.

The total non-farm employment in this area has increased from 72,177 in 1964 to 121,560 in 1997 due to expansion in agricultural production and irrigation development. However, it has been forecasted that the unmet water shortage in future will reduce the job growth to 41,000 by 2030 and to 130,000 by 2050. The economy restricted by reduced water

9

availability from Ogallala Aquifer could not be able to create these jobs in order to sustain the rural communities in the area.

The depletion of the Ogallala by the excessive pumping of water is threatening the future development of agriculture and the economy of the Texas Panhandle. There is a critical need for developing sound water management policies that may result in balancing utilization and extension of the Ogallala life in order to sustain the rural economies of the area. Greater efficiency from the application of irrigation water, alternative water management strategies (Almas et al 2002), and reallocation of water to higher value products can greatly reduce the rate of decline of the rural community and the availability of services in the area. Expansion of the non-agricultural economic sectors through the development of value added process, the development of transportation and distribution centers, and the expansion of medical and retirement facilities could significantly increase job opportunities and add economic stability to the area.

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Table 1. Correlation matrix indicating relationship between irrigated corn acres, value of agricultural products, livestock products, employment and payroll expenses in the Texas Panhandle region.

Variable	Corn	Ag Value	Live Value	Employment	Payroll
Corn	1.00				
Ag Value	0.85	1.00			
Livestock Value	0.83	1.00	1.00		
Employment	0.83	0.91	0.90	1.00	
Payroll	0.73	0.97	0.96	0.91	1.00

Table 2. Analysis of Variance and Regression Statistics

Multiple R	0.987		
R Square	0.974		
Adjusted R Square	0.969		
Standard Error	744.086		
Observations	26		
Dependent Variable	Population Change		

ANOVA

	Df	SS	MS	F
Regression	4	430,701,406	107,675,352	194.478
Residual	21	11,626,934	553,664	
Total	25	442,328,340		

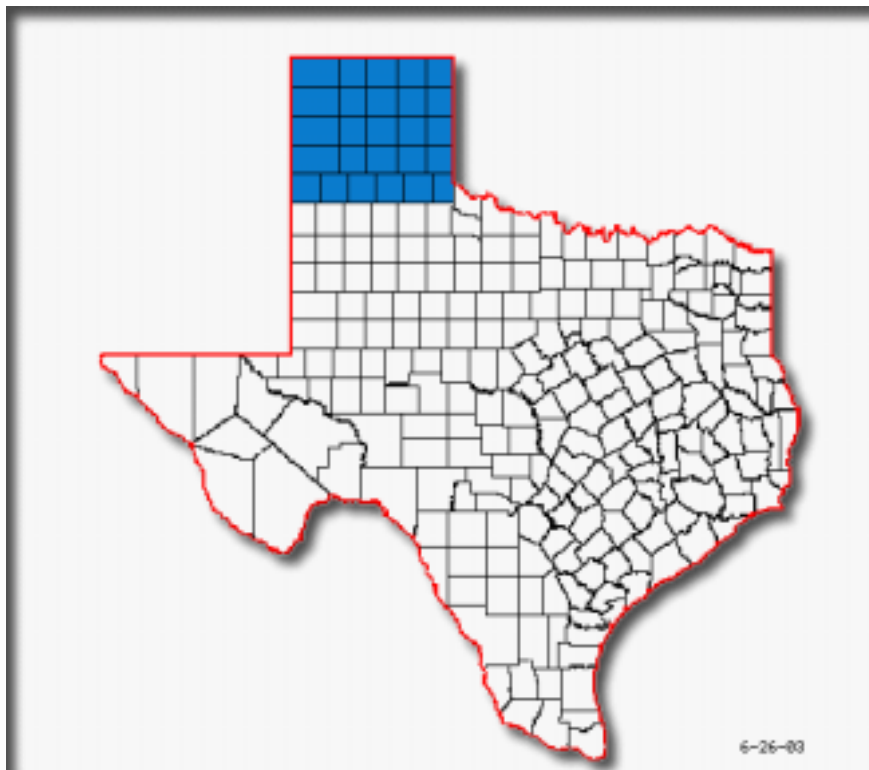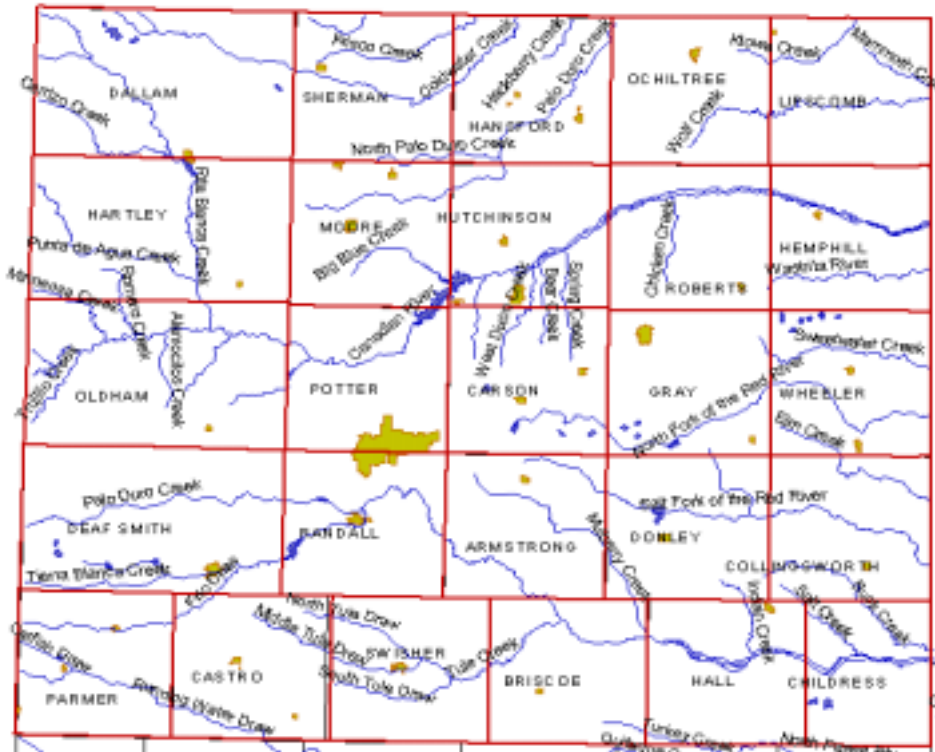|	Coefficients	Standard Error	t Stat	P-value
Intercept	-53.636	302.209	-0.177	0.861
Population	-78.414	29.457	-2.662	0.015
Population Square	2.418	0.306	7.909	0.000
N-S Highways	1287.705	333.463	3.862	0.001
E-W Highways	-271.496	407.739	-0.666	0.513

Figure 1.   The 26 Counties of the Texas Panhandle and their location in the State of Texas.
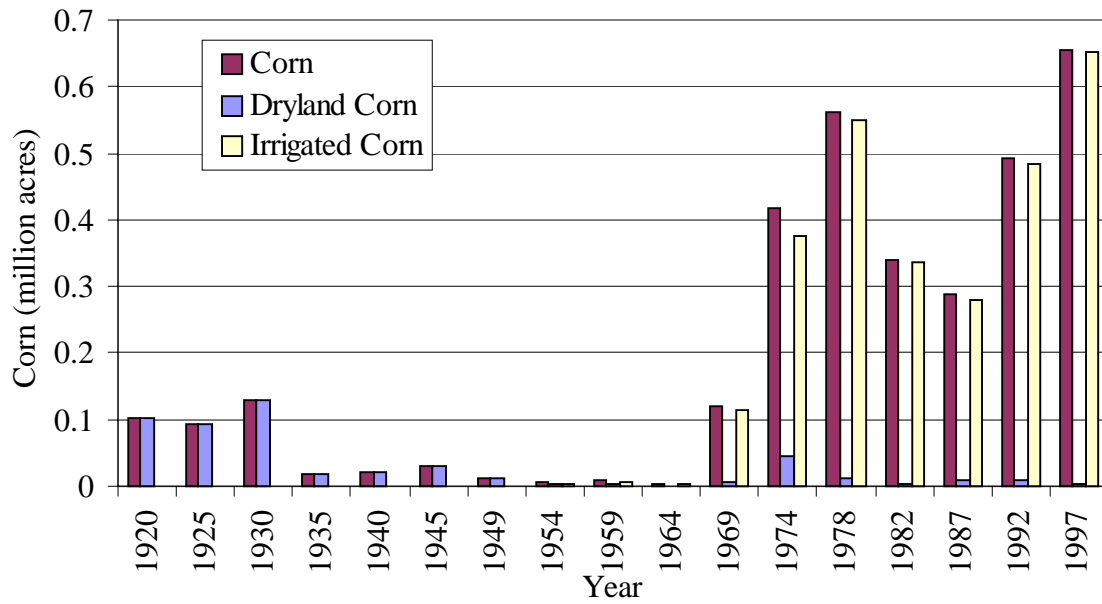
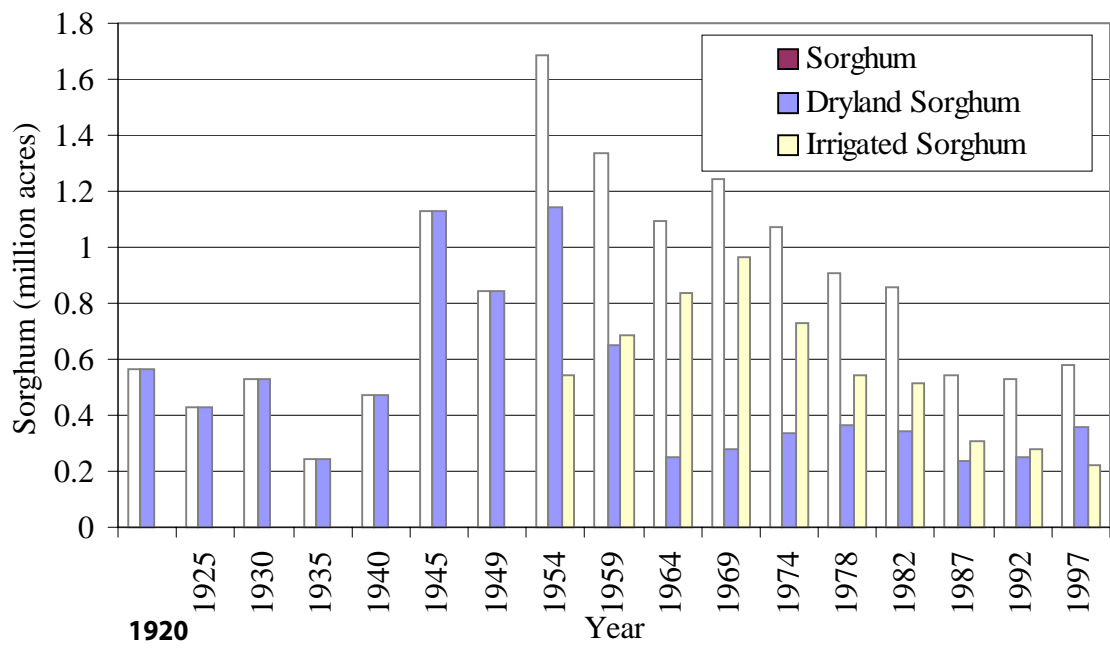Figure 2. Corn Acreage in 26 Counties, 1920-1997.

Figure 3. Acreage of Grain Sorghum in 26 Counties, 1920-1997.
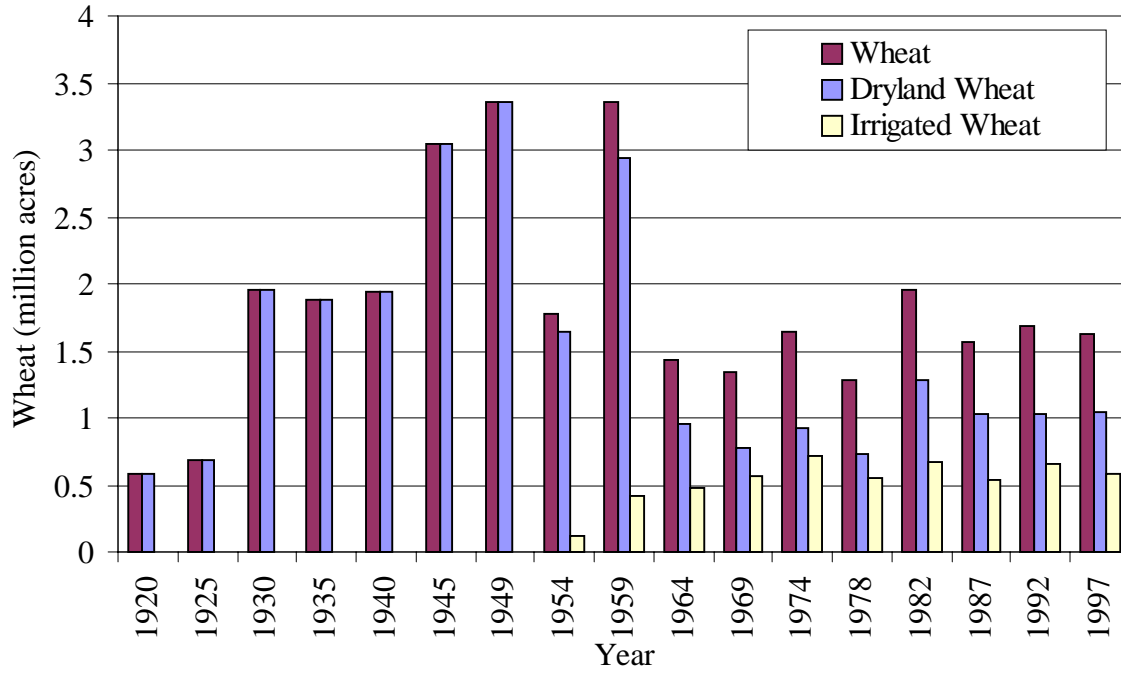
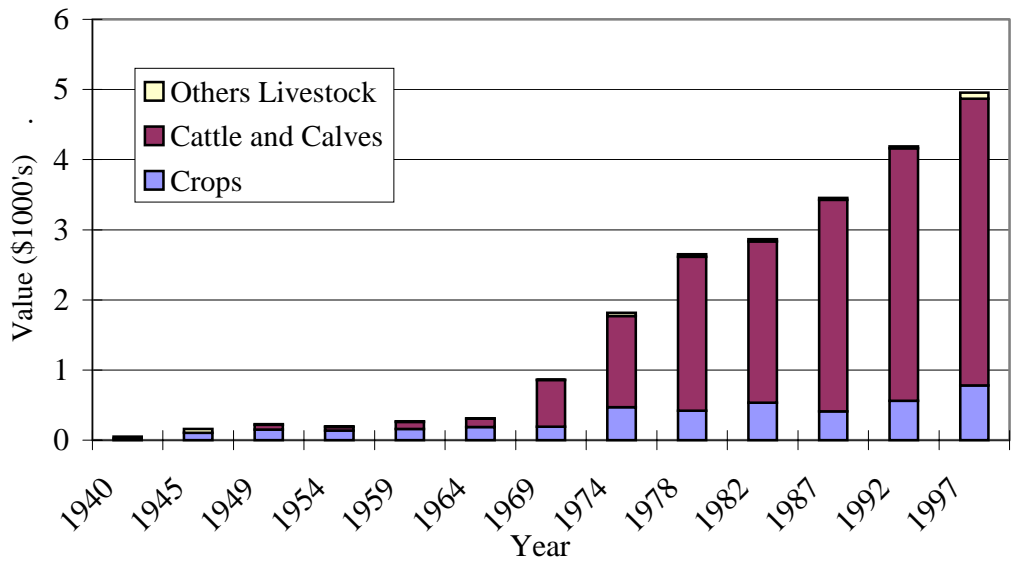Figure 4. Acreage of Wheat in 26 Counties, 1920-1997.

Figure 5.   Estimated Market Value of Agricultural Products Sold in the Texas
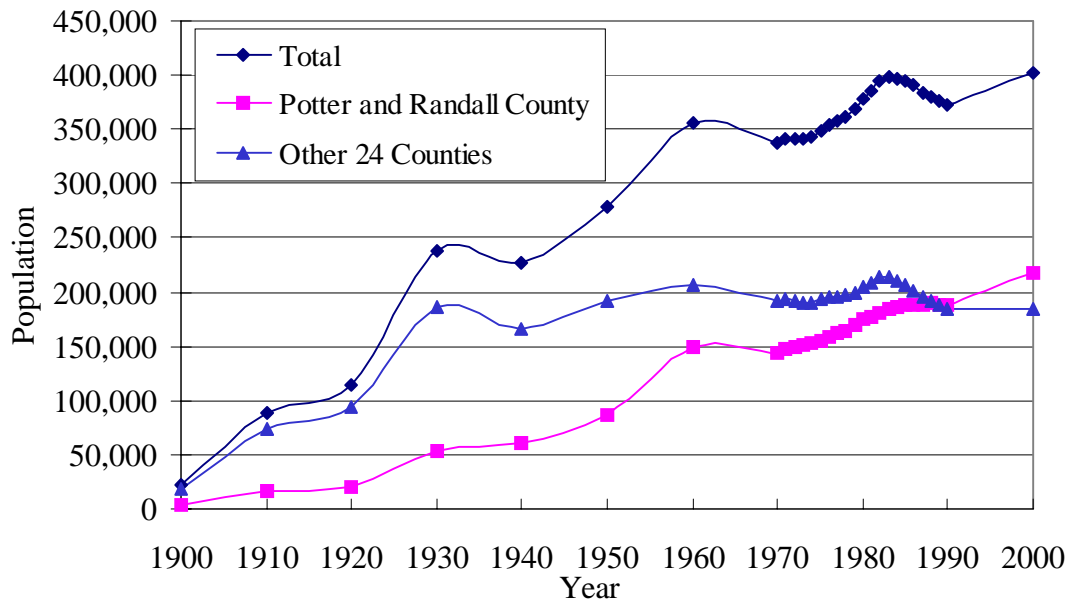   Panhandle, 1940-1997.

Figure 6. Population of the Texas Panhandle, 1900-2000.

County	% Change	1990	2000
Dallam	9.13	5461	6222
Sherman (US-287)	11.48	2858	3186
Hansford	-8.19	5848	5369
Ochiltree	-1.34	9128	9006
Lipscomb	-2.74	3143	3057
Hartley	52.37	3634	5537
Moore (US-287 US-87)	12.63	17865	20121
Hutchinson	-7.13	25689	23857
Roberts	-13.64	1025	887
Hemphill	-9.92	3720	3351
Oldham (I-40)	-4.08	2278	2185
Potter	16.01	97874	113546
Carson	-0.91	6576	6516
Gray	-5.10	23967	22744
Wheeler	-10.12	5879	5284
Deaf Smith	-3.09	19153	18561
Randall	16.32	89673	104312
Armstrong	6.28	2021	2148
Donley (US-287)	3.57	3696	3828
Collingsworth	-10.27	3573	3206
Parmer	1.55	9863	10016
Castro	-8.65	9070	8285
Swisher (I-27 US-87)	3.01	8133	8378
Briscoe	-9.18	1917	1790
Hall	-3.15	3905	3782
Childress	29.14	5953	7688

Figure 7. Changes in County Population in the Texas Panhandle from 1990 to 2000.