# Estimation of Historical Returns to Land for Selected Texas Counties and Crop Enterprises


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## ABSTRACT

**Historical returns to investments in farmland were estimated for selected counties and crop enterprises in Texas over the period 1976 to 1990 using data on historical land prices, crop yields, crop prices, and estimated costs of production. The results indicated substantial differences in returns between participation and nonparticipation in government commodity programs. A large number of crop enterprises analyzed did not provide an expected return in excess of the rate on US treasury bills. It was concluded, however, that Texas farmland may offer attractive investment potential for some enterprise combinations in selected Texas counties.**



KEY WORDS: farmland, investment


Agricultural land is owned and operated for the purpose of receiving a return to the land. The returns received will likely vary according to region, crop produced, government payments and management level. For investors in agricultural land, the decision to purchase will require knowledge of expected farmland returns relative to expected returns on alternative investments of similar risk. Future returns to land investments, however, are always going to be uncertain. Historical returns can provide agricultural producers and other investors a benchmark on which to compare farmland investments with returns to alternative assets. This study estimates a farm operator's return to investments in Texas cropland for various crop enterprises.

Past studies of land returns have primarily examined aggregated state or regional data (Alston, 1986; Barry, 1980; Burt, 1986; Irwin et al., 1988). However, investors are rarely able to invest in a portfolio of farm real estate assets representative of aggregated state or regional data. Farm real estate assets should be viewed as a heterogenous group of assets in the same manner as the stock market is viewed as a heterogenous group of assets. The problem of aggregation was specifically discussed by Irwin et al. (1988), "Risk in farm real estate returns may be understated because returns are calculated as average annual returns for all real estate in the U.S. Returns in a particular geographic area may be more variable than returns across the nation." Homogenous regions may have structural differences in the land market (Gertel and Canning, 1990). In some regions the influence of nonfarm investors can create a stronger demand for land which may reduce land price variability. Also, different areas may have different weather patterns or soil types which may result in varying yield histories. For example, irrigated farmland would be expected to have less yield variability than unirrigated farmland, thus

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contributing to differences in land price variability. As contrasted with the previous studies cited above, this study estimates returns to cropland for specific as opposed to aggregated regions.

One option is to examine total returns to land as the cash rent divided by the real estate value. This approach, however, assumes that all land is rented on a cash rent basis. The largest portion of agricultural land is owned by farmers and a large proportion of rental arrangements are crop share type arrangements rather than cash rent. Cash rent statistics are typically reported as regional or state averages for all crops. Also, the amounts and terms of cash rents are frequently determined prior to the crop year. Therefore, examination of land returns using cash rent ignores many of the impacts that different crops, regional weather patterns, government programs and management levels may have on the variability of returns.

This study estimated returns to farmland assuming the land is owned and operated by an agricultural producer. A historical series of farmland returns which incorporated regional differences in costs, land values, yields, and prices were estimated for selected counties and crop enterprises in Texas. Returns were estimated assuming the owner has full equity. Of course, many farm operators do carry debt. The USDA estimates that approximately 50% of US farms hold some outstanding liabilities (Morehart et al., 1990). The impacts of leverage are examined by comparison of the estimated returns with interest rates on farm loans. Estimated returns were utilized to compare differences in returns between regions and crops produced and the influence of government programs on farmland returns. The paper proceeds by first describing the procedures and data required to estimate land returns. A subsequent section provides a discussion of the counties and crops chosen for the analysis with results and implications presented in the final section.

## DATA AND PROCEDURE

Counties for which returns were estimated are displayed in Figure 1. These counties were chosen from different crop reporting districts established by the Texas Agricultural Statistics Service (TASS). Crops were chosen from counties analyzed to represent typical crop production patterns within those regions. The specific crops and associated crop reporting district are further described in Table 1. Returns as a proportion of the total land investment were calculated using estimated crop receipts, production costs, and land values as shown in Equation 1.

$$
\begin{aligned}
(1)\quad ROL^{i}_{jt} = {} & \{(SAPRICE^{i}_{jt} * YLD^{i}_{jt}) + OINC^{i}_{jt} + \\
& [(TARGET^{i}_{t} - SAPRICE^{i}_{jt}) * YLD^{i}_{jt} * GVT] - \\
& PREHAR^{i}_{jt} - (HARCOST^{i}_{jt} * YLD^{i}_{jt}) - \\
& (ASIDEACRE^{i}_{t} * ASIDECOST^{i}_{jt}) - MACHFIX^{i}_{jt} - \\
& (RETAX_{t} * AVELAND^{i}_{jt})\ \} \\
& /AVELAND_{jt} * [1 + (ASIDEACRE^{i}_{t}) * GVT)].
\end{aligned}
$$

Where:

$ROL^{i}_{jt}$ = Estimated return on land for crop i in county j for year t as a proportion of the land investment.

$SAPRICE^{i}_{jt}$ = Season average price per unit (bushel, pound, etc.) for crop i in county j for year t.

$YLD^{i}_{jt}$ = Average per acre yield for crop i in county j for year t.

$OINC^i_{jt}$ = Other crop income per acre received for crop i in county j in year t.
$TARGET^i_t$ = Government target price per unit for crop i for year t.
GVT = A binary variable representing participation in government programs.
0 = no participation.
1 = participation.
$PREHAR^i_{jt}$ = Estimated preharvest cost per acre for crop i in county j in year t.
$HARCOST^i_{jt}$ = Estimated harvest cost per unit for crop i in county j in year t.
$ASIDEACRE^i_t$ = Required setaside as a proportion of total acres for crop i in year t.
$ASIDECOST^i_{jt}$ = Estimated variable and fixed machinery cost per setaside acre for crop i in county j for year t.
$MACHFIX^i_{jt}$ = Estimated fixed cost of machinery and equipment per acre for crop i in county j in year t.
$RETAX_t$ = Real estate tax as a percent of market value for year t.
$AVELAND_{jt}$ = Past four quarter moving average value of land for county j in year t.

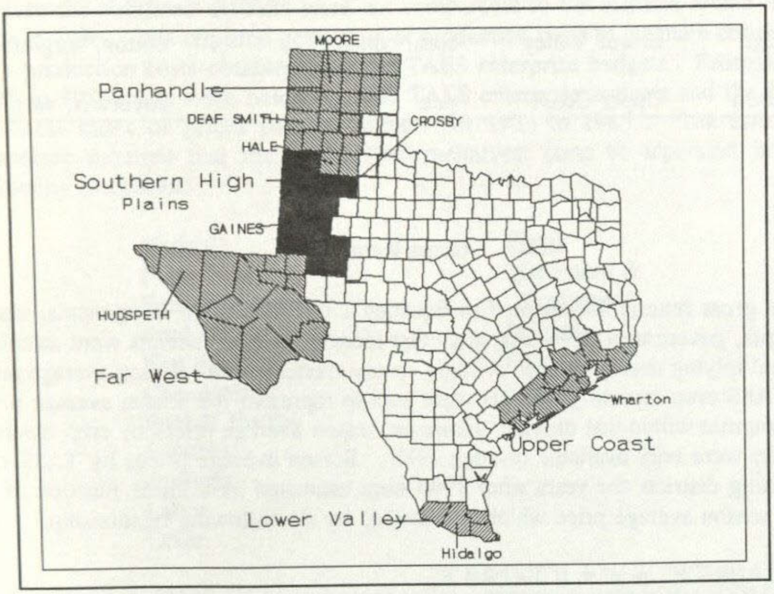


Figure 1. Diagram of counties and associated crop reporting districts chosen for analysis.

Table 1. Crop enterprises, counties and associated crop reporting districts analyzed.

| County | Crop Reporting District | Irrigated Crops | Dryland Crops |
|---|---|---|---|
| Moore | Panhandle | corn, sorghum, wheat | wheat |
| Deaf Smith | Panhandle | corn, sorghum, alfalfa, wheat | sorghum, wheat |
| Hale | Panhandle | corn, cotton, wheat sorghum, soybeans | cotton, wheat |
| Crosby | South Plains/ heavy soils | cotton, sorghum | wheat |
| Gaines | South Plains/ sandy soils | cotton, sorghum | sorghum |
| Hudspeth | Far West | cotton | |
| Hidalgo | Lower Valley | corn, cotton | cotton, sorghum |
| Wharton | Upper Coast | rice | soybeans, sorghum |

## Gross Returns

The gross returns documented in Equation 1 included three components; market receipts, government payments, and other income. Market receipts were calculated by multiplying season average price by county average yield. Season average prices by TASS crop reporting districts were used to represent the season average prices for counties within that district. However, season average prices by crop reporting district were only available through 1985[1]. Season average prices by TASS crop reporting districts for years after 1986 were estimated as a linear function of the state season average price which is described by the following relationship,

$$(2)\ \ SAPRICE^{i}_{jt} = \alpha + \beta\ TXPRICE^{i}_{t}$$

where is $TXPRICE^{i}_{t}$ represents season average price for crop i in Texas for year t; $\alpha$ is an intercept term, and $\beta$ is a slope coefficient. Equation 2 was estimated using ordinary least squares techniques over the period 1976 through 1985 with the results displayed in Appendix 1. In all but 4 of the 19 cases, Equation 2 explained 85% or more of the variation in season average price by TASS district. These estimates were subsequently used to generate crop reporting district season average prices for 1986 to 1990.

County average yield data for 1976 to 1990 were obtained for each crop analyzed using TASS publications. Equation 1 considered both deficiency payments and commodity loan receipts as government program payments. Income from receipts obtained from sources other than crop sales, such as grazing income from wheat and sale of cottonseed were also included in Equation 1 as other income.

## Costs

The production costs described in Equation 1 were separated into preharvest cost, harvest cost, cost of maintaining setaside acres, and fixed costs. Costs were estimated using Texas Agricultural Extension Service (TAES) enterprise budgets. Enterprise budgets are constructed annually by TAES personnel for each crop reporting district. These budgets represent approximations of actual crop costs. They should, however, reflect any technical changes in production technology. Crop costs estimated for each crop reporting district by TAES were used to represent production cost for counties within that district. For example, costs estimated for crop enterprises located in the Panhandle were used to represent costs for Deaf Smith, Hale and Moore counties. The previously mentioned budget cuts for the Texas Department of Agriculture in 1986 also resulted in a redefinition of TASS crop reporting districts. The redefinition created an inconsistency in the data because the redefined districts were not comparable to the districts which existed prior to 1986. This required generation of production costs to maintain consistency with production costs obtained from the TAES enterprise budgets. Estimation of 1976 to 1985 costs were based on 1986 TAES enterprise budgets and the USDA historical index of prices paid by farmers for 1976 to 1985. The estimation procedure required that the TAES 1986 preharvest costs be separated into the following categories:

| Variable | Fixed |
|---|---|
| Feed | Machinery & Equipment |
| Feeder Livestock | Irrigation |
| Seed | Land |
| Fertilizer | Other |
| Chemicals | |
| Fuel & Energy | |
| Supplies | |
| Services | |
| Labor | |
| Other | |

The categories listed above correspond to the components used in the USDA index of prices paid by farmers. Production costs for 1976 through 1985 for the redefined TASS crop reporting districts were recursively estimated using the USDA index of prices paid by farmers and 1986 TAES data in a manner described by Equation 3 for fertilizer cost. This procedure assumes that the technology which existed in 1985 was equivalent to the technology which existed in 1976. Equation 3 demonstrates the estimation of fertilizer cost for 1985 using estimated fertilizer costs for 1986 and USDA index of prices paid for fertilizer.

$$\text{(3)}\quad FERT^j_t = FERT^j_{t+1} * \left(1 - \left(\frac{INDF_t - INDF_{t+1}}{INDF_t}\right)\right)$$

where: $FERT^j_t$ = Estimated fertilizer cost for crop j in year t.

$INDF_t$ = USDAs index of prices paid for fertilizer in year t.

Harvest cost per production unit was estimated for each crop for 1986 from the TAES budgets. Harvest cost per unit for 1976 to 1985 was estimated recursively using the index of prices paid for services (INDS) obtained from USDA data and 1986 level of harvest cost per unit.

$$\text{(4)}\quad HARCOST^i_{jt} = HARCOST^i_{jt+1} * \left(1 - \left(\frac{INDS_t - INDS_{t+1}}{INDS_t}\right)\right)$$

where: $INDS_t$ = Index of prices paid for services in year t.

Total harvest cost per acre was subsequently estimated by multiplying the harvest cost per harvested unit by county average yield as shown in Equation 1.

Costs estimates for maintaining diverted acres for each crop were based on setaside requirements. The setaside cost per acre was obtained from TAES enterprise budgets for 1986 to 1989 with per acre costs for 1976 to 1985 generated using the USDA index of prices paid. The estimated cost of maintaining the diverted acres includes the variable costs plus the fixed cost of machinery and equipment.

Fixed costs considered in the analysis included insurance, depreciation, taxes, and interest associated with machinery and equipment and real estate taxes. Data on the average tax rate for Texas agricultural land was obtained from USDA (1990).

Fixed irrigation charges were omitted from the analysis because it was assumed that these charges would be capitalized into the land cost. As with other costs, the amount of fixed machinery and equipment cost per unit for 1976 through 1985 was estimated recursively using the index of prices paid for machinery and the 1986 level of fixed machinery and equipment cost.

The residual remaining in the numerator in Equation 1 after all calculations have been performed represents a residual return to land. This residual was subsequently divided by the average land value for the year to estimate farm operator returns as a percent of land value. It should be recognized that this represents a return per harvested acre and does not incorporate abandonment (i.e. acres planted but not harvested). Readers knowledgeable about Texas agriculture would recognize that abandonment does occur frequently on the Texas High Plains with dryland wheat and to a lesser extent with dryland cotton. Abandonment is less common in other areas and other crops. Readers should consider these factors when examining the results.

Average values of irrigated and unirrigated cropland for each TASS crop reporting district for 1976 to 1990 were determined from quarterly surveys conducted by the Dallas Federal Reserve Bank (unpublished). The number of survey respondents was not reported until 1986 and was not reported for 1990. Small numbers of survey respondents were indicated in some crop reporting districts (Table 2). Statistical procedures generally require a minimum of 25 to 40 observations depending on accuracy desired and the sample variance to insure that the sample reflects the population. The average number of respondents indicates a possibility of inadequate size samples in the Lower Valley and Far West crop reporting districts. In their statistical releases, the Dallas Federal Reserve Bank uses 3 and 4 quarter moving averages to smooth any bias due to the small sample sizes. In this analysis, land values represented a 4 quarter moving average.

Table 2. Average number of quarterly survey respondents by crop reporting district, 1986 - 1989.

| | Average Number of Respondents | |
|---|---|---|
| Crop Reporting District | Dryland | Irrigated |
| Panhandle | 29.5 | 28.4 |
| South Plains | 25.8 | 24.9 |
| Far West | | 3.8 |
| Lower Valley | 6.9 | 8.3 |
| Upper Coast | 205.0 | 122.2 |

Capital gains on farmland were added to the returns obtained from farm operations to estimate the total returns to land:

$$(5)\ TOTRET^{i}_{jt} = ROL^{i}_{jt} + CAPGAIN_{jt},$$

where $TOTRET^{i}_{jt}$ represents total operating returns and capital gains for farmland producing crop i in county j in year t; $CAPGAIN_{jt}$ represents the estimated amount of capital gain for cropland in county j for year t.

Capital gains were calculated based on changes in the land values over the period (Equation 6).

$$(6)\ CAPGAIN_{jt} = (AVELAND_{jt} - AVELAND_{jt-1})/AVELAND_{jt-1}$$

Distinctions were made between participation and nonparticipation in government programs. Calculations of returns for participation assumed that producers were fully enrolled in government programs. This implied producers received the season average price for harvested yield plus government deficiency payments, commodity loan receipts and other income. However, participation required that some land may have to be set aside. This was accounted for by increasing the average land investment in the denominator of Equation 1:

$$AVELAND_{jt} * [1 + (ASIDEACRE^{i}_{j}) * GVT)].$$

## RESULTS

Means and standard deviations calculated using Equation 1 are displayed in percentage terms in Table 3 for selected irrigated crop enterprises and Table 4 for selected dryland crop enterprises. The figures include both the residual return from farm operations and capital gains. The data displayed in Table 5 specifically details historical capital gains on farmland for the crop reporting districts analyzed. Comparison of capital gains statistics with total returns shown in Tables 3 and 4 provides an indication of the relative influence of capital gains versus residual returns on returns to land. Aggregated statistics calculated by USDA indicate that a majority of the variability in returns on agricultural assets is due to capital gains (USDA, National Financial Summary-1990). The results in this study indicates that when examined on a disaggregated basis, a large portion of the variability in returns to land investments is due to variability in the residual returns to farm operators. For example, the average annual capital gain for Panhandle irrigated farmland was -0.41% with a standard deviation of 8.22%. In contrast, estimated average annual total returns for irrigated crops produced in the Panhandle ranged from -1.56% for wheat in Hale county to 37.01% for sugar beets in Deaf Smith county (Table 3)[2]. Also, the average standard deviation for irrigated crop returns in the Texas Panhandle ranged from 9.37% for sorghum produced in Moore county to 21.41% for sugar beets produced in Deaf Smith county.

The results indicate that nonparticipants in government programs would have received lower expected total returns with higher standard deviations than government program participants over the analysis period. Mean returns of irrigated crops declined by approximately 30% and mean dryland crop returns declined by approximately 60% when government program payments were excluded. In some instances the standard deviation of dryland returns with government program participation was slightly higher than the option assuming no government participation. This occurred with cotton in Hale and Hidalgo counties and wheat in Moore county (Table 4). This is probably due to the shortness of the data series and that government programs have regularly increased the returns to land for these crops thus increasing the upper range of returns.

Mean returns are generally positive when full government participation is considered. Exceptions for irrigated crop enterprises included sorghum in Gaines, Crosby, and Hale counties and irrigated wheat in Hale county. Dryland sorghum in Gaines and Hidalgo county also resulted in negative returns when government payments were included. The negative returns are merely an indication that prices and yields of these crops were insufficient to cover costs. Producers have responded to these negative returns through reductions in acreage. For example, planted acres of sorghum in Gaines county declined from approximately 100,000 acres in 1976 to less than 30,000 acres in 1990. Exclusion of government program payments contributed to an increase in the number of crops analyzed displaying negative expected returns. Approximately 40% of expected irrigated returns were negative when government program payments were excluded. These negative returns primarily concentrated among sorghum and cotton enterprises.

Highest returns occurred for sugar beets, alfalfa, and rice. In the case of sugar beets, government program payments are made to the processor with the processor negotiating a price contract with the producer. The contract price received by the producer does not distinguish the market price from the government payment making it infeasible to estimate a return to sugar beets which differentiated between government program participation and nonparticipation. While sugar beet returns are apparently high, it should be realized that acreage is limited by processor contracts, thus restricting any major expansion of acreage in response to high levels of returns. High returns were also shown for alfalfa production in Deaf Smith, rice in Wharton county and cotton production in Hudspeth county. The accuracy of total returns for Hudspeth county, however, may be limited by small sample sizes.

Table 3. Estimated total percentage returns to irrigated crop enterprises for selected Texas counties (1976 - 1990).

| | | Government Program Participation | | No Government Program Participation | |
|---|---|---|---|---|---|
| Crop | County | Mean | Standard Deviation | Mean | Standard Deviation |
| | | % | | | |
| Corn | Deaf Smith | 14.82c | 12.07 | 8.20 | 19.61 |
| Corn | Hale | 10.28b | 12.30 | 5.21 | 20.71 |
| Corn | Hidalgo | 0.05 | 17.49 | -1.35 | 19.54 |
| Corn | Moore | 14.39a | 10.08 | 7.73 | 18.67 |
| Cotton | Crosby | 5.50 | 14.51 | -2.89 | 21.31 |
| Cotton | Gaines | 13.36b | 20.33 | 4.02 | 23.34 |
| Cotton | Hale | 10.36b | 15.63 | -0.15 | 18.78 |
| Cotton | Hidalgo | 11.94b | 15.46 | 5.99 | 18.18 |
| Cotton | Hudspeth | 18.83a | 17.80 | 9.68 | 17.65 |
| Sorghum | Crosby | -5.20 | 13.69 | -9.73 | 17.63 |
| Sorghum | Deaf Smith | 4.08 | 9.58 | -0.60 | 15.38 |
| Sorghum | Gaines | -2.89 | 13.89 | -5.91 | 17.01 |
| Sorghum | Hale | -1.75 | 12.48 | -5.96 | 17.54 |
| Sorghum | Moore | 7.74b | 8.90 | 3.53 | 15.71 |
| Soybeans | Hale | | | 2.84 | 15.15 |
| Rice | Wharton | 20.05a | 17.63 | 12.05c | 20.44 |
| Alfalfa | Deaf Smith | | | 33.67a | 18.01 |
| Sugar Beets | Deaf Smith | 37.01a | 21.41 | | |
| Wheat | Deaf Smith | 5.37d | 10.16 | 0.68 | 14.20 |
| Wheat | Hale | -1.56 | 9.37 | -6.28 | 14.02 |
| Wheat | Moore | 7.74b | 9.91 | 2.67 | 13.19 |
| | AVERAGE | 8.96 | 17.91 | 3.76 | 21.13 |

a = Significantly different from 0 at the .0001 level of significance.
b = Significantly different from 0 at the .01 level of significance.
c = Significantly different from 0 at the .05 level of significance.
d = Significantly different from 0 at the .10 level of significance.

Table 4. Estimated total percentage returns to dryland crop enterprises for selected Texas counties (1976 - 1990).

| Crop | County | Government Program Participation Mean | Government Program Participation Standard Deviation | No Government Program Participation Mean | No Government Program Participation Standard Deviation |
|---|---|---|---|---|---|
| | | % | | | |
| Cotton | Hale | 10.36 | 25.42 | 0.45 | 22.35 |
| Cotton | Hidalgo | 21.13 | 47.46 | 4.22 | 46.07 |
| Sorghum | Deaf Smith | 15.15a | 11.26 | 13.42b | 13.77 |
| Sorghum | Gaines | -2.87 | 13.84 | -5.31 | 16.89 |
| Sorghum | Hidalgo | -3.16 | 27.23 | -7.18 | 29.67 |
| Sorghum | Wharton | 7.22 | 20.59 | 5.08 | 22.86 |
| Soybeans | Wharton | | | 9.46 | 25.50 |
| Wheat | Crosby | 3.77 | 14.71 | 1.50 | 16.50 |
| Wheat | Deaf Smith | 13.31a | 9.87 | 11.45 | 11.82 |
| Wheat | Hale | 5.33d | 10.85 | 3.16 | 12.01 |
| Wheat | Moore | 5.02 | 26.27 | -0.64 | 25.94 |
| | AVERAGE | 7.57 | 23.20 | 3.24 | 24.09 |

a = Significantly different from 0 at the .0001 level of significance.
b = Significantly different from 0 at the .01 level of significance.
d = Significantly different from 0 at the .10 level of significance.

Table 5. Expected capital gains and standard deviation of capital gains for dryland and irrigated farmland in selected Texas crop reporting districts (1976 - 1990).

| Crop Reporting District | Dryland Mean | Dryland Standard Deviation | Irrigated Mean | Irrigated Standard Deviation |
|---|---|---|---|---|
| | % | | % | |
| Panhandle | 1.21 | 7.99 | -0.41 | 8.22 |
| South Plains | 3.09 | 12.88 | 2.14 | 10.57 |
| Far West | | | 3.56 | 18.06 |
| Lower Valley | -2.73 | 21.54 | 0.82 | 14.92 |
| Upper Coast | 4.04 | 17.41 | 2.43 | 14.64 |

T-statistics indicated that none of the mean capital gains were significantly different from 0 at the .10 level of significance or less.

A complete analysis of land returns should focus not only on means and standard deviation but covariances. While covariances may indicate the diversification possible through a combination of enterprises, it is beyond the scope of the current study. An alternative available which does provide useful information would be a comparison of expected total returns with the risk free rate of return. The risk-free rate of return represents a lower bound to the returns which rational investors would expect. Also, numerous studies have shown that investments in agricultural assets display little systematic risk and under financial theory should provide a return approximately equal to a risk free asset (Barry, 1980; Irwin et al., 1988). This simply means that most of the variability in returns to agricultural assets is random and not related to returns in the stock market or macroeconomic changes. Investors in agricultural assets could, through holding several assets, diversify away the variability associated with agricultural assets. Therefore, diversified investors would view agricultural assets as risk-free investments and require a return no greater than the risk-free rate.

One indicator of the risk free rate is the rate on US treasury bills. The average annual treasury bill rate over the period was 7.99% (Ibbotson, 1990). Results indicate that 11 of the 19 irrigated crop enterprises analyzed for the full government program participation option produced returns greater than the risk free rate. It was also indicated that 5 of the 20 returns on irrigated crops with no government program participation were greater than the treasury bill rate. Returns for dryland crops were much lower relative to the treasury bill rate. Only 4 of 10 dryland crops produced average annual returns greater than the treasury bill rate when government program participation was included. Only 3 dryland crop average annual returns were greater than the treasury bill rate when no government program participation was considered.

Results presented in Tables 3 and 4 can also be used to determine which county/crop enterprises could have supported debt over the analysis period[3]. This can be done by comparing estimated returns with the cost of debt over the period. The average annual interest rate paid by farmers on Farm Credit System debt for the period was 10.99%.[4] Results indicated that only 4 of 19 irrigated enterprises receiving government payments would have produced returns in excess of the cost of debt. Only 2 of 20 the irrigated enterprises not receiving government payments would have received returns in excess of the cost of debt. Results for the dryland enterprises indicated that 4 of the 10 enterprises receiving government payments would have had the potential to support debt while only 2 of the 11 enterprises not receiving government payments could have supported debt.

## SUMMARY AND CONCLUSIONS

A historical series of farmland returns was estimated for selected counties and crop enterprises in Texas using data on land prices, crop yields, crop prices and estimated costs of production. When examined on a disaggregated basis, returns to land were highly variable. A large portion of the variation was explained by the selection of crop enterprise. This is in contrast to analysis of aggregate farming returns by USDA which indicate that the variation in returns to agricultural assets is due to changes in the price of assets. Positive expected returns are indicated for most crop enterprises. However, the exclusion of government program payments results in large declines in mean returns and increases in standard deviations in most cases.

Institutional investors in farm real estate such as insurance companies or pension funds may be restricted from participation in government commodity programs. Therefore, investment potential is limited for these investors among the enterprises analyzed. A majority of the enterprises analyzed did not return in excess of the treasury bill rate when government payments were excluded. Of the enterprises analyzed, only a small portion would have had the potential to service debt over the period. The results indicated, however, that net returns in excess of the risk free rate can be earned in some cases, demonstrating that farmland may offer attractive investment potential for individuals or institutions not restricted from participating in government programs. For example, a parcel of farmland in Deaf Smith county that produced equal proportions of irrigated corn and sugar beets along with dryland wheat and sorghum would have an expected total return of about 19%.

Results from this study should be qualified because of the limited time period analyzed, quality of data, and level of aggregation. The time period analyzed (1976 to 1990) includes the farm financial bust of the 1980s and excludes much of the period of rising nominal real estate prices which occurred between 1950 and 1977. The period of analysis was limited, however, by the availability of data on land values at crop reporting district level. It is recognized that TAES enterprise budgets are approximations and are subject to error. Farm accounting data would be a preferable data source for costs but was not available over the time period for the enterprises analyzed. It is also recognized that the feasibility of investment in farmland is best analyzed at the farm level. Variances of yields may be less at the county level than at the farm level due to covariances between farms. County level data on yields, however, was the lowest level of aggregation available. The results are limited to crop enterprises analyzed and no implications can be drawn beyond these counties and crops. Also, returns are estimated for harvested acres and do not consider the additional cost which may be associated with acres planted but not harvested.

This study has not attempted to consider the impacts of covariance or determine combinations of enterprises which may have investment potential. These topics are left for future study. Despite the limitations of the study, the historical returns developed in this study should provide Texas agricultural producers and investors in agricultural land a benchmark on which to compare investments in farmland with returns to alternative assets.

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## ENDNOTES

1. Budget cuts for the Texas Department of Agriculture in 1986 prevented the collection and reporting of several important data series including season average prices for each crop reporting district.

2. Assuming full participation in government programs.

3. The returns presented in Tables 3 and 4 are returns on assets which assume no leverage. The reader can easily determine a return on equity which assumes leverage using the following relationship:

$$ROE = \frac{ROA - i\,(D/A)}{(D/A)}$$

   where: ROE = return on equity; i = cost of debt; (D/A) = debt to asset ratio; ROA = return on assets, which is equivalent to $TOTRET^{i}_{jt}$ from Equation 5.

4. The average rate on Farm Credit System loans represented a weighted average of rates on Federal Land Bank loans and Production Credit loans. Average rates paid by US farmers on Federal Land Bank Loans and Production Credit Association loans were weighed based on the amount of Federal Land Bank and Production Credit Association outstanding debt in Texas.