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Groundwater Irrigation

Declining Water Levels in the Texas High Plains Translate to Declining Economic Performance

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ABSTRACT

Rapid development of irrigation systems in a seven-county area of west Texas following World War II led to the establishment of a highly intensified agricultural production system. As irrigation grew, so did population and employment. This was not without consequence. The source of irrigation water, the Ogallala Aquifer, is drying up. As the water level declines, farmers in the area are faced with some rather severe decisions: be more efficient in the use of water, change cropping practices to raise plants that need less water, or revert to a dryland economy. As a comparison, an eight-county dryland area, just east of the irrigated area where irrigation water is not available, is analyzed to determine how farmers in this area have learned to operate in a dryland area.

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INTRODUCTION

The period of rapid growth in irrigation in the High Plains of Texas started after World War II and lasted about 20 years. This development triggered a rapid increase in population, employment, farm product sales, and total area income. By the mid-1960's, irrigation development started to taper off due mainly to a decrease in the water table level. The Ogallala Aquifer, the source of the water for irrigation, was being pumped down faster than it was being recharged (1, 5, 6).[1] With the decrease in the rate of irrigation development came a decrease in the rate of growth of the area's general economy.

To assess the importance of the development of irrigation to farmers and the regional economy as a whole, we have selected as a study area 15 counties in the Texas Panhandle (fig. 1). Seven of these counties were chosen because they generally conform to the geographic configuration of the Ogallala Aquifer and draw heavily on it for irrigation water. These irrigated counties are: Castro, Crosby, Floyd, Hale, Lamb, Parmer, and Swisher. The remaining eight counties (Baylor, Cottle, Foard, Haskell, King, Knox, Stonewall, and Throckmorton) are referred to as the dryland counties and serve as a basis for comparisons between irrigated farming and dryland farming. These eight counties lie just to the east of the Ogallala Aquifer and have never had the benefit of developing an irrigated agriculture economy.

We have chosen the 1940-84 period to compare and contrast growth and development trends in the two study areas. This period was selected because widespread irrigation was introduced in the 1940's. Emphasis is given to a limited set of economic variables that either indicate changes in farm structure or measure community well-being. Measures of farm structure include the number and size of irrigated farms, proportion of cropland acres irrigated, changes in crop production, and value of farm sales. Performance of the local economy is measured by changes in population numbers, employment, and per capita income.

With a continued drawdown of the aquifer, it may be only a matter of time until it becomes economically infeasible to irrigate from this portion of

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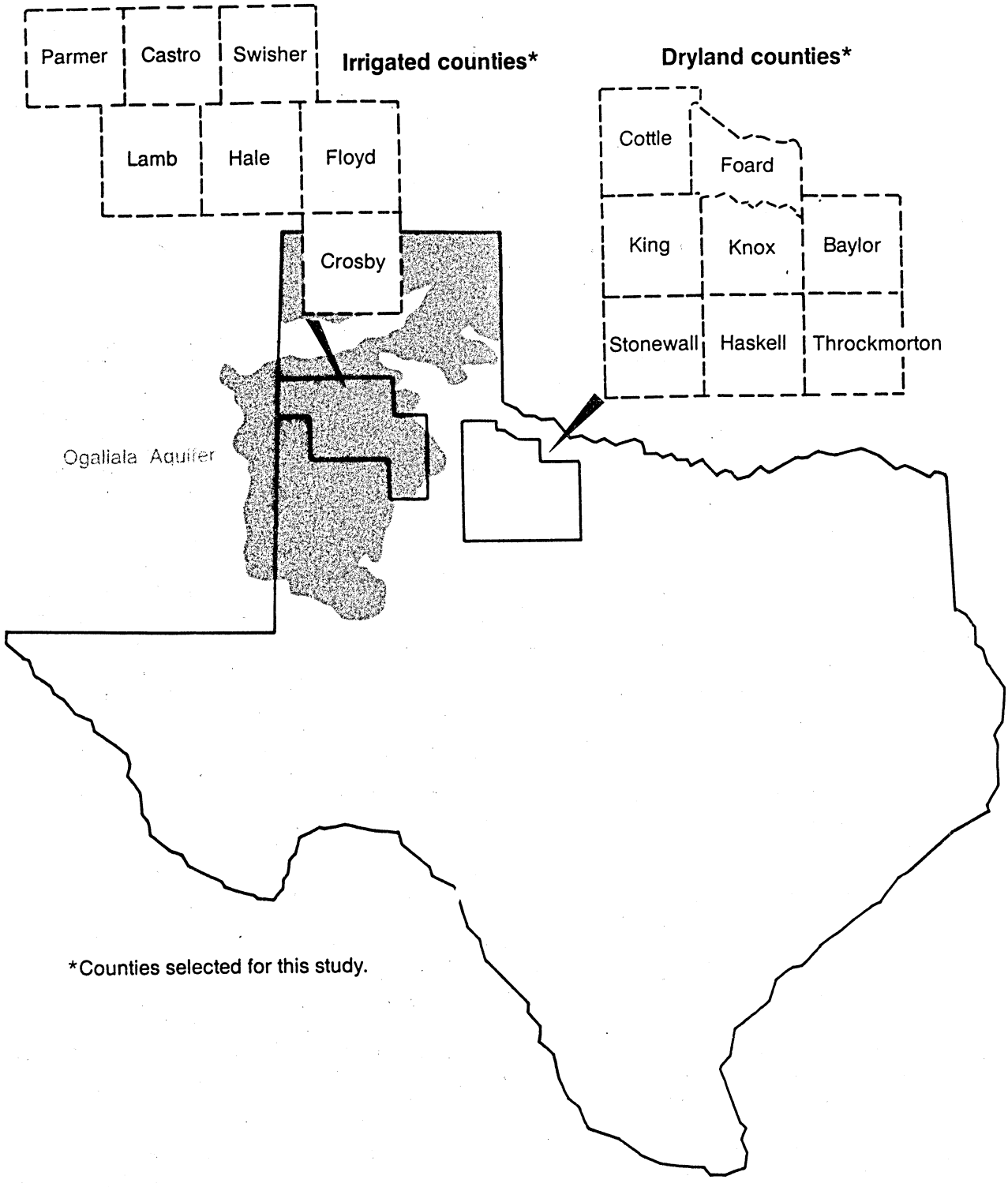
[1] Underscored numbers in parenthesis refer to items in the References section.

Figure 1 Study counties, Texas Panhandle



*Counties selected for this study.

the Ogallala Aquifer. Concern has been voiced about the effect of this development on the intensively irrigated farm economy of the area and its surrounding communities.

HISTORICAL PERSPECTIVE

The development of the agricultural economy of west Texas has been largely a function of the introduction of mechanized farming techniques coupled with the discovery of oil and gas in the region. The area grew rapidly in the first part of the 20th century based primarily on large-scale ranching and cotton production. During this time, the economy was also spurred by the building of military bases, manufacturing of farm equipment, and processing of farm commodities.

The two study areas (the irrigated and the dryland counties) initially followed a development pattern similar to that of the west Texas economy. Both areas started the century as underpopulated frontier counties. The 1900 Census of Population recorded only 15,000 residents in the eight dryland counties and 6,000 in the seven irrigated counties. In the following three decades, both areas participated fully in the booming west Texas agricultural economy, and both areas experienced rapid population growth. By 1930, total population had reached 79,000 in the irrigated counties and peaked at 63,000 in the dryland counties. Growth came to a halt in the 1930's with the Great Depression. Farm prices plummeted, and drought conditions persisted in west Texas. Since attempts to farm marginal land under these conditions proved futile, many small-scale farmers sought employment opportunities elsewhere. Population between 1930-40 declined 6 percent in the irrigated counties and 12 percent in the dryland counties.

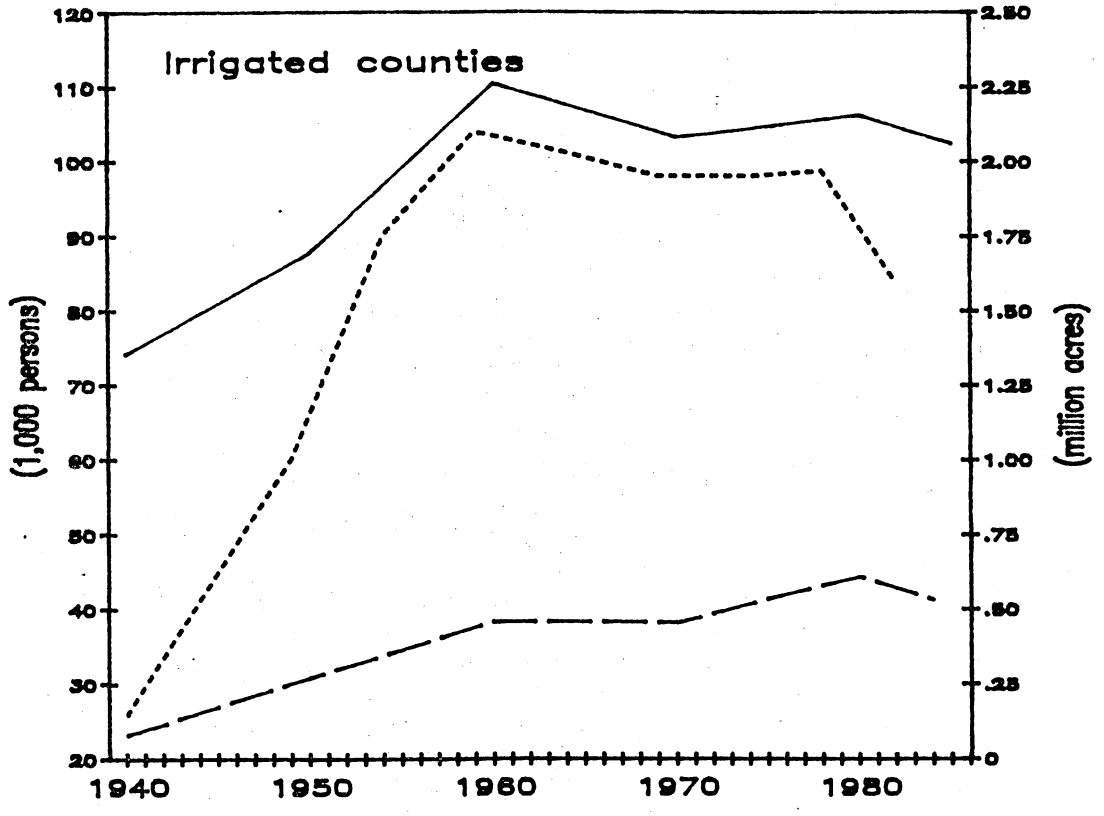
In the 1940's and following World War II, economic development took sharply different paths in the two study areas. The economy of the dryland farming area continued to stagnate, and periodically worsen, because of inadequate moisture for crops. The area is subject to erratic rainfall, where adverse weather cycles may last several years, and lacks sufficient water for irrigation. One result has been a continued heavy outmigration. During 1940-85, total population dropped 50 percent, and employment declined by 22 percent. In contrast, the irrigated counties, which were fortunate enough to be located in the Ogallala Aquifer basin, experienced rapid economic growth and development throughout most of this period. By the mid-1980's, total population in the area exceeded 100,000 (a 38-percent increase over 1940) and employment hovered over 41,000 (a 78-percent increase over 1940) (fig. 2). Economic growth in the irrigated area appears to be closely linked to developments in the local agricultural economy, which has passed through three distinctive phases: (1) introduction of irrigation, (2) intensive use of irrigation, and (3) declining water resources.

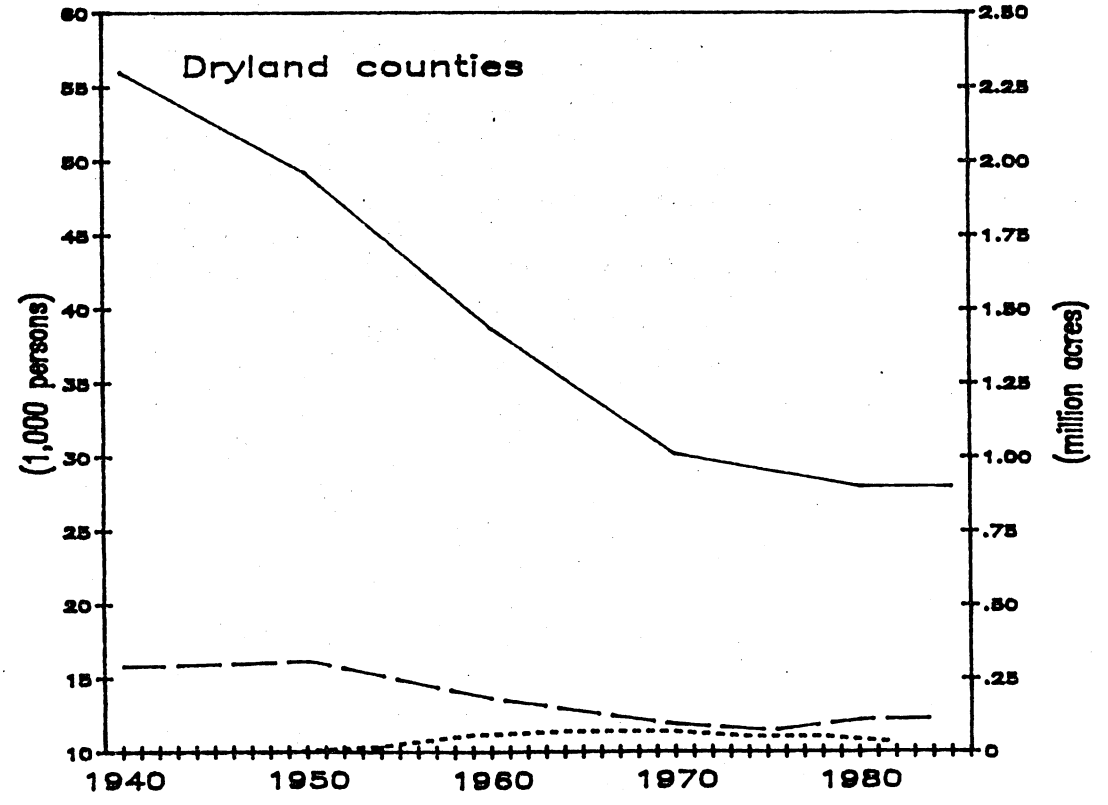
1940-59: Irrigation Comes to West Texas

During the 1940's and 1950's, the irrigated study area underwent a major transformation as local farmers adopted the widespread use of irrigation systems based on underground water pumped from the Ogallala Aquifer. In 19

Figure 2

Population, employment, and acres irrigated in West Texas, 1940-85





years, the number of irrigated farms more than doubled, and average size of irrigation farms rose from 47 acres to 324 acres (table 1) (8, 9, 10, 11).

Plentiful water supplies and the introduction of furrow irrigation followed by center pivot irrigation systems enabled farmers to apply water to more types of land and crops efficiently and with a minimum of labor. Development of this new technology in irrigation water application allowed farmers to intensively cultivate areas of land which without irrigation were arid or semi-arid. As a result, overall agricultural production soared as yields of cotton, sorghum, wheat, and corn on previously dryland farms nearly tripled, and the value of farm products sold increased more than tenfold.

As the proportion of irrigated cropland rose from 7 to 72 percent, the mix of farm products sold also changed. In 1940, cotton accounted for the greatest share of farm product sales followed by wheat and cattle and calves. By 1959, cotton still led--but by a much greater margin--followed by cattle and calves and then wheat.

Changes in the farm structure were also accompanied by considerable changes in the overall local economy which have had long-range implications. The introduction of irrigated agriculture which allowed the land to be intensively cultivated provided increased employment opportunities for many people as well as supporting a large infrastructure of farm labor services and supplies. In the 19 years ending in 1959, population in the area had increased 46 percent and total employment had risen 65 percent.

This new innovation in agriculture was not without its rewards. Total income in the irrigated area, which had slumped in the 1930's, rebounded and by 1959 had registered an eightfold increase over that of 1940. Farm income growth was even better, increasing some tenfold in this same time period.

Even with a relatively large increase in population, per capita income increased $1,743. The increase in per capita income represented almost a 600-percent increase over the period, which was much greater growth than that for the United States as a whole (370 percent) or for the State of Texas (450 percent).

The eight dryland counties, in contrast, experienced little, if any, irrigation development and showed considerably different growth characteristics. The number of irrigated farms increased only to 641 and irrigated cropland rose to about 65,000 acres, accounting for 6 percent of total cropland. As a result, the total number of farms declined 38 percent, a rate of decline that was nearly double that in the irrigated study area. The lack of irrigation also affected the total sales of farm products which increased only 480 percent during the period, as compared with an 1,100-percent increase in the irrigated area.

The relatively dismal performance of the farm sector in the dryland counties carried over to the nonfarm sector as well. Population declined 32 percent

Table 1--West Texas economic indicators and farm structure: Irrigated counties versus dryland farming counties, 1940-84

Indicator	Unit	Irrigated counties				Dryland farming counties			
		1940	1959 1/	1978	1984 2/	1940	1959 1/	1978	1984 2/
Local economy:									
Population	1,000	74	109	105	102	56	38	28	28
Employment	1,000	23	38	44	41	16	14	12	12
Total income	Mil. dol.	28	230	697	1,058	17	58	178	327
Farm income	Mil. dol.	12	121	165	135	7	25	33	40
Per capita income	Dol.	376	2,119	6,632	10,331	294	1,519	6,466	11,693
Farm structure:									
All farms	Number	9,053	7,301	4,939	4,370	6,334	3,952	2,727	2,597
Irrigated	Number	3,081	6,494	4,085	3,271	36	641	317	235
Irrigated	Percent	34	89	83	75	1	16	12	9
Cropland acreage	1,000	2,061	2,942	3,228	3,050	909	1,145	1,200	1,230
Irrigated	1,000	145	2,105	1,966	1,599	**	65	46	30
Irrigated	Percent	7	72	61	52	*	6	4	2
Farm products sold	Mil. dol.	20	218	1,212	1,168	10	48	112	123
Share of sales:									
Cotton	Percent	30	48	16	7	41	43	40	21
Cattle and calves	Percent	16	10	63	64	27	38	45	44
Grains	Percent	37	N/A	17	24	15	N/A	11	28
Corn	Percent	*	*	12	12	*	*	*	*
Sorghum	Percent	12	3	3	4	6	1	3	3
Wheat	Percent	22	8	1	4	7	10	8	24

* Less than 0.5 percent.
** Less than 500.
N/A Not available.
1/ Employment data are as of 1960.
2/ Farm structure data are as of 1982.

Sources: (8,9,10,11).

and total employment dropped 14 percent. As new opportunities for employment off the farm and out of the area opened up following World War II, many left the area seeking employment elsewhere. Dryland farming does not require a large labor force nor can it support a large population. Thus, there was little inducement for people to move into the area, or having been born there to stay there. More and more people found employment elsewhere.

Despite decreasing population and employment, total income generated, as well as farm income, did grow in the area during the 19 years under consideration. This growth, however, was at a much lower rate than in the seven irrigated counties. Total income in the dryland counties increased at less than half the rate and farm income growth at about a third the rate as in the irrigated area. Per capita income growth, on the other hand, was only slightly lower than that in the irrigated area, 520 percent compared with 560 percent, and exceeded that of the State of Texas as well as that of United States. However, these per capita income gains were achieved primarily through an outmigration of local residents.

1959-78: Intensive Use of Irrigation

The 19 years ending in 1978 were quite different from the preceding 19 years. When irrigation systems were widely adopted, both the farm and nonfarm economy of the irrigated counties expanded rapidly. The economy of the dryland area, however, continued to contract as population numbers and employment declined. Although per capita income in the dryland area increased, this was due to a continued substantial outmigration of local residents who presumably left the area in search of employment opportunities elsewhere.

By 1960, much of the rapid development of irrigation was over and the economy of the irrigated area entered a period of consolidation and slower growth. In the ensuing 19 years, the value of farm products sold increased about 600 percent, compared with an 1,100-percent increase in the earlier period, but the number of irrigated farms and the acres of cropland irrigated started to decline. By 1978, almost 2,400 operators of irrigated farms had gone out of business and some 140,000 acres of cropland had been withdrawn from irrigation (see table 1). A major result of this adjustment was an increase in the average size of irrigated farms from 320 acres to 480 acres.

These adjustments were accompanied by much slower growth in farm income, 37 percent compared with nearly an elevenfold increase in the previous period, and considerable changes in farm production patterns and in the mix of farm products sold in the irrigated area. In 1959, cotton sales accounted for 48 percent of all farm products sold, followed by cattle and calves and then wheat. By the end of the period, cattle and calves accounted for 63 percent of total sales, nearly four times the value of cotton, and corn had supplanted wheat as the major grain of the area. In this same time period, the custom feed industry was developing in this area that accounted for much of the increase in cattle and calves sales over cotton sales.

The slowdown in the expansion of the irrigated farm economy appears to have carried over to the local nonfarm economy. Total employment increased only 15 percent, compared with a 65-percent increase in the previous period, and total population declined (3 percent) for the first time since the Great Depression. Despite the slowdown in economic activity, total income and per capita income grew. However, the gap between local per capita income and that of the State of Texas and the United States began to widen. In 1959, local per capita income exceeded that of the State of Texas and totaled 98 percent of the national average (Table 2) (9, 10). By 1978, per capita income in the irrigated area had dropped to 89 percent of the Texas average and 85 percent of the national average.

In contrast to the slow growth exhibited by the economy of the irrigated area, the performance of the dryland farming economy continued to deteriorate in a manner similar to that of the previous period. Population declined 28 percent. Total employment dropped 12 percent. And, 31 percent of the farm operators went out of business.

Despite these declines, farm income, total income, and per capita income increased, but at a slower rate than in the preceding period. Farm income, for example, rose only 34 percent as the total value of farm products sold doubled. In the preceding period, farm income had more than tripled when the value of farm products sold had increased nearly fivefold. The slower growth in farm income was accompanied by only minor changes in the distribution of farm product sales. As in the irrigated area, cotton, which was number one in 1959, was replaced by cattle and calves. Wheat maintained its last place status. While sales of cattle and calves rose, cotton and wheat sales both declined slightly.

Table 2--West Texas per capita income: Irrigated counties versus dryland farming counties

Area	1940	1959	1978	1984
		Dollars per capita		
Irrigated	376	2,119	6,632	10,331
Dryland	294	1,519	6,466	11,693
Texas	430	1,919	7,486	12,575
United States	592	2,161	7,783	12,772
		Percent of U.S. per capita income		
Irrigated	63.5	98.1	85.2	80.9
Dryland	49.7	70.3	83.1	91.6
Texas	72.6	88.8	96.2	98.5

Sources: (8,9).

Per capita income in the dryland farming area improved substantially, more than quadrupling during the period. This may be due to increased oil royalties and outmigration. However, the population that remained in the area achieved a per capita income that was only $166 below that of the irrigated area. In 1959, the differential in per capita incomes had reached $680.

1978-84: Declining Water Resources

The mid-1980's were extremely stressful times for the farm economy of the irrigated counties. In this period, U.S. agriculture and the west Texas farm economy declined as worldwide recession and the dollar's rise in value reduced the export demand for U.S. farm commodities. Declining exports, in turn, led to surplus domestic stocks, lower commodity prices, and lower farm income. On the cost side, farmers were hurt as stringent monetary controls curbed inflation, real interest rates climbed to unprecedented levels of 8-10 percent, and prices paid by farmers for farm inputs began to exceed the prices they receive for farm products.

In addition, farmers in the irrigated area had to cope with declining water levels in the Ogallala Aquifer, which resulted in increased energy costs for pumping water (5, 7). For example, the average annual cost of energy per farm in the irrigated area increased about $13,500 between 1978 and 1982. The comparable increase in the dryland farming area was less than half, about $5,700. These developments made some marginally productive land and irrigation systems uneconomical to operate and in many cases the only recourse for the farm operator was to return the land to what it originally was, a dryland unit.

As a result, irrigation development and the number of irrigated farms dropped sharply during 1978-82 (3). This was true in both study areas, although the largest decline occurred, as would be expected, in the seven irrigated counties where irrigation was discontinued on 814 farms and 367,000 acres of cropland (see table 1). Some of these farms and cropland acres reverted to dryland farming. For example, the 1982 Census of Agriculture showed the number of nonirrigated farms (254) and nonirrigated cropland (189,000 acres). However, most of these farm operators appear to be no longer in business and nearly half of this acreage is no longer used in farm production. In the dryland area, with only 46,000 acres of irrigated cropland on 317 farms in 1978, the declines were 16,000 acres and 82 irrigated farms. But, the total amount of nonirrigated cropland increased by 46,000 acres, while the number of nonirrigated farms dropped only by 48.

The effects of deteriorating conditions in U.S. agriculture and curtailment of irrigation are also reflected in the value of local farm product sales. Between 1978 and 1982, total value of farm products sold dropped 4 percent in the irrigated area and increased only 9 percent in the dryland farming area. The poor record for farm product sales may be attributed to: (1) the poor performance of the cattle and calves sector, which accounted for the greatest share of the value of farm product sales in both areas during 1978

and 1982 but showed virtually no increase in sales; (2) inclement weather; and (3) the increase in cotton set-aside acres. Grain sales, primarily corn in the irrigated area and wheat in the dryland farming area, rose by a third in the irrigated area and nearly tripled in the dryland farming area. However, the increased grain sales failed to offset the 59-percent drop in cotton sales in the irrigated area and barely compensated for the 42-percent decline in the dryland area.

The downturn in the farm economy also appears to have affected the well-being of the nonfarm sector in the irrigated study area. During 1978-84, population in the area declined about 3 percent, and total employment fell (7 percent) for the first time since the Great Depression. The employment decline was due to substantial job losses for farmworkers (-1,596), providers of agricultural services (-1,444), and public sector employees (-524). Although nonfarm income for the area was up 72 percent, farm income dropped 18 percent. Thus, total income rose only 52 percent and per capita income, partially supported by the drop in local population numbers and an increase in oil royalties, increased 65 percent. However, the increase in local per capita income averaged 12 percentage points less than the national increase.

The trends were quite different for the nonfarm economy in the dryland area. For the first time since the 1930's, population increased (almost 2 percent) and employment rose (nearly 3 percent). Total income increased 84 percent as farm income rose 22 percent and nonfarm income nearly doubled. As a result, per capita income rose 81 percent, considerably more than in the irrigated area, the State of Texas, or the Nation. In fact, this is the first time that per capita income in the dryland farming area ($11,693) exceeded that of the irrigated area ($10,331).

SUMMARY

Irrigation development in the irrigated study area increased greatly during the 1940's and the 1950's as local agriculture changed from dryland farming to highly irrigated farming. Irrigated agriculture required large amounts of labor, agricultural supplies, and equipment. As the level of irrigation grew, the population of the area also increased, both on and off the farm.

In this 20-year period, prosperity favored the local economy. Total employment increased. Farm income as well as total income grew. Even with the increase in population, the per capita income of the area increased, growing faster than that of the State of Texas and the Nation.

In the dryland area, changes were also underway but in a different direction. As farms grew larger and hence fewer, employment opportunities declined. With the decline in the number of farms, the need for agricultural services declined. The population on the farm as well as off the farm declined. However, per capita income in this area was only slightly lower than in the irrigated area, primarily because of outmigration.

Before irrigation, both areas were basically dryland areas with cotton as the chief farm product. Cotton sales continued to be the number one farm cash crop throughout the 1940's and 1950's in both areas. Though the product mix of items sold continued to be mainly cotton, cattle and calves, and wheat, the dollar value of these items increased sharply as the 1950's ended.

The boom in irrigation development came to an end in the 1960's and 1970's. The aquifer underlying this area was rapidly being depleted (2, 4, 5). Early in the 1960's, the number of irrigated farms and acres of irrigated cropland started to decline. With the decline in irrigation came a decline in demand for most agricultural inputs, including labor.

Although irrigation development and use was declining, incomes grew slightly in this period. The increased financial health of the area was primarily due to improved cost of production/market price ratios and the adjustments farmers made in the product mix of their production. Cattle and calves replaced cotton as the number one farm sales item. Livestock production required much less labor and fewer cash inputs than either cotton or wheat.

As the 1970's came to a close, irrigation development not only declined but the absolute number of irrigated acres and irrigated farms also declined. Population, which dropped slightly in the irrigated area, remained about stable in the dryland area. All incomes, except farm income, rose greatly in both areas with per capita income in the dryland area increasing by 81 percent.

The mix of farm products sold remained about the same with cattle and calves leading the way, followed by grains in the irrigated area, and cotton in the dryland area.

The entire history of the area since 1940 appears to be one of change and adjustment by farmers to forces that were mostly from outside of agriculture. Technology spinoffs from World War II, the resulting increase in irrigation, then the decline of the water table forced local farmers either to adjust or to move out. Those who chose to adjust were able to continue farming. Others chose off-farm employment either within the region or elsewhere.

IMPLICATIONS

Change and adjustment seem to be the norm for U.S. agriculture, and nowhere has change and adjustment been more imperative than in the study area of west Texas. To maintain a viable agricultural economy, this area may have to revert to dryland production. How soon the transition will be made will depend somewhat on farmers' willingness to change their irrigation practices. Some irrigation will probably continue for a number of years. Development of new technology in irrigation and more drought-tolerant plants may delay the absolute end of irrigation. Whatever the time, adjustments must be made so as to be ready if the wells do indeed run dry.

The end of the irrigated era in west Texas does not necessarily spell the end of agriculture in the area nor the demise of the rural economy. Many benefits from irrigation have been incorporated into the infrastructure of the area and will no doubt continue. For example, the area has an ideal climate for cattle feeding, has established itself as a cattle feeding and processing area, and has set up all the attendant facilities. This seems likely to continue. Moreover, past irrigation development has left a legacy of what appears to be a fairly large population base with diversified employment opportunities for local residents.

The larger cities of the High Plains area such as Amarillo and Lubbock seem viable and should be able to weather the economic adjustments necessitated by the changes in agriculture. Some of the smaller cities and towns may be hurt. Farmers may expand their operations to more fully utilize their equipment and labor resources.

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