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A STATISTICAL ANALYSIS OF THE SORGHUM GRAIN INDUSTRY

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SUMMARY AND CONCLUSIONS

Sorghum grain has been under price support operations since 1941. The seasonal average price was above the average support price in every year during 1941-52 except in 1949. The seasonal average price was below the average support price (except in 1955) during 1953-59. This was a result of increased sorghum grain acreage through diverted cotton and wheat acreage and increased yields through hybrid sorghum grain seed which cause supplies to be in excess of domestic and foreign demand particularly during 1956-59.

The total cost to the government from the beginning of the program until September 30, 1959 was 235 million dollars. Five million dollars of this total cost were for the disposition of sorghum grain under Title I and Title II programs.

Production for sorghum grain is concentrated primarily in Texas, Oklahoma and the Corn Belt. Kansas was second to Texas as a major producing state. Texas produces about 42 percent of the nation's supply.

Sorghum grain harvested acreage trends for Texas and the United States were similar during 1930-55. However, after 1955, Texas production increased at a considerably faster rate. This was a result of Texas producers using primarily hybrid sorghum planting seed, fertilizers and irrigation practices on diverted cotton and wheat acreage on the High Plains.

The number of animal units on feed in the United States was compared with Texas and U. S. sorghum grain production. There was no particular relation between animal units on feed and sorghum grain production. The number of animal units on feed has been rather constant; whereas sorghum grain production has shown a consistently upward trend since 1955, particularly in Texas. This perhaps can be attributed to guaranteed support prices and to the fact that sorghum grain was a more profitable alternative crop in utilizing diverted cotton and wheat acreage on the High Plains.

The index of seasonal price variation for sorghum grain was developed using weighted average seasonal prices for 1947-56. Prices were adjusted for cycles and trends. A range of an expected monthly variation from the seasonal index of prices also was computed. Sorghum grain prices usually remained above normal from November to June and below normal during the remaining months. Sorghum grain prices had two seasonal highs in January and May and one seasonal low in August. The widest spread in price from a low in August to a high in May amounted to about 36 cents per hundredweight. The smallest variation in price from the seasonal average usually occurred in March. The optimum period for storing sorghum grain was between October and December and the optimum time to sell was between February and May. The seasonal index of price variatio[n] cated that the most inopportune time to stor[e] was between May and August.

The difference in price variation betwe[en] ghum grain and corn in Texas during 1930-[...] about 8 percent; it was about 3 percent [...] United States. During 1946-58, these va[...] were less than 1 percent for both Texas a[nd] United States, which reflected a better bala[nce] tween the demand for the two commodities [...] grains.

An analytical model was fitted to the U.S[...] Texas harvested acreage data for 1946-58 t[...] tain the influence of diverted cotton and whe[at] age, a preceding year's production of s[...] grain and price supports on the variation [...] and U. S. harvested sorghum grain acreag[e] of these factors accounted for 62 percent of th[e] ation in Texas sorghum grain harvested a[...] Diverted cotton acreage accounted for more [...] tion than any of the other factors. The [...] model was fitted to U. S. harvested acreag[e] and the variables accounted for 69 percent [...] variation in harvested acreage. Diverted [...] acreage on a national basis accounted for [...] erably more variation in U. S. harvested [...] than did the other factors.

A statistical price model was fitted to U.S[...] Texas sorghum grain prices for the periods [...] and 1946-57, to ascertain the principal fact[ors] fluencing the variation in sorghum grain [...] Sorghum grain production, cotton and whe[at] age combined, total of the other three feed [...] number of animal units on feed and the ratio [...] prices to sorghum grain prices were the factor[s] to account for sorghum grain price variation[s] combined effect of these variables for the p[...] period in Texas accounted for 52 percent [...] variation; whereas in the postwar period, th[...] counted for only 44 percent. The model wa[s] to the U. S. data and the same factors in the [...] period accounted for 71 percent of the vari[...] sorghum grain prices. All factors accounted [...] percent of the variation in prices during the p[...] period.

General recommendations as reflected [...] analysis are: (1) that the Federal Governm[ent] tablish for all grain producers a single suppor[t] program for all feed grains and control the a[...] or quantity produced; (2) that research org[...] tions and agencies continue and expand re[...] programs to develop sorghum grain by-pro[...] (3) that research agencies continue and e[...] research relative to nutritive values amon[g] grains, and (4) that the United States Dep[...] of Agriculture continue to furnish necessary [...] sonnel and funds for investigating the po[...] of increasing foreign demand for sorghum g[...]

A STATISTICAL ANALYSIS OF THE SORGHUM GRAIN INDUSTRY

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HUM GRAIN has been under government upport prices since 1941, with the percent rity ranging from 35 percent in 1941 to 85 nt in 1953-54. Sorghum grain has become y important commodity in Texas with the e of sales for the 10-year period, 1948-57, nting to about 103 million dollars. The e of sales in 1958 amounted to about 235 n dollars which was about 2 percent of the income from all agricultural commodities exas. Sorghum grain production ranged 74 million bushels in 1948 to 238 million ls in 1957, with a low of 54 million bushels 52. Prices averaged $1.19 per bushel during 10-year period, while production averaged t 114 million bushels.

his publication attempts to ascertain the ction and price patterns in the sorghum industry in relation to government pro- s and the effect of price programs for wheat otton on the supply of sorghum grain. A derable amount of statistical analyses were to determine factors responsible for changes ield, harvested acreage and prices for sor- grain. Within these analyses, the effect vernment programs for wheat and cotton e incorporated into the sorghum grain model e form of diverted acreage for wheat and , primarily to determine the effects of and wheat support price programs on the y of sorghum grain.

he sorghum grain industry under govern- t support price programs was analyzed on a al basis as well as on a separate state basis Texas. Texas produces 42 percent of the n's sorghum grain supply.

IGHLIGHTS OF FARM PROGRAM OPERATIONS

t is difficult to single out any specific legis- n on sorghum grain because most of the lation has been under the classification of s, rather than under a specific commodity— sorghum grain, rye, oats and such. How- specific statistics on Commodity Credit ration operations were obtained relative to quantity of stocks, value and cost of disposi- of sorghum grain since the initiation of the ram in 1941. Corn usually has set the price ern for the other three principal feed grains ghum grain, oats and barley. Even though as has always produced a large segment of nation's sorghum grain supply, there never has been a supply problem until the past several years, particularly since the advent of hybrid seed. In the past 2 or 3 years, however, the CCC inventories of sorghum grain have been rather large, particularly for 1958-59 crops. The quantity of sorghum grain under contract to purchase as of September 30, 1959 was 275 million hundredweight. The cost of this contract amounted to 695 million dollars with a reserve for losses of 220 million dollars, resulting in a net book value of 475 million dollars. The quantity of sorghum grain pledged for outstanding loans as of September 30, 1959 was about 14 million hundredweight, or a CCC investment valued at 25 million dollars. As of this same date there was 275 million hundredweight of

CONTENTS

TABLE 1. U. S. SORGHUM GRAIN INVENTORIES ACQUIRED UNDER THE PRICE-SUPPORT PROGRAM BY TYPE OF DISPOSITION FOR SEPTEMBER 1959 AND FISCAL YEAR TO DATE

Commodity, period and item	Unit of measure	Total dispositions	Sales for dollars		Public Law 480—export		Barter (Export)[4]
			Domestic[1]	Export[2]	Title I[3]	Title II[3]	
		— — — — — — — — — — — — — — — — 1,000 dollars — — — — — — — —					
Sorghum Grain							
Current Month							
Quantity	Cwt.	2,898	1,503	3	189	122	934
Cost value		$11,122	3,685	18	571	462	5,592
Proceeds		$ 5,376	2,398	7	558	401	1,736
Fiscal Year							
Quantity	Cwt.	6,953	4,852	3	425	309	908
Cost value		$23,735	13,202	18	1,298	1,026	5,885
Proceeds		$13,846	9,038	7	1,262	983	1,821

[1]Includes inventory gains, losses and related recoveries. Also includes quantitative gains and losses in processing op…
[2]Includes some sales which may be applied subsequently to barter contracts or P. L. 480, Title I authorizations. Any … classification will cause downward adjustments in "Sales for Dollars—Export."
[3]Proceeds represent the Corporation's full investment amount charged to the statutory limitation.
[4]Proceeds represent exchange value of strategic or other material to be delivered under contract.
[5]Amount delivered as payment in kind for exportation under P. L. 480 is included in P. L. 480 (Export) Title I column and … included in this column.

sorghum grain in CCC inventory. This was an investment of approximately 695 million dollars. There was, as of September 30, 1958, a total CCC investment, before a reserve for losses, of 185 million hundredweight of sorghum grain which was valued at 433 million dollars. The total investment in 1959 was almost twice that of the 1958 investment in CCC inventories.

Farm programs for wheat and cotton have affected the supply of sorghum grain considerable, particularly in Texas. As a result of cutbacks in acreage for wheat and cotton and high support prices for sorghum grain, farmers gave considerable impetus to diverting acreages from these two crops to that of sorghum grain. The use of sorghum grain as an alternative cash crop on diverted cotton and wheat acreage has been practiced primarily in the Rolling Plains cotton area and in the southern portion of the Panhandle wheat belt. In the past several years, sorghum grain has been planted as an alternative cash crop in the Gulf Coast area. Within this area, however, sorghum grain was produced primarily because of the ease with which it could be harvested with rice combines and the profit that could be realized by producing the crop relative to other agricultural commodities. Sorghum grain production in the Gulf Coast area was not necessarily a result of diverted acreage from any basic commodity as was true in the High Plains and Panhandle areas.

The disposition of CCC inventories of sorghum grain under Title I and II contracts amounted to nearly 2 million hundredweig… an investment cost of 3.8 million dollars. … stocks were accumulated from the beginn… the program through September 30, 1959. … gross cost to the government of financing … portation under Title I and the cost of … transportation under Title II amounted to … proximately 1 million dollars. The dispo… of sorghum grain under Title I and II prog… has cost the government approximately 5 m… dollars. However, this cost is quite neg… compared to other commodities such as … cotton, corn, tobacco and rice. The dispo… of inventories acquired under the support … programs, by type of disposition for Septe… 1959 and fiscal year to date, is shown in Ta… The table gives a breakdown on dollar sale… domestic export, Title I and Title II, dispos… for sorghum grain. The acquisition of sor… grain under support price programs from … duction during 1955-58 are given in Tab… Table 2 shows that the larger accumulati… sorghum grain stocks and loan and pur… operations took place since 1957. It is antic… that these figures in Table 2 will be highe… the 1959 crop since 1959 was a record prod… year, particularly in Texas.

The total loss from the inception of the … program operation for sorghum grain thr… September 30, 1959 amounted to approxim… 235 million dollars. However, the total co… the fiscal year's 1958-59 stocks amounte… roughly 13 percent of the total cost of the … gram from its beginning to 1959. Sorghum …

TABLE 2. ACQUISITIONS OF SORGHUM GRAIN UNDER THE PRICE SUPPORT PROGRAM FROM PRODUCTION OF RECENT YEARS THROUGH SEPTEMBER 30, 1958

Commodity and production year	Unit of measure	Purchases		Collateral acquired	
		Quantity	Value	Quantity	Value
Sorghum grain 1955	Cwt.	125,419	221,272.00	51,735,179	[illegible]
1956	Cwt.	200,347	392,627.31	18,000,608	[illegible]
1957	Cwt.	3,935,988	8,044,309.45	151,517,060	[illegible]
1958	Cwt.	3,897,927	7,458,839.75	133,857,051	[illegible]

TABLE 3. SORGHUM GRAIN, AVERAGE PRICE SUPPORT LEVELS AND AVERAGE PRICES RECEIVED BY FARMERS FOR 1940-59 CROP YEARS

Percent of parity	Average support level for sorghum grain, cwt.	Seasonal average price received by farmers
	— — — — Dollars — — — —	
35.0	.54	.87
46.0	.71	1.03
55.0	.98	1.41
78.0	1.52	2.04
83.0	1.70	1.63
79.0	1.65	2.14
80.0	1.72	2.50
76.0	2.12	3.27
77.0	2.31	2.29
70.0	2.09	2.02
65.0	1.87	1.88
75.0	2.17	2.36
80.0	2.38	2.82
85.0	2.43	2.36
85.0	2.28	2.25
70.0	1.78	1.78
76.0	1.97	2.30
70.0	1.86	1.94
70.0	1.83	2.00
60.0	1.52	1.78[1]

[1]Preliminary.

...merly had been listed under "other nonbasic ...modities," but was reclassified effective ...ember 30, 1959 on the basis of Public Law ...35. This law provided for mandatory support prices on barley, sorghum grain, oats and rice. These mandatory support prices were to begin with the 1959 crop.

The percentage of parity, average support level for sorghum grain and the seasonal average price received by farmers since the government support price program was initiated in 1941, are given in Table 3. The seasonal average price received by farmers since the start of the price program was greater than the average support price in every year during 1941-52 inclusive, with the exception of 1949 when the seasonal average price was only 7 cents below the average support level. The seasonal average price was below the support level during 1953-59 inclusive, with the exception of 1955 when the two prices were equal.

SORGHUM GRAIN PRODUCTION

Sorghum grain production was, for many years before and after World War II, concentrated primarily in Texas and Oklahoma. These two states produced roughly two-thirds of the nation's supply of sorghum grain until the latter part of the 1940's. Since sorghum grain can be produced in semi-arid as well as irrigated regions, and since the crop is a very profitable alternative enterprise, the production in the early fifties began to spread north into the Corn Belt, all through the Southeast and through the Southwest as far as California, Figure 1. Texas and

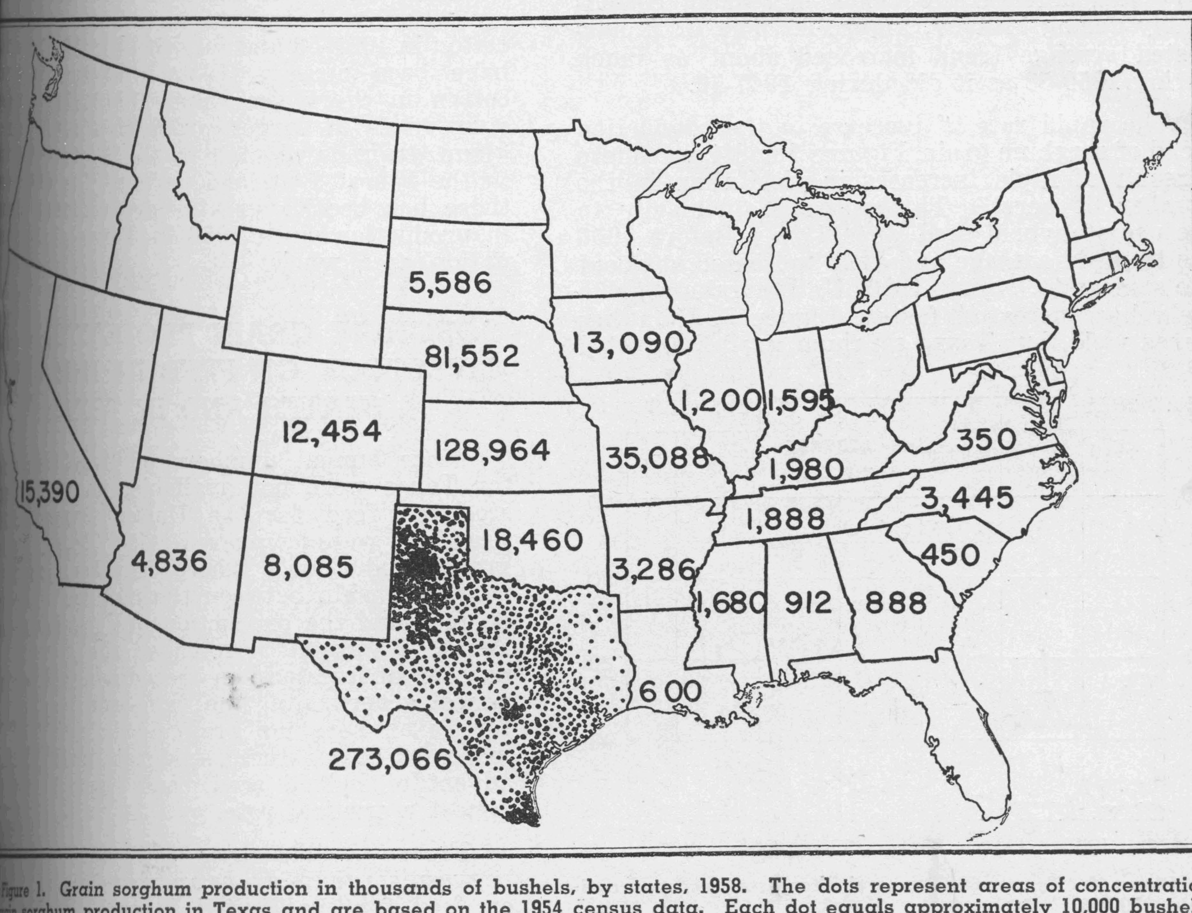


Figure 1. Grain sorghum production in thousands of bushels, by states, 1958. The dots represent areas of concentration of grain sorghum production in Texas and are based on the 1954 census data. Each dot equals approximately 10,000 bushels.

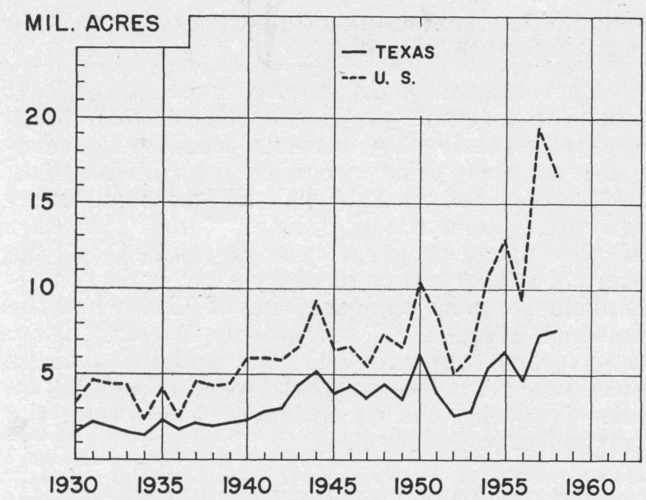


Figure 2. Sorghum grain harvested acreage, United States and Texas, 1930-58.

Kansas are the major producing states, with Texas producing about 42 percent of the nation's supply.

U. S. and Texas Harvested Acreage and Yields

Sorghum grain harvested acreage for Texas and the United States during 1930-58 has a comparable trend pattern, but with the trend in harvested acreage for Texas increasing considerably during 1950-57, Figure 2. The U. S. harvested acreage trend increased about as much during 1950-58 as it did during 1947-50.

The rapid rate of increase in the production trend of sorghum grain, Figures 3 and 4, was more a result of rapid increases in yield than in the number of acres. This was due primarily to the use of hybrid seed since 1955. Before 1956 the trend in acreage and yield increased at about the same rate. Since 1956, U. S. sorghum grain yield has increased faster, Figure 5, than has Texas yield, but Texas sorghum grain harvested

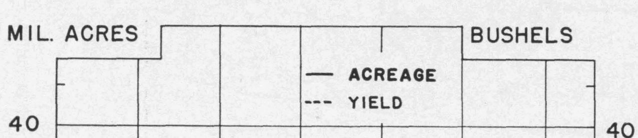


Figure 3. Texas sorghum grain harvested acreage and yield, 1930-58.

acreage increased at a faster rate than the harvested acreage. Figure 5 shows the trend in yield for the United States and T for 1930-58 was about the same. The U. S. vested acreage trend during 1930-58, in com to the Texas trend, increased on the avera a more rapid rate than did the yield. perhaps was due to the rapid spread of sorg grain production all over the South and S west after the introduction of hybrid se 1955; yield did not increase as rapidly fo nation as a whole as it did in the irrigat tions of the Rolling and High Plains area Texas.

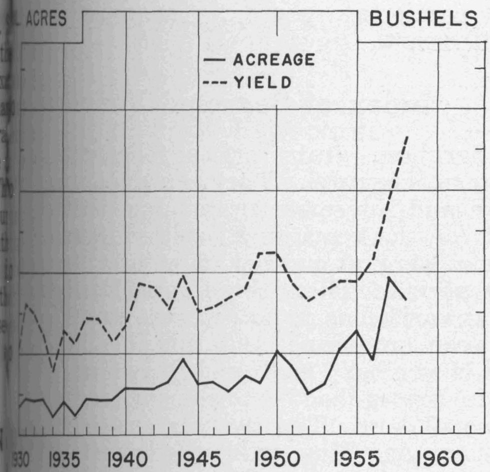
U. S. AND TEXAS SORGHUM GRA PRODUCTION TRENDS

The trend in production for Texas an United States for 1930-58 shows that the duction trend for Texas and the United was almost the same until hybrid sorghum seed came into widespread use, Figure 6. that time there has been a phenomenal u production trend for Texas sorghum grain. was perhaps a result of considerable di acreage in cotton and wheat, particularly, most of Texas' sorghum grain is produced the cotton and wheat areas. This prod trend increased considerably after 1954 therefore sorghum grain was a very pro alternative crop for these diverted areas. ers were free to plant any desired acrea cotton in 1951-53 and for wheat in 1947-49. have been acreage allotments for wheat cotton in every year since 1949 and 195 spectively. A larger proportion of Texas ghum grain is planted in the Cotton Belt in the Wheat Belt, and perhaps for this r there has been a greater proportional inc in production since 1956 in Texas than fo nation as a whole.

SORGHUM GRAIN PRODUCTION A LIVESTOCK ON FEED IN THE UNIT STATES AND IN TEXAS

Since annual numbers of livestock on for Texas were not available, numbers of stock on feed for the United States, Fig 7 and 8, were compared with Texas' sorg grain production. There has been prac no relationship between the number of live on feed and the production of sorghum gr Texas, Figure 7. Actually, the trend i number of livestock on feed during 1930-58 almost a horizontal line; whereas, the trend for Texas' sorghum grain production since increased at a rather rapid rate until 1956 advent of hybrid seed) and then increa almost a vertical rate.

Figure 8 illustrates the same relati between sorghum grain and numbers of live on feed for the United States. The pri



igure 4. U. S. sorghum grain harvested acreage and 1930-58.

ference between U. S. and Texas sorghum in production and livestock on feed is only the rate of increase of sorghum grain production, since the number of livestock on feed, ures 7 and 8, is for the United States. However, the U. S. sorghum grain production trend ing 1930-56 did not increase quite as rapidly the Texas production trend. The faster increase in Texas sorghum grain production relato U. S. production, particularly since World r II, was perhaps a result of Texas sorghum in producers invariably utilizing diverted ton acreage for sorghum grain production. ghum grain production has been the most fitable alternative crop on Texas diverted ton acreage. In other principal sorghum in-producing states, in which diverted wheat eage afforded the greater amount of available d, many of the resources were devoted to the duction of corn and forage crops.

RGHUM GRAIN AND CORN PRICES IN THE UNITED STATES AND IN TEXAS

U. S. and Texas sorghum grain seasonal rage prices followed a close pattern during 0-58. This was to be expected since U. S. d Texas sorghum grain prices followed a price tern set primarily by corn prices. U. S. and as corn prices varied slightly during 1930-58. ce corn is the price-determining feed grain, a ce difference was expected between the Texas rage annual price and the U. S. average anl price. The only major deviation in prices ween the two commodities was in 1944, at ich time the U. S. average price took a sudden p and the Texas average price actually inased slightly. During 1930-58, however, Texas n prices fluctuated on the average, slightly e than U. S. corn prices.

Texas sorghum grain prices during 1930-58 ged behind corn prices throughout every year ing 1933-34. The corn-hog program and the 1933 Triple "A" program might have af-

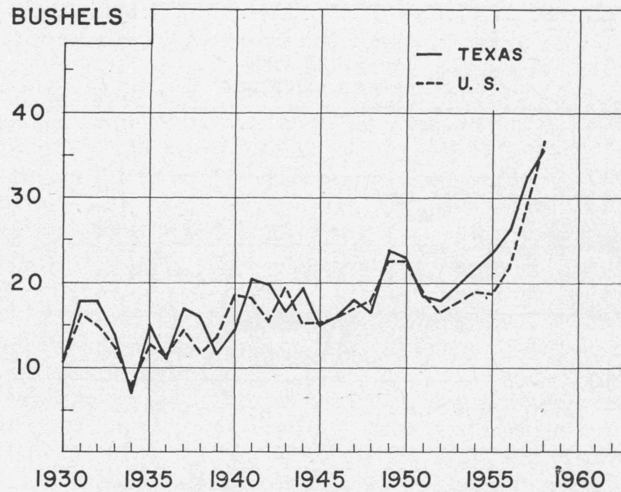


Figure 5. Sorghum grain yields, United States and Texas, 1930-58.

fected corn prices more than sorghum grain prices during these 2 years. The two prices were about equal in 1935, 1936 and 1939, with the greatest difference occurring in 1947. The 1947 crop year was the best season, pricewise, that farmers have experienced since World War II.

U. S. sorghum grain and corn price patterns were similar to the Texas sorghum grain and corn price patterns except for more price stability in U. S. corn prices than for Texas corn prices. However, this was to be expected since the U. S. average price for most commodities usually will be more stable than the price of a commodity in a particular state.

ADJUSTED SEASONAL INDEX AND ZONE OF PRICE EXPECTANCY FOR TEXAS SORGHUM GRAIN

Many factors such as weather conditions, business activities and trends in farm prices and farm policies, here and abroad, alter the seasonal

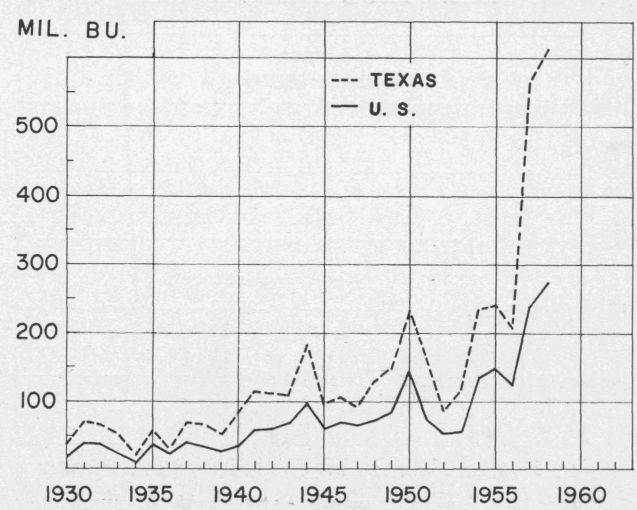


Figure 6. Sorghum grain production, United States and Texas, 1930-58.

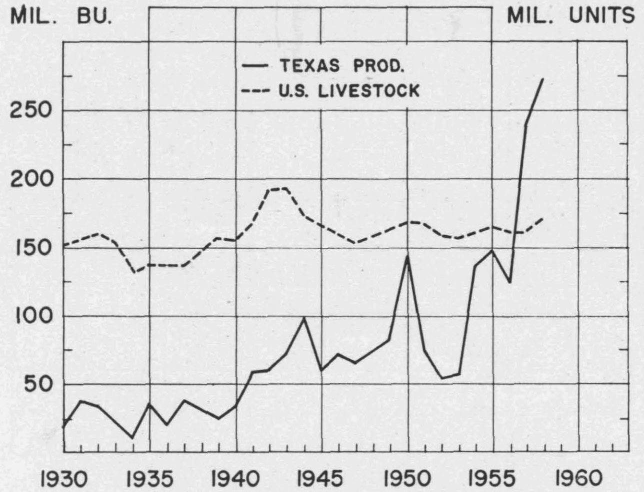


Figure 7. The relationship between U. S. numbers of livestock on feed and Texas sorghum grain production, 1930-58.

price movement of a commodity in any particular year. The variation in price patterns for some commodities remains approximately the same year after year, while for other commodities the variation is pronounced. Therefore, the average adjusted seasonal variation for Texas farm commodities should not be applied as a criterion of price change for any one year until adjustments are made, for current as well as probable future changes in economic conditions. Any particular analysis based on past years is a relative concept and should be relied on with discretion when used as a forecast of future years. The index of seasonal variation for sorghum grain was developed, using the weighted season average monthly prices, for 1947-56, Figure 9. The prices were adjusted for cycles and trends. The zone of price expectancy was calculated for 1947-56 to afford a measure of the monthly variation in prices from the seasonal average price for the 10-year period. The zone is the range of the average seasonal price that can be expected for

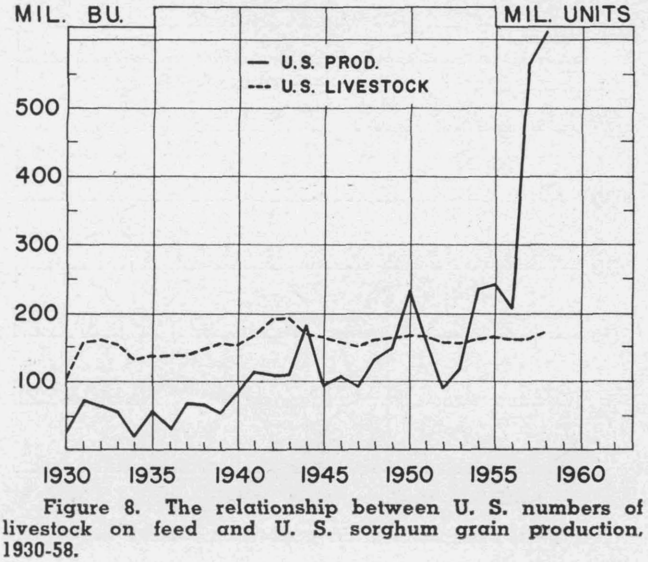


Figure 8. The relationship between U. S. numbers of livestock on feed and U. S. sorghum grain production, 1930-58.

any particular month, in approximately of 10 years.

Index of Seasonal Variation

Sorghum grain prices followed a uni pattern, Figure 9. They remained above from mid-November to mid-June and below mal for the remaining months. Sorghum prices were at normal only three times this period. These three normal periods sonal variations in prices were in mid-Feb between mid-June and mid-July and mid-November and mid-December. Sor grain prices had two seasonal highs and seasonal low. The two seasonal highs were January and May, while the low was in Au

The index of seasonal variation in price sorghum grain reached a low of 93 in Au and a high of 109 in May. This made a di ence of 16 points or 36 cents per hundred The widest spread above and below the inde seasonal price variation was from A through October. This was to be expecte view of the heavy marketings of sorghum g during these months and competitive feed g reaching the market. This relation will depending on the supply of sorghum grain well as the potential supplies of competing g The smallest variation in price was in M when the smallest quantity moves into the ma and the demand is relatively stable. Usually most profitable time to store sorghum grain when the supply is large or prices are ris Therefore, the best time to store would be tween mid-October and mid-December and best time to sell, between mid-February and May. The least profitable time to store sorgh grain, relative to the seasonal price patte would be between mid-May and mid-Aug Decisions that concern when to store or to should be compared with average conditions vailing relative to the general economy, gen price levels, economic considerations, clim

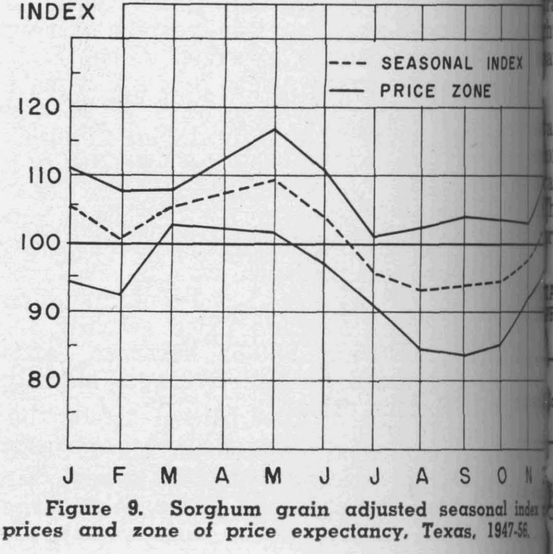


Figure 9. Sorghum grain adjusted seasonal index prices and zone of price expectancy, Texas, 1947-56.

itions and government programs closely ap-ching those that prevailed during the base od.

Zone of Price Expectancy

he amount of variation in the price for a month from the average price prevailing hat month for the 10 years, 1947-56, was uted as follows: if the average price for nth was 120 percent of the annual price and ndex of price variation was 5 percent, this d mean that the price in that month varied een an index of 115 to about 125 in approxi-ly 7 out of 10 years. The narrower the of the index of the price zone, Figure 9, greater the stability and closeness of the thly seasonal price to the average price for 10-year period. Conversely, if the value is , the monthly prices in individual years ed considerably from the average monthly es.

IATIONS IN SORGHUM GRAIN AND RN PRICES FOR 1930-40 AND 1946-58

A statistical technique was used to determine percentage variation between corn prices sorghum grain prices during these two pe-s, Table 4. These percentage variations in es for sorghum grain and corn were computed Texas and the United States for both periods. principal difference between the percentage ation of sorghum grain compared with corn Texas during 1930-40 was that sorghum n prices varied about 8 percent more than corn prices. During this same period, U. S. hum prices varied only about 3 percent more corn prices. The greater variation in Texas hum grain prices varied only about 3 percent e than corn prices. The greater variation in s sorghum prices as compared with corn s during 1930-40 was perhaps a result of s sorghum grain being produced primarily as atch" crop. Consequently, Texas sorghum n prices followed as closely as did U. S. sor-m grain prices the commercial grain price ern as was determined by corn prices.

During 1946-58, Texas sorghum grain prices ied about .5 of 1 percent more than Texas n prices, while U. S. sorghum grain prices ied .7 of 1 percent more than corn prices. e smaller variation in Texas sorghum grain es as compared with corn prices during 1946-58 resulted primarily from the shift in the production of Texas sorghum grain from a "catch" to a "cash" crop and to a greater balance between the demand for Texas and U. S. sorghum grain and corn supplies in meeting the needs, both in quantity and nutritional values, for an ever increasing postwar livestock feeding industry.

LE 4. PERCENTAGE VARIATION OF TEXAS AND U. S. ES FROM THE AVERAGE PRICE DURING THE PERIODS, 1930-40 AND 1946-58

modity	Texas		United States	
	1930-40	1946-58	1930-40	1946-58
	Percent			
um grain	39.1	19.6	37.6	19.4
n	31.1	19.1	34.5	18.7

STATISTICAL ANALYSIS OF HARVESTED ACREAGE AND PRICES

An analysis was made to determine the factors responsible for the variation in Texas harvested acreage and the price of U. S. and Texas sorghum grain. Texas sorghum grain harvested acreage model (following) was considered for 1946-58; the U. S. and Texas sorghum grain price model (shown on page 12) was made for 1924-40 and 1946-57.

Harvested Acreage Model

The following model was fitted to U. S. and Texas harvested acreage data during 1946-58:

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4$$

Y = harvested acreage for sorghum grain (1,000 acres)
X_1 = diverted acreage in cotton as percent of 1951, 1952 and 1953 average
X_2 = diverted acreage in wheat as percent of 1947, 1948 and 1949 average
X_3 = 1 year lagged production in sorghum grain
X_4 = U. S. sorghum grain support prices

More emphasis was placed on the analysis for harvested acreage than on the analysis for sorghum grain prices, since one of the basic objectives of this manuscript was to determine the effect of Federal price programs, which were initiated at the beginning of World War II, for cotton and wheat on the supply of sorghum grain. However, the importance of knowing the price behavior of sorghum grain is not discounted; but since corn prices generally set the pattern for sorghum grain prices, a more thorough analysis on harvested acreage was deemed necessary to arrive at possible effects of cotton and wheat programs on the supply of sorghum grain.

Since a detailed analysis was needed on harvested acreage and factors responsible for variations in harvested acreage of sorghum grain, Equation I, for example, was fitted with Texas data and a significance test was run to detect the factor that contributed least to the cause of of variation in harvested acreage and therefore could be eliminated from the equation. Then Equation II was fitted using the remaining variables and again the factor that contributed least to the variation in harvested acreage was eliminated. This procedure was repeated (see Equations III through VIII) until only one factor remained in the final equations (Equations IV and VIII) that contributed more than any other single factor toward the cause of the variation in harvested acreage of sorghum grain during 1946-58.

However, this procedure of deleting variables was not followed for the analysis on prices. Only total variation and partial correlation coefficients were estimated. A partial correlation coefficient is a measure of the extent to which that part of the variation in the dependent variable (price), which was not explained by the other independent factors, can be explained with the addition of a new factor.

Texas Harvested Acreage Data, 1946-58

EQUATION I

$$Y = \underset{}{10360.49} - \underset{(2458.47)}{3872.03X_1} - \underset{(1131.68)}{766.39X_2} + \underset{(.00765)}{.0089X_3} - \underset{(1917.26)}{1453.73X_4}$$

These four factors accounted for 62 percent of the variation in harvested acreage during 1946-58. The figures in parentheses are standard errors of the regression coefficients. As attested by the "t" values, the partial correlation $r_{y2.134}$ had the smallest value. The "r" value means that out of the 38 percent unaccounted for, diverted acreage in wheat accounted for less of the unexplained variation than any of the other three variables. As noted in Equation II, with diverted acreage in wheat omitted, the R^2 is 64 percent, or a difference of 2 percent improvement in the variation of harvested acreage. The difference ($R^2_{y.1234}$ — $R^2_{y.134}$), between the 62 percent accounted for in Equation I and the 64 percent accounted for in Equation II, when divided by 38 percent (the difference between the value of R^2 in Equation I and 100 percent), gives the squared value of the partial correlation coefficient. If the "r" (−.23) value is squared, a 5.26 percent reduction in the unexplained variance is ascribable to diverted acreage in wheat. Since $b_{y2.134}$ was negative, the sign of $r_{y2.134}$ was also negative. A similar explanation of the meaning of the r's and the adjusted R's hold for each successive equation.

EQUATION II

$$Y = 9280.21 - \underset{(2387.25)}{4119.92X_1} + \underset{(.00707)}{.0111X_3} - \underset{(1787.77)}{1157.68X_4}$$

The reason the analysis was improved, that is the R^2 value, in Equation II compared with that of Equation I, was because by eliminating diverted wheat acreage some intercorrelation or serial correlation between independent variables in the equation could be reduced. Therefore, by eliminating an intercorrelated or partially correlated independent variable, there would be some improvement in the percentage variation in the dependent variable accounted for by the remaining independent variables. A variable that may show no correlation with the dependent variable would show significant correlation after the relation of other variables has been allowed for in the equation. The value of $r_{y4.13}$ (—.22), for example, indicated that support prices accounted for less of the unexplained variation in prices and was therefore deleted before fitting Equation III to diverted cotton acreage and lagged production data.

EQUATION III

$$Y = 7382.07 - \underset{(2134.86)}{4955.08X_1} + \underset{(.0067)}{.0126X_3}$$

As shown in Equation III, with diverted wheat acreage and support prices removed from the equation, the percentage variation accounted for, was improved to slightly over 66 percent as shown by the R^2 values in this equation. Diverted acreage in cotton and 1 year lagged production in sorghum grain contributed most to the variation in sorghum grain harvested acreage. The lesser importance of sorghum grain lagged production relative to diverted acreage in cotton in Equation III was verified by an r value of .59.

EQUATION IV

$$Y = 9555.26 - \underset{(2446.06)}{6108.98X_1}$$

With 1 year lagged production in sorghum grain eliminated, 53 percent of the variation in sorghum grain harvested acreage was accounted for by diverted acreage in cotton. This high percentage of the variation accounted for by diverted cotton acreage was to be expected since the larger proportion of sorghum grain is produced in the Cotton Belt of Texas. However, the remaining 47 percent that was not accounted for can perhaps be attributed to the fact that a sizable proportion of the total quantity of sorghum grain was produced in the Gulf Coast area of Texas where diverted cotton acreage was not a significant factor.

The reduction in unexplained variance in Texas harvested acreage, by the addition of a new factor in Equations IV through I, respectively, is given in Table 5.

U. S. Harvested Acreage Data, 1946-58

EQUATION V

$$Y = 16673.65 - \underset{(7182.97)}{4448.53X_1} - \underset{(9745.31)}{17068.77X_2} + \underset{(.0074)}{.0082X_3} - \underset{(4370.86)}{452.69X_4}$$

The harvested acreage equation with the same independent variables was fitted to U. S. data during the same period, 1946-58. With all four factors included in Equation V, the correlation was 89 or, in other words, percent of the variation in U. S. sorghum grain harvested acreage was accounted for by all four factors. In this equation, as estimated by the "t" test, the support price contributed least ($r_{y4.123}$ = —.037) to the variation in harvested acreage and was therefore deleted.

EQUATION VI

$$Y = 26006.30 - \underset{(5625.36)}{4869.89X_1} - \underset{(9156.94)}{17000.86X_2} + \underset{(.0070)}{.0082X_3}$$

E 5. RELATIVE IMPORTANCE OF INDIVIDUAL FACTORS AFFECTING THE DEPENDENT VARIABLE (HARVESTED ACREAGE) TEXAS, 1946-58

Factors already considered	Factor added	The r's	Coefficient of partial correlation	Reduction in unex-plained variance	Coefficient of multiple determination (R^2)
X_1 (Diverted cotton acreage)	None	$r_{y1.0}$	—.753	5.67	.53
X_1 (Diverted cotton acreage)	X_3 (lagged production)	$r_{y3.1}$	.590	.348	.66
X_1 (Diverted cotton acreage) X_3 (Lagged production)	X_4 (support prices)	$r_{y4.13}$	— .22	0.48	.64
X_1 (Diverted cotton acreage) X_3 (Lagged production) X_4 (Support prices)	X_2 (diverted wheat acreage)	$r_{y2.134}$	— .23	0.53	.62

quation VI was fitted to the data again using rted acreage in cotton, diverted acreage in at and 1 year lagged production in sorghum in. The result, after elimination of support es from the independent variables, was tly improved and acounted for 72 percent he variation in harvested acreage. Similarly, "t" test indicated that diverted acreage in on contributed less than did diverted acreage heat and lagged production of sorghum grain. is indicated by the partial correlation co-ient, $r_{y1.23}$ and is equal to $-.29$. Diverted age in cotton was therefore eliminated and tion VII was fitted to the data using only rted acreage in wheat and lagged production.

EQUATION VII

$$= 25451.34 - \underset{(8595.39)}{21313.76X_2} + \underset{(.0069)}{.0099X_3}$$

y eliminating diverted acreage in cotton including only lagged production and di-d acreage in wheat, the percentage varia-was improved by only one half of 1 percent. ever, the "t" test indicated that of the two ining variables (diverted acreage in wheat lagged production), lagged production con-ted least, as is verified by the partial cor-ion coefficient, $r_{y3.2}$ and is equal to .456.

EQUATION VIII

$$= 30903.27 - \underset{(9178.20)}{25664.67X_2}$$

quation VIII was fitted to the data using diverted acreage in wheat and this single factor accounted for a little over 68 percent of the variation in harvested acreage for U. S. sorghum grain.

The results of these series of equations fitted to U. S. data were to be expected since diverted acreage in wheat for the nation as a whole would be more significant than diverted acreage in cotton, particularly since diverted acreage in cotton is primarily utilized for the larger proportion of the Texas sorghum grain production. Diverted wheat acreage alone accounted for about 16 percent more variation in U. S. sorghum grain harvested acreage than did diverted cotton acreage alone account for the variation in Texas sorghum grain harvested acreage. This was to be expected since the U. S. model included diverted wheat acreage in the High Plains of Texas where most of the Texas sorghum grain is produced. Also, a sizeable quantity of sorghum grain is produced in the Texas Gulf Coast area in which there is no diverted wheat acreage and in which diverted cotton acreage is not as significant as in the High Plains area. In fitting the equations to the U. S. data, recognition of the contribution of Texas diverted wheat acreage and diverted cotton acreage to the results was necessary so that more logical interpretations of U. S. analyses could be made. The proportional significance of Texas diverted wheat acreage relative to Texas diverted cotton acreage also must be considered when interpreting the results of Texas analyses. For example, Kansas, other than Texas, produces nearly as much sorghum grain as the other principal producing

E 6. RELATIVE IMPORTANCE OF INDIVIDUAL FACTORS AFFECTING THE DEPENDENT VARIABLE (HARVESTED ACREAGE) UNITED STATES, 1946-58

Factors already considered	Factor added	The r's	Coefficient of partial correlation	Reduction in unex-plained variance	Coefficient of multiple determination (R^2)
X_2 (Diverted wheat acreage)	None	$r_{y2.0}$	—.843	.711	.68
X_2 (Diverted wheat acreage)	X_3 (lagged production)	$r_{y3.2}$	.456	.208	.73
X_2 (Diverted wheat acreage) X_3 (Lagged production)	X_1 (diverted cotton acreage)	$r_{y1.23}$	— .29	.084	.72
X_1 (Diverted cotton acreage) X_2 (Diverted wheat acreage) X_3 (Lagged production)	X_4 (support prices)	$r_{y4.123}$	—.037	.001	.69

states combined and Kansas is primarily a wheat state. When lagged production was eliminated from U. S. data, leaving only diverted wheat acreage, and from Texas data, leaving only diverted cotton acreage, the variation in Texas harvested acreage was considerably more than was the variation in U. S. harvested acreage, Tables 5 and 6. This perhaps was attributable to a stronger relationship between U. S. diverted wheat acreage and U. S. sorghum grain production than was true for the relationship between Texas diverted cotton acreage and Texas sorghum grain production. Texas sorghum grain is a major farm commodity and is grown primarily as a cash crop and therefore Texas producers would perhaps pay more attention to a prior year's sorghum grain supply and alternative crops than would be evident for the nation as a whole.

The reduction in unexplained variance in U. S. harvested acreage, by the addition of a new factor in Equations VIII through V respectively, is given in Table 6.

Price Model

The following model was fitted to U. S. and Texas sorghum grain price data during the period, 1924-40 and 1946-57. All pertinent coefficients for the U. S. and Texas data are shown in Table 7.

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5$$

Y = price of sorghum grain (cents per bushel)
X_1 = production of sorghum grain (1,000 bushels)
X_2 = cotton and wheat acreage combined (1,000 acres)
X_3 = total corn, barley and oats (1,000 bushels)
X_4 = number animal units on feed (1,000 units)
X_5 = ratio of corn prices to sorghum grain prices

TABLE 7. RELATIVE IMPORTANCE OF INDIVIDUAL FACTORS AFFECTING THE DEPENDENT VARIABLE (PRICES)

Equation	Coefficients		
	Multiple determination (R^2)	The r's	Reduction in unexplained variance[1]
Texas			
1924-40			
IX	.52	$r_{y1.2345}$	.23
1946-57			
		$r_{y4.1235}$	.44
X	.44		
		$r_{y2.1345}$	.12
United States			
1924-40			
		$r_{y3.1245}$	.31
XI	.71		
		$r_{y5.1234}$	.19
1946-57			
		$r_{y2.1345}$	.24
		$r_{y3.1245}$	.57
XII	.77		
		$r_{y4.1235}$	.18
		$r_{y5.1234}$	.32

[1]All r's not listed were zero.

Texas Data, 1924-40

EQUATION IX

$$Y = 1.8042 - \underset{(.00069)}{.0014X_1} - \underset{(.0037)}{.00021X_2} - \underset{(.0003)}{.000064X_3} -$$
$$\underset{(.00078)}{.00081X_4} + \underset{(5862)}{.1166X_5}$$

Equation IX was fitted to Texas data to termine how much of the variation in Te sorghum grain prices was attributable to the independent variables. All five indepen variables accounted for 52 percent of the va tion in Texas sorghum grain prices during 19 40. The production of sorghum grain contrib most to the variation in prices, followed by nu ber of animal units on feed. The coefficie partial determination ($r^2_{y1.2345}$) was 23 per for the production of sorghum grain, but zero for all other variables. These results w reasonable since sorghum grain, during period, was not considered a major crop. It planted primarily as a "catch" crop, and uti principally as an on-the-farm feed grain. The fore, a prior year's supply and the number animal units on feed were the principal fac in accounting for more than 50 percent of variation in sorghum grain prices during period.

Texas Data, 1946-57

When the same equation was fitted to Texas data during 1946-57, (Equation X), results differed considerably from those of pre-World War II period.

EQUATION X

$$Y = -3.1685 + \underset{(.00031)}{.000029X_1} + \underset{(.0029)}{.0039X_2} + \underset{(.00077)}{.00019X_3} -$$
$$\underset{(.0016)}{.0046X_4} + \underset{(1.8034)}{1.539X_5}$$

One of the primary reasons the results fered was because sorghum grain was un government support price programs during 19 57, and subjected to free market conditions ing 1924-40. Consequently, a prior year's su or production was of no consequence whate during 1946-57. All five variables accounted 44 percent of the variation in sorghum gr prices during this 1946-57 period. The m important variable during this period was number of animal units on feed, which, w deleted from the equation, removed all att utable variation in sorghum grain prices. T is verified by a coefficient of partial determi tion ($r^2_{y4.1235}$) of 44 percent. However, the efficient of partial determination for the ot variables was zero with the exception of cot and wheat acreage combined and this vari ($r^2_{y2.1345}$) accounted for about 12 percent of unexplained variation accounted for by all v iables other than X_4, the number of animal u on feed.

U. S. Data, 1924-40

The price model was fitted to U. S. d during 1924-40 (Equation XI) with the s variables and the results were considerably proved on the national basis.

EQUATION XI

$$= -1.7943 - \underset{(.00026)}{.00014X_1} - \underset{(.00044)}{.00029X_2} - \underset{(.0000071)}{.000017X_3} -$$

$$\underset{(.00058)}{.0003X_4} - \underset{(.1772)}{.3333X_5}$$

he five variables accounted for 71 percent e price variation, with the total amount of r feed grains—corn, barley and oats—being most important variable on a national basis. three feed grains were followed in impor- e by the ratio of corn prices to sorghum n prices as verified by $r^2_{y3.1245}$ and accounted 1 percent of the unexplained variation. The ficient of partial determination for the X_5 able ($r^2_{y5.1234}$) accounted for about 19 percent. ratio of corn prices to sorghum grain prices used as an independent variable to allow for full effect of corn prices on sorghum grain es. The greatest improvement in accounting the variation in sorghum grain prices was ieved when the production of the sorghum n variable (X_1) was deleted from the equa- . The results from Equation XI during 1924- were a reflection of the composite national and for sorghum grain relative to all other grains and therefore corn prices would con- te more on the national basis to governing hum grain prices.

S. Data, 1946-57

EQUATION XII

$$= -2.2539 - \underset{(.000045)}{.000028X_1} - \underset{(.00045)}{.00077X_2} - \underset{(.0000095)}{.000029X_3} -$$

$$\underset{(.0014)}{.0021X_4} - \underset{(.2512)}{.487X_5}$$

When Equation XII was fitted to U. S. data for 1946-57 (with the same variables that are in Equations IX through XI), the picture was completely changed, in that variable X_2, X_3, X_4 and X_5 all contributed to the unexplained variation in the price. The total feed grain variable, X_3, accounted for most of the unexplained variation. Total feed grains were followed in importance by the ratio of corn prices to sorghum prices, combined cotton and wheat acreage and the number of animal units on feed. Sorghum grain production (X_1) accounted for none of the unexplained variation. All five variables accounted for 77 percent of the variation in sorghum grain prices in Equation XII, but with production left out of the equation the amount of the variation accounted for was improved slightly and amounted to 79 percent.

These results were reasonable expectations in the light of a rapidly expanding postwar economy, guaranteed support prices (eliminating the significance of prior years' supplies), technological innovations, relatively high free market prices and the shift and reallocation of alternative land resources.

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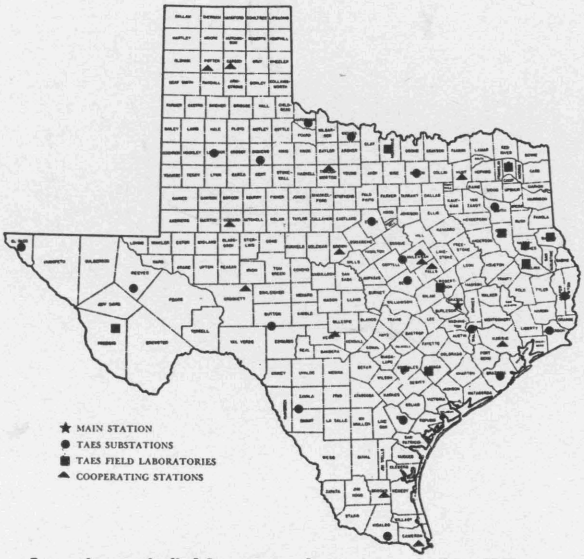

Location of field research units of the Texas Agricultural Experiment Station and cooperating agencies

State-wide Research

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The Texas Agricultural Experiment Statio is the public agricultural research agency of the State of Texas, and is one of the parts of the A&M College of Texas.

ORGANIZATION

IN THE MAIN STATION, with headquarters at College Station, are 16 su matter departments, 2 service departments, 3 regulatory services and administrative staff. Located out in the major agricultural areas of Texa 21 substations and 9 field laboratories. In addition, there are 14 coopera stations owned by other agencies. Cooperating agencies include the T Forest Service, Game and Fish Commission of Texas, Texas Prison S U. S. Department of Agriculture, University of Texas, Texas Technolo College, Texas College of Arts and Industries and the King Ranch. S experiments are conducted on farms and ranches and in rural homes.

OPERATION

THE TEXAS STATION is conducting about 400 active research projects, gr in 25 programs, which include all phases of agriculture in Texas. A these are:

- Conservation and improvement of soil
- Conservation and use of water
- Grasses and legumes
- Grain crops
- Cotton and other fiber crops
- Vegetable crops
- Citrus and other subtropical fruits
- Fruits and nuts
- Oil seed crops
- Ornamental plants
- Brush and weeds
- Insects
- Beef cattle
- Dairy cattle
- Sheep and goats
- Swine
- Chickens and turkeys
- Animal diseases and parasit
- Fish and game
- Farm and ranch engineering
- Farm and ranch business
- Marketing agricultural produ
- Rural home economics
- Rural agricultural economics
- Plant diseases

Two additional programs are maintenance and upkeep, and central ser

Research results are carried to Texas farmers, ranchmen and homemakers by county agents and specialists of the Texas Agricultural Extension Service

AGRICULTURAL RESEARCH seeks the WHATS, the WHYS, the WHENS, the WHERES and the HOWS of hundreds of problems which confront operators of farms and ranches, and the many industries depending on or serving agriculture. Workers of the Main Station and the field units of the Texas Agricultural Experiment Station seek diligently to find solutions to these problems.

Today's Research Is Tomorrow's Progress