Sorghum

Background for 1990 Farm Legislation

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Introduction

Production of sorghum--also known as milo--is concentrated in the Central and Southern Plains. Kansas, Texas, Nebraska, and Missouri produce over 80 percent of U.S. sorghum. Production in the Delta expanded in the early 1980's, but declined recently. Although total U.S. sorghum acreage has varied between 12 and 27 million acres since 1950, acreage in 1988 was the lowest since 1950, down a third from the 1950 level.

Livestock and poultry feeding account for about 98 percent of total domestic use of sorghum. This report examines the relationship between corn and sorghum; sorghum has about 95 percent of the feeding efficiency of corn in livestock rations. Sorghum's share of all concentrates fed to all livestock and poultry is only 6-8 percent, compared with corn's 60-65 percent. But for beef cattle, sorghum's share is around 20 percent, primarily because a large fed beef industry has developed in the sorghum belt.

In 1987, U.S. production accounted for about a third of total world sorghum production. In recent years, U.S. exports have taken 15-35 percent of U.S. sorghum production. U.S. sorghum exports accounted for nearly 75 percent of world sorghum trade in the 1987/88 marketing year, up from 45 percent in 1982/83 but down from 80 percent in the early 1960's. Argentina has greatly reduced sorghum production and exports since 1980, especially in response to decreases in the foreign currency value of U.S. sorghum in recent years. U.S. sorghum exports totaled $566 million in 1987, about 2 percent of U.S. agricultural exports.

Sorghum was brought under Government acreage control programs in the 1960's because earlier acreage programs for wheat, cotton, and corn left land available which led to increased acreage of sorghum, an uncontrolled crop. Production was also boosted by new sorghum varieties which raised yields starting around 1960. Because sorghum is a close substitute for corn as a feed grain, the corn program itself provides substantial benefits to the sorghum industry. This report traces the links between the sorghum and corn programs. It also assesses effects of the

program on producer incomes, prices paid and quantities bought by consumers, and taxpayer costs.

Structure of the Sorghum Industry

Sorghum acreage is second to corn among feed grains grown in the United States. In 1987, the 12 million acres planted to sorghum by U.S. farmers accounted for about 4 percent of the area planted to principal crops. About 90 percent of the acreage was harvested for grain, and most of the balance was harvested for silage and forage. With an average yield of 70 bushels per acre, U.S. sorghum production reached about 740 million bushels. The value at the farm gate totaled $1.2 billion, nearly 1 percent of all farm cash receipts and 2 percent of receipts from crops.

Production Characteristics

The structure of the U.S. sorghum production sector has been changing. Planted acreage rose from 12 million in 1952 to 27 million in 1957. Acreage fell to about 14 million by 1961 and has been between 15 and 20 million since then, except for drops in 1983, 1987, and 1988. Between 1964 and 1982, the number of farms producing sorghum fell 57 percent, from 249,000 to 106,900. The average acreage of sorghum harvested per farm nearly tripled from 45 to 126. These changes were more dramatic than those occurring for the U.S. farming sector as a whole. During the period, U.S. farm numbers fell 29 percent and average acreage per farm rose 25 percent.

Structure of Sorghum Farms

Of the 106,900 farms harvesting sorghum in 1982, 75 percent were located in the eight most important sorghum-producing States: Colorado, Kansas, Missouri, Nebraska, New Mexico, Oklahoma, South Dakota, and Texas. These States have accounted for 85-95 percent of total sorghum production since 1950. Sorghum accounted for about 32 percent of the major crops (sorghum, corn, wheat, soybeans, cotton, hay, other feed grains, rice, and tobacco) on farms growing sorghum in these States. These farms averaged 457 acres planted to major crops.

The average sorghum farm had corn, wheat, soybeans, cotton, and hay on two-thirds of its harvested acreage of major crops in 1982 (table 1). Sorghum farms with fewer than 100 acres of cropland had more than half of their harvested area in sorghum, and wheat and hay were their next major crops. Larger sorghum farms were more diverse, growing proportionally more wheat, soybeans, cotton, and hay. Corn, soybean, and hay shares were largest for medium-sized farms having 250-499 acres of cropland. Large farms with more than 1,000 acres of cropland, which accounted for 17 percent of farms growing sorghum, harvested 46 percent of all sorghum in 1982. The 33 percent of farms with fewer than 250 acres of cropland accounted for only 10 percent of sorghum production. Fifty-five percent of all farms growing sorghum had sales receipts of more than $40,000 per farm (table 2).

Table 1--Distribution of harvested acreage of major crops on farms harvesting sorghum, eight States, 1982 1/

Farm size class	Sorghum	Corn	Wheat	Soybeans	Cotton	Hay	Other 2/	Total	Area of major crops per farm
Acres	Percent								Acres
1-99	51.9	4.2	16.7	9.2	2.5	13.8	2.1	100.0	51
100-249	38.3	7.5	23.1	12.3	3.0	13.4	2.4	100.0	139
250-499	32.1	10.5	26.8	13.2	3.8	11.3	2.3	100.0	291
500-999	30.5	9.8	32.2	11.2	5.7	8.5	2.1	100.0	536
1,000 or more	31.3	7.8	38.9	7.5	7.2	5.5	1.8	100.0	1,272
All farms	31.9	8.7	33.6	9.9	5.9	8.0	2.0	100.0	457

1/ Colorado, Kansas, Missouri, Nebraska, New Mexico, Oklahoma, South Dakota, and Texas.
2/ Oats, barley, rice, and tobacco.

Table 2--Number of farms harvesting sorghum by cropland area and sales class for eight States, 1982 1/

Cropland	Farms	Proportion of all farms	Sales class	Farms	Proportion of all farms
Acres	Number	Percent		Number	Percent
1-99	9,542	11.9	Less than $2,500	1,900	2.4
100-249	16,817	20.9	$2,500-$9,999	8,864	11.0
250-499	20,338	25.3	$10,000-$39,999	25,424	31.7
500-999	20,114	25.1	$40,000-$99,999	23,866	29.7
1,000 and over	13,465	16.8	$100,000-$249,999	14,898	18.6
			$250,000-$499,999	3,872	4.8
			Greater than $500,000	1,843	2.3
Total	80,276	100.0	Total	80,276	100.0

1/ Calculated from a 1982 Census of Agriculture special tabulation for Colorado, Kansas, Missouri, Nebraska, New Mexico, Oklahoma, South Dakota, and Texas. For this tabulation, a farm is defined as any place that grows sorghum and from which $1,000 or more of agricultural products were sold or normally would have been sold during the census year.

Sole proprietorships are the predominant form of organizational structure among farms growing sorghum, 84 percent of the total in 1982. Partnerships and corporations made up the balance with 12 and 4 percent. However, corporations accounted for 10 percent of sorghum farms with 1,000 or more acres. Over 90 percent of incorporated sorghum farms were family held.

About 72 percent of U.S. sorghum farms rented all or part of their cropland in 1982. For all farms growing sorghum, 28 percent were full owners, 54 percent were part-owners, and 18 percent were tenants.

Acreage Trends

Sorghum is produced under a wide range of soil and climatic conditions and requires less water than corn. Production is

highly concentrated in the Central and Southern Plains where rainfall is low and variable. During the 1950's, the top three producing States--Texas, Kansas, and Oklahoma--produced 85 percent of the U.S. crop. Since then, the Central and Northern Plains States have gained at the expense of the Southern Plains.

Over the past three decades, Oklahoma has reduced acreage by 50 percent, falling from 7 percent to around 4 percent of U.S. acreage (table 3). However, production has remained relatively constant due to increasing yields. Meanwhile, Texas' share of sorghum plantings fell from 39 percent in 1960 to 22 percent in 1988, and it is no longer the leading producing State. The declining share of sorghum acreage in Texas and Oklahoma coincided with gains in Kansas, Nebraska, and Missouri. Kansas has become the leading sorghum producing State since 1984, and in 1988 planted 35 percent of U.S. acreage. Together, Kansas, Texas, Nebraska, and Missouri produce more than 80 percent of U.S. sorghum.

One of the most significant developments in sorghum production in the early 1980's occurred in the Delta. Acreage expanded sharply between 1982 and 1984. While U.S. sorghum acreage rose only 1 percent, acreage in Arkansas, Louisiana, Mississippi, and Missouri rose 77 percent, from 1.5 to 2.6 million acres. There were several reasons that explain the expansion of sorghum production in the Delta. The poultry industry is growing in the South, and it can use sorghum. Sorghum's drought resistance also makes it attractive, especially after the 1983 drought. Further, many southern farmers who have double-cropped wheat and soybeans are switching to double-cropped wheat and sorghum. Because the second crop has to grow during the hot, dry months of the summer, drought resistance is a factor. Also, double-cropping wheat and sorghum allows the farmer to grow two crops with Government price and income support programs on the same acre in one year.

An equally dramatic development in sorghum production was a sharp drop in the Delta after 1985. Acres planted to sorghum in this region declined by two-thirds between 1985 and 1988, down from

Table 3--Distribution of sorghum planted acreage, selected years, by major producing States

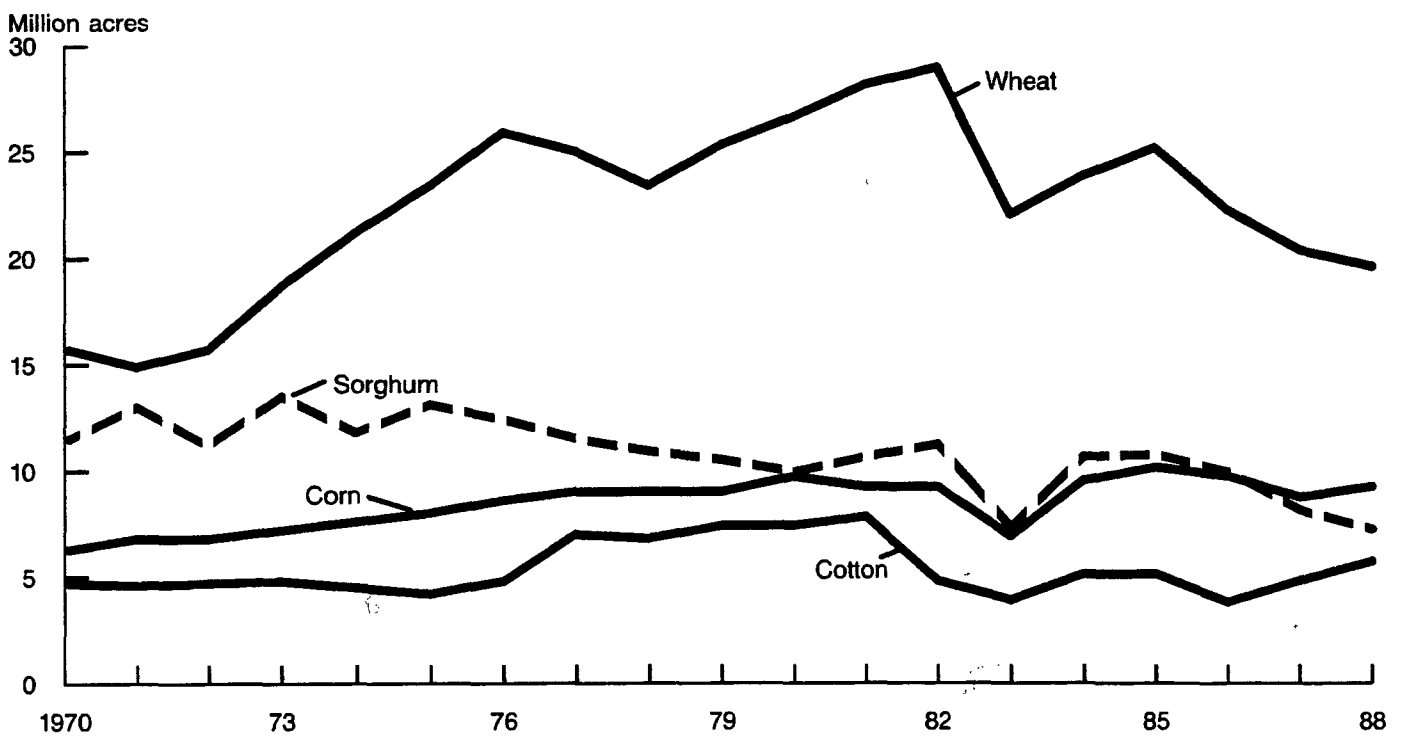
State	1950	1955	1960	1965	1970	1975	1980	1985	1988
					Percent				
Kansas	19.8	27.2	28.0	23.7	25.4	22.7	28.8	26.3	34.8
Missouri	.7	1.2	3.0	2.0	1.7	3.5	5.9	7.9	4.8
Nebraska	3.0	5.4	10.4	15.8	10.3	11.6	14.1	11.5	15.4
Oklahoma	10.7	9.7	6.5	5.8	5.4	4.2	4.5	3.2	4.0
Texas	50.9	36.4	39.4	35.8	40.6	44.2	30.7	23.5	22.2
Other	14.9	20.1	12.7	16.9	16.6	13.8	16.0	27.6	18.8
U.S. total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
					1,000 acres				
U.S. total acreage	16,055	23,921	19,598	17,079	16,957	18,080	15,639	17,254	10,358

3.5 million acres to 1.1 million. Lower sorghum prices and returns in recent years contributed to the decline in sorghum acreage nationwide and in this region. More important, double-cropping of sorghum in the summer following the harvest of winter wheat crop declined as more acres of wheat base were set aside under the acreage reduction, paid land diversion, the 50-92 (later 0-92) provision, and the conservation reserve program. In 1985/86, only 18.8 million acres of wheat base were set aside; however, by 1988/89 the set-aside acres totaled 30.1 million. Removing wheat base acres from production reduced the amount of cropland that can be double-cropped with sorghum.

Sorghum acreage in the Central and Southern Plains is inversely related to acreage of competing crops (fig. 1). Changes in total acreage are much smaller than those for individual crops, and total harvested acreage of major crops in 1970 was only slightly less than in 1988. Sorghum acreage declines in the late 1970's were offset by increased wheat, cotton, and corn acreage. In Texas, winter wheat, corn, and cotton are the most important competitors of sorghum. In California and Oklahoma, cotton is the main competitor. In parts of Kansas and Nebraska, wheat and corn compete with sorghum.

Figure 1

Acres harvested: Sorghum, wheat, corn, and cotton in Kansas, Nebraska, Oklahoma, and Texas



Factors Affecting Production

Many analyses show that a 10-percent change in U.S. sorghum prices in one year leads to a 1- to 2-percent change in the same direction in U.S. sorghum acreage during the next year. The responsiveness of acreage to price varies greatly by region. The response in Nebraska and Kansas has been less than that for the United States and changes in other crop prices have also had only small effects on sorghum area in those States. In Texas and Oklahoma, a 10-percent change in net returns from sorghum has been associated with a 4-percent change in sorghum area. However, a given percentage change in cotton or wheat net returns was found to change sorghum area by an even larger percentage. The Delta was found to be highly responsive to changes in sorghum net returns: a 10-percent net-return change has been associated with a 10- to 15-percent change in planted area.

Factors affecting sorghum prices and net returns would have to cause large changes in prices and net returns to get moderate changes in U.S. sorghum acreage. However, regional shifts can be very large, as demonstrated for the Delta in 1982-84. Also, changes in other crop prices, especially wheat, cotton, and corn, can greatly affect the outcome for sorghum area.

Higher yields explained most of the increase in sorghum production during 1950-72 (app. table 1). Sorghum yields climbed steadily beginning with the introduction of short-stemmed hybrids in 1956. By 1972, yields reached a record high 61 bushels per acre, triple the pre-hybrid level. Yields appeared to stabilize after 1972, although record levels of 63 and 64 bushels per acre were reached in 1979 and 1981. Those 2 years aside, growth of sorghum yields has been negligible since the late 1960's. No new technology in the late 1960's and 1970's was as effective in boosting sorghum yields as were the first hybrids. Also, the switch of irrigated sorghum acres to corn in the Plains, in response to higher returns from corn during the 1970's, increased the proportion of dryland sorghum production, from 74 percent of sorghum acreage in Texas, Nebraska, and Kansas in 1968 to 80 percent in 1987.

In 1987, about 14 percent of the sorghum acreage in Texas, Kansas, and Nebraska was irrigated, down from 19 percent a decade earlier. Sorghum yields on irrigated land in 1982 were higher than on dryland by about 55 percent in Texas, 62 percent in Kansas, and 15 percent in Nebraska. The drop in irrigated acreage was a factor in the lack of yield growth. Irrigation of sorghum is likely to continue to drop as water levels in the Ogallala Aquifer (the primary underground water source in the Plains States) fall and pumping costs rise. Sorghum's drought resistance could cause its acreage to expand in areas which shift from irrigated to dryland farming. Also, higher value crops that are more susceptible to drought are likely to replace sorghum on irrigated acreage. These riskier crops, such as corn, likely experienced increased acreage at sorghum's expense after the introduction of the Government disaster protection program in the early 1970's. The shift to crop insurance in place of disaster

payments in the 1980's will require farmers to pay premiums. Some farmers trying to avoid or lower their premiums could expand sorghum acreage at the expense of riskier, less drought-tolerant crops.

In response to rising feed grain stocks and falling prices, the Government put into effect an acreage reduction program (including a payment-in-kind program, or PIK) for feed grains in 1983. The program and drought in the summer of 1983 reduced U.S. sorghum production by 43 percent, from 835 million bushels in 1982/83 to 488 million in 1983/84 (table 4). Carryover stocks were cut a third to around 290 million bushels. Although this level was below the previous two seasons, it was still nearly 70 percent higher than the 1978-80 average. Despite another acreage reduction program, higher 1983/84 prices helped boost 1984 sorghum acreage nearly 40 percent above 1983. Sorghum production totaled 739 million bushels in 1987 and declined to 578 million in 1988 in part because of the drought.

Trends in Domestic Use

Total sorghum use rose from 500 million bushels in 1960/61 to a record 935 million bushels in 1973/74: 701 million bushels for domestic use and 234 million for exports (app. table 2). After a short crop because of low yields and because of sharply rising global grain prices, which led to reductions in livestock, total use of sorghum declined by nearly a third in 1974/75. Use has fluctuated between 650 and 870 million bushels since then (fig. 2).

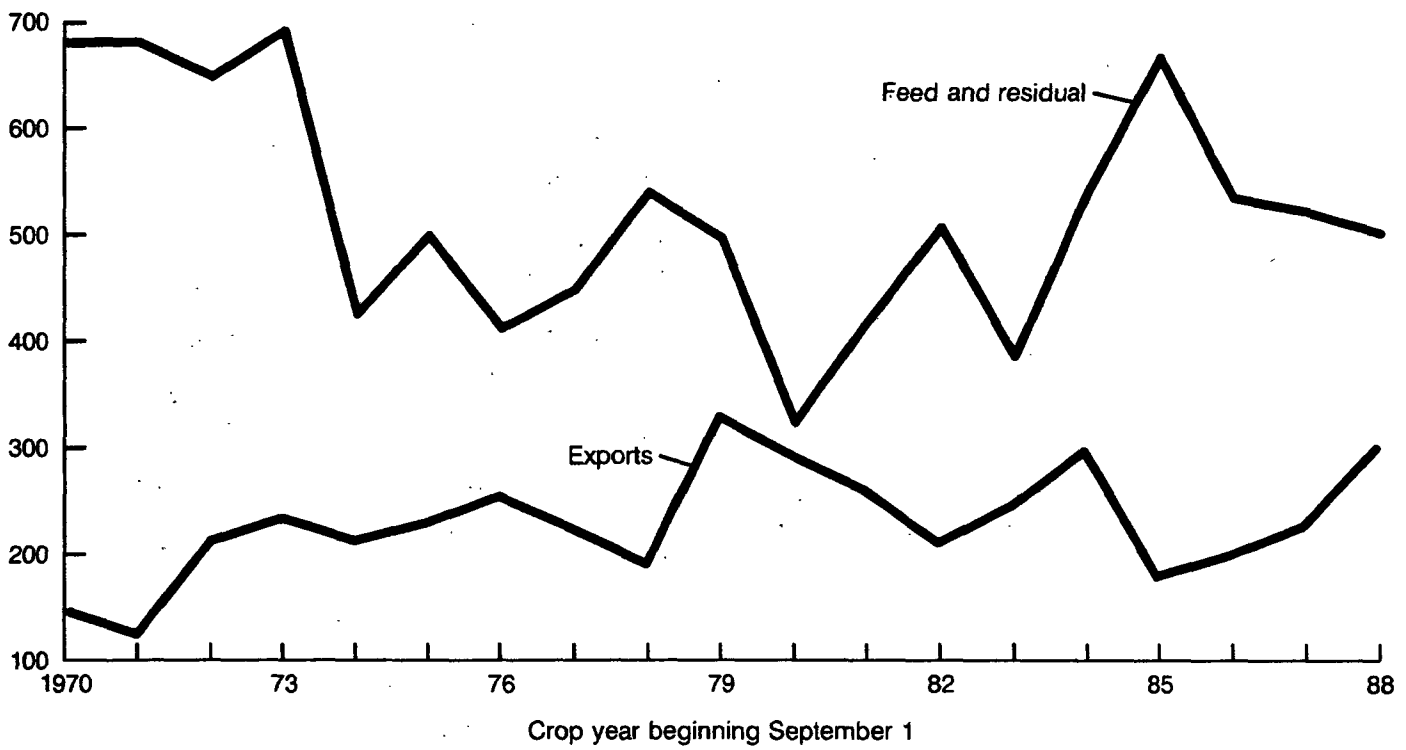
Table 4--U.S. sorghum supply and disappearance, 1982-1988

Year beginning September	Supply			Disappearance				Ending stocks		
	Beginning stocks	Production	Total	Food, seed, and industrial	Feed and residual	Exports	Total	Govt. owned	Privately owned	Total
	Million bushels									
1982/83	319	835	1,154	10	495	210	715	172	268	439
1983/84	439	488	927	10	385	245	639	103	185	287
1984/85	287	866	1,154	18	539	297	854	112	188	300
1985/86	300	1,120	1,420	28	664	178	870	207	344	551
1986/87	551	938	1,489	15	533	198	746	409	334	743
1987/88	743	739	1,483	25	564	231	820	464	199	663
1988/89 1/	663	578	1,240	25	475	300	800	355	85	440

1/ Estimated.
Sources: (1) U.S. Department of Agriculture, Feed Situation and Outlook Report, FdS-309, Feb. 1989.
(2) U.S. Department of Agriculture, World Agricultural Supply and Demand Estimates, WASDE-232, July 1989.

Figure 2

Trends in sorghum use



Livestock and Poultry Feeding

Livestock and poultry feeding account for about 98 percent of total domestic use. Data on feed use are not estimated directly, but are computed as a residual: supply less exports; seed, food, and industrial use; and ending stocks. Measurement errors in these supply and demand categories affect feed use data. Thus, the data on feed use are often called feed and residual use to emphasize the added sources of error.

About two-thirds of the nearly 90-percent increase in total sorghum use during 1960/61-1973/74 was attributed to increased feed use. Exports accounted for the rest. The feed use gain reflected the shift of the cattle feeding industry from the Corn Belt to the Southern Plains in the early 1970's (table 5). Cattle marketings gained in this region while other regions remained fairly stable. The Southern Plains offered the cattle feeding industry an expanding source of feed grain, ample supplies of feeder cattle, financing from individuals who were not owner-operators, and a favorable, dry operating climate which permitted large-scale, mechanized feedlots.

Sorghum accounts for only 6-8 percent of all concentrates (feed grains, oilseed meals, and the like) fed to livestock and poultry. Corn dominates with a 60-65 percent share. But, for

Table 5--Cattle marketed, selected years, by region

Region 1/	1965	1970	1975	1980	1985	1988
			Percent			
Corn Belt	30.3	26.1	18.9	16.8	11.9	10.2
Northern Plains	17.5	17.3	19.1	18.1	16.8	17.7
Southern Plains	30.9	42.0	47.3	54.8	62.3	64.6
West	21.3	14.6	14.7	10.3	9.0	7.5
Total 2/	100.0	100.0	100.0	100.0	100.0	100.0
			1,000 head			
Total	15,192	21,810	18,276	21,306	22,857	23,339

1/ Corn Belt: IL, IA; Northern Plains: CO, ID, MN, SD; Southern Plains: KS, TX, NE, OK; West: AZ, CA, WA.
2/ Totals may not add to 100 percent due to rounding.

beef cattle, sorghum's share runs 18-22 percent. Sorghum's share is much lower in other livestock rations. For example, it accounts for only about 3 percent of concentrates fed to hogs, 1 percent fed to dairy cattle, and 6 percent fed to poultry. The biggest poultry use is for hens and pullets, for which sorghum has about a 9-percent share.

Nearly 30 percent of sorghum production is fed to livestock and poultry on the farms that grow it; the rest passes through the marketing system. Country elevators are the primary assemblers of sorghum sold from farms--accounting for about 90 percent of the volume, although some sorghum moves directly from farms to feedlots, feed mills, dealers, and ranchers. Country, subterminal, and terminal elevators are the main sources of sorghum for feed manufacturers, processors, and exporters.

The feed manufacturing industry is the most important user of sorghum in terms of sales volume, accounting for about 40 percent of total feed use.

Factors Affecting Feed Use

Animal feeds are generally classified by three categories: roughages (such as hay), protein feeds (such as the oilseed meals), and energy feeds (such as the feed grains). Sorghum, like corn, is fed mainly as a carbohydrate for energy. Although the levels are low, feed grains do contain protein, and some limited substitution between protein and energy feeds can occur in livestock and poultry rations. However, protein and energy feeds are basically complements, and the most significant competition sorghum faces is from other energy feeds.

Competition among feed materials depends on relative prices and relative feed values. Feed values for each ingredient differ for each livestock class. Feed values for major grains averaged across all livestock classes are presented in the following tabulation. The values on a bushel basis differ from a pound basis because bushel weights differ, although standard corn and sorghum bushels each weigh 56 pounds. Total digestible nutrients (feed value) of several crops compared with that of corn are:

	Pound for pound	Bushel for bushel
	Percent	
Corn	100	100
Oats	90	51
Barley	90	77
Wheat	105	113
Sorghum	95	95

Feed values suggest that when national average sorghum prices are below 95 percent of corn prices, feeders will prefer sorghum to corn. This relationship is not always evident in the data on relative prices and relative quantities of sorghum and corn fed, because other factors also affect feed use. During 1978/79-1982/83, feed and residual use of sorghum averaged 10.4 percent of corn use. In 1978/79, when sorghum prices averaged 89 percent of corn, sorghum feed use rose to 12.6 percent of corn use. However, between 1980/81-1982/83, relative sorghum prices were stable at 94-96 percent of corn prices, but sorghum feed use varied widely, from 7.3 to 11.2 percent of corn use.

An important development in the early 1980's has been the large wheat surplus which has driven the price of this food grain down to its feed value. This is especially important in the sorghum belt where wheat production is substantial and the beef cattle industry is concentrated. The feed values of sorghum and wheat for fattening cattle are 92 (this differs from 95 percent for all livestock classes) and 113 percent of corn on a bushel-for-bushel basis. Thus, when wheat prices fall to 123 percent (113 divided by 92 times 100) of sorghum prices or below, wheat has a price advantage. In most years since World War II, wheat prices have exceeded sorghum prices by much more than 23 percent, and three to six times more sorghum has been fed per year than wheat. However, season-average wheat prices relative to sorghum fell from 153 percent in 1981/82 to 140 percent in 1982/83 to an estimated 124 percent in 1983/84. Consequently, sorghum feeding, which was 3.2 times wheat feeding in 1981/82, is estimated to have about equalled wheat feeding during 1983/84, the record wheat feeding year. In contrast, sorghum feeding nearly doubled wheat feeding in 1987/88 as wheat prices relative to sorghum rose to 150 percent.

Wheat supplies are expected to decline to 2.8 billion bushels due to drought in 1989/90. These relatively tight supplies have kept wheat prices above feed value during the summer of 1989. The

U.S. capacity to produce wheat, however, is very large and yields are rising. Thus, wheat prices may remain competitive with sorghum. However, an important factor for competitiveness will be relative support prices. Support prices tend to act as a price floor and have restricted wheat feeding. Wheat support prices averaged 181 percent of sorghum support prices during 1960/61-1963/64. Such support kept wheat prices well above feed value, despite excessive supplies. By 1970/71-1973/74, wheat support prices had dropped to 130 percent of sorghum support prices. The wheat support price is 131 percent of sorghum for 1989/90, down from 145 percent in 1983/84, but still above average feed value with sorghum. If wheat support prices continue falling relative to sorghum, wheat feeding will likely continue expanding, partly at sorghum's expense.

Statistical analysis has been used to quantitatively estimate the effects of changes in a few key factors on sorghum feed demand during a marketing year. A 10-percent change in the season-average sorghum farm price has been associated with a 5-percent change in the opposite direction in sorghum feed demand, assuming prices of other energy feeds do not change. The observed response frequently seems smaller, because prices of energy feeds often move together. Many analyses show that a 10-percent change in corn prices has a fairly small effect on sorghum feed demand, 1-2 percent in the same direction. Because corn and sorghum prices move together so closely, it is difficult to independently measure their effects. When changes in corn production are examined, larger effects have been found. For example, it has been estimated that a bushel change in corn production in four South Central States--Texas, Oklahoma, Kansas, and Nebraska--changes U.S. sorghum feed demand in the opposite direction by a quarter of a bushel.

In addition to substitution among energy feeds, the level of activity in the livestock industry is critical to the quantity of sorghum fed. A 10-percent change in the number of cattle on feed in Texas, Kansas, Nebraska, and Oklahoma will change sorghum feed demand in the same direction by 5-6 percent. Table 6 shows how sorghum relates to wheat and corn feed use and livestock numbers. Total feed use of grains and meals since the early 1970's has varied, but without an apparent trend. However, sorghum feed use has trended down, replaced by corn and, in recent years, wheat. Overall economic activity affects retail demand for animal products, which, in combination with feed prices, determines the number of animals that livestock producers choose to raise and feed. Animal numbers, in combination with feeding rates, determine feed demand for grains and meals. Feeding rates depend on the profitability of livestock production. In 1974 and 1980, drought boosted grain prices, lowering profitability and feeding rates. In the fall of 1982, large supplies pushed feed grain prices well below loan rates, and feeding rates rose. Given feeding rates and animal numbers, how sorghum then fares depends on the supplies and prices of sorghum in relation to other grains.

Table 6--Feed use and animal numbers, marketing years, 1979/80-1988/89

Item	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89
					Million metric tons					
Feed:										
Sorghum	12.3	7.7	10.9	12.9	9.9	13.6	16.8	13.8	13.9	14.0
Corn	114.5	105.0	106.7	114.9	98.4	103.5	103.9	119.6	124.4	114.3
Feed grains 1/	128.4	122.6	128.5	139.5	119.7	131.1	134.9	145.5	145.6	136.6
Wheat	2.5	5.3	3.1	7.8	12.3	11.0	7.3	10.5	7.5	7.5
All grains	130.9	127.9	131.6	147.3	132.0	142.1	142.2	156.0	153.1	144.1
Meals 2/	19.7	18.1	18.3	19.6	17.4	19.6	19.1	20.0	20.7	21.7
All grains and meals	150.6	146.0	149.9	166.9	149.4	161.7	161.3	176.0	173.8	165.8
					Million units					
Animals:										
GCAU 3/	82.3	80.6	77.5	78.5	78.3	76.5	75.4	75.0	77.3	76.4
					Million head					
Cattle 4/	10.4	9.8	9.0	10.3	9.9	10.3	10.6	9.7	9.2	9.7
					Dollars per bushel					
Prices:										
Corn	2.52	3.11	2.50	2.68	3.25	2.63	2.23	1.50	1.94	2.60
Sorghum	2.34	2.94	2.39	2.52	2.85	2.32	1.93	1.37	1.56	2.30
Wheat	3.78	3.91	3.65	3.55	3.50	3.39	3.08	2.42	2.59	3.70
					Metric tons per GCAU					
Feed rate 5/	1.83	1.81	1.93	2.13	1.93	2.11	2.15	2.36	2.30	2.17

1/ Also includes oats, barley, and rye. 2/ Include the following meals: soybean, cottonseed, peanut, linseed, and sunflowerseed. 3/ Grain-consuming animal units (GCAU's) (See glossary). 4/ 13 major States, January 1 of the second year indicated. 5/ Total grains and meals per grain-consuming animal unit.

An event which alters feed grain supplies and prices can cause a sequence of events in the livestock sector which may last for several years. For example, a sharp restriction in grain supplies and a boost in grain prices can reduce profitability of livestock production and lead to increased slaughter and reduced breeding herds. The larger meat supplies will then cause lower meat prices, further reducing profitability and causing even more livestock liquidation. The smaller breeding herd eventually will cause reduced meat marketing and livestock prices will rise, raising profitability and signaling higher meat production. Raising meat production in response to higher meat prices (or lower grain prices) can take up to 4 years for cattle and 2 years for hogs. Complete expansion including herd rebuilding would require breeding and gestation (4 months for hogs and 9 months for cattle); growth and entrance to the breeding herd (6 months for hogs and 18 months for cattle); and breeding, gestation, growth, and finally slaughter. The stability of the livestock sector and the well-being of livestock producers depend on developments in feed grain markets.

High feed grain prices, resulting from the drought reduced feed grains feed use in 1988/89. Feeding rates were lowered because animals were fed to slightly lighter weights. With lighter weights, and smaller sorghum supplies, feed use of sorghum in 1988/89 is estimated at 475 million bushels, down from 564 million in 1987/88.

Seed, food, and industrial uses account for only a small proportion of total sorghum use, about 2.5 percent in 1960 and 1 percent since 1970. About 3 million bushels of sorghum have been used in the brewing industry in recent years. In 1977, sorghum accounted for 9 percent of the total grains used in distilleries. Sorghum makes up only a small share of grain going to the dry-milling industry and is virtually unused by the wet-milling industry.

Trends in the World Sorghum Market

Although sorghum ranks second to corn in U.S. coarse grain production, it is third to corn and barley in world coarse grain trade. Corn, barley, and sorghum averaged about 56, 22, and 8 percent of world coarse grain production and consumption during 1986-88. World coarse grain production rose by about 87 percent between 1960-86, while sorghum production rose by 59 percent (table 7). Sorghum's share of total coarse grain output and use has remained fairly steady. However, an increase in corn trade, especially during the past decade, has reduced sorghum's share of world coarse grain exports to an average of 10 percent for 1986-88, down from 12 percent in 1980.

Sorghum trade is not only closely linked to overall coarse grain supply and demand conditions, but also to high-protein meals and nongrain substitutes such as manioc. Livestock feeding accounted for an average 61 percent of world sorghum consumption during the 1986-88 crop year, compared with only 38 percent in 1960. Thus, much of the gain in world sorghum production and consumption

Table 7--World production, use, trade, and ending stocks of coarse grains and sorghum, selected years 1/

Item	1960/61	1970/71	1980/81	1986/87	1987/88	1988/89	1989/90 2/
				Million metric tons			
Production:							
Coarse grains	447	569	732	836	792	723	824
Sorghum	41	55	59	65	56	57	60
Use:							
Coarse grains	439	583	748	810	813	803	820
Sorghum	38	59	58	60	59	62	63
Exports:							
Coarse grains	24	46	108	84	83	98	95
Sorghum	3	7	13	8	8	11	10
Stocks:							
Coarse grains	110	84	126	234	213	134	139
Sorghum	22	8	11	23	20	15	12

1/ Aggregate of differing local marketing years.
2/ Estimated.

Table 8--Coarse grain exports and sorghum exports and imports, selected countries and world, October to September years, 1985-89

Item	1985/86	1986/87	1987/88	1988/89	1989/90 1/
			Million metric tons 2/		
Coarse grain exports:					
United States	36.4	47.5	53.5	62.0	57.0
Canada	5.8	6.6	4.2	3.9	4.8
Australia	5.0	3.1	2.5	2.6	2.5
Argentina	9.7	5.0	5.2	3.6	5.6
South Africa	1.5	2.6	.8	2.0	3.5
Thailand	4.0	2.8	.8	2.6	1.8
World total	83.2	84.1	83.1	97.5	94.9
Sorghum exports:					
United States	4.1	5.1	6.1	7.6	6.5
Australia	1.1	.6	.6	.6	.8
Argentina	2.2	1.0	1.2	1.0	1.3
World total	8.7	8.0	8.2	10.5	9.5
Sorghum imports:					
USSR	.1	.1	0	.8	.8
Japan	5.1	4.2	3.9	4.2	4.0
Mexico	.6	.8	.9	1.5	1.2
Taiwan	.8	.8	.3	.3	.2
Venezuela	.8	.8	1.7	1.6	1.4
Saudi Arabia	.2	.1	.1	.1	.1
World total	8.7	8.0	8.2	10.5	9.5

1/ Estimated.
2/ Divide by 0.025401 to convert sorghum trade to bushels.

during the last two decades has been for livestock feeding. However, since only an estimated average of 39 percent of world sorghum consumption is for nonfeed purposes, world supply and demand conditions for foodstuffs, seed, and industrial uses also influence the world sorghum market.

U.S. sorghum exports rose from 2.7 million metric tons in 1960 to 11.1 million metric tons in 1988 and are estimated at 9.6 million in 1989 (app. table 6). Strong grain demand and a weak U.S. dollar contributed to the record 14.1 million metric tons exported in 1980, more than double the volume exported at the beginning of the 1970's. Exports trended down between 1980 and 1986, but since have begun to rise (table 8).

About 32 percent of U.S. sorghum production was exported in 1987. The U.S. market share of world sorghum trade has risen steadily from its 48 percent share in 1985 to 73 percent in 1988. Features of the Food Security Act of 1985 have helped regain lost market share (app. tables 7 and 8).

Several factors have contributed to the decline in world sorghum trade since 1984: Africa imported less in 1985 and 1986 because of good crops harvested in many of its countries, Mexico imported less as a result of its drop in cereal use for animal feed, the USSR continued its decline in sorghum imports that were replaced by other grains, and corn prices declined more than sorghum prices in 1986 because of the world excess supply situation for wheat and corn.

Major Importers

World imports of sorghum are concentrated in a few medium- to high-income countries, all sorghum producers. This demand indicates a relationship between familiarity with sorghum and demand for its import. The share of world sorghum imports by developing countries has been steadily increasing, reflecting the growth in domestic livestock production.

Japan, Mexico, and Venezuela were the largest export markets for U.S. sorghum during 1983-87, accounting for slightly more than three-quarters of total U.S. exports (table 9). Venezuela's imports were artificially high because of a ban on corn imports to protect domestic growers. Israel, Spain, Portugal, Taiwan, and South Korea have also been important markets.

The shares of world sorghum imports for the EC-12 have fallen since the 1960's while those for the developing nations have gained. These changes have followed the patterns for wheat and corn. After the mid-1960's, Japan surpassed the EC and became the leading importer of sorghum. Japan's rapidly increasing market share reached 60 percent of world sorghum imports in 1969, up from under 20 percent in the early 1960's. The rise reflected both rapid income growth and adoption of protective policies for Japanese livestock industries. By the early 1980's, Japan's sorghum imports had leveled off and growth by other importers had caused Japan's share of world imports to fall to around 25

Table 9--U.S. sorghum exports to selected countries, October to September years, 1983/84-1987/88

Destination	1983/84	1984/85	1985/86	1986/87	1987/88 1/
			1,000 metric tons		
Israel	574	503	493	229	366
Japan	1,505	2,390	2,182	2,508	2,389
Mexico	2,758	2,062	372	788	849
Portugal	117	50	40	38	0
Spain	347	45	0	0	199
South Korea	115	66	0	0	0
Taiwan	104	280	244	598	90
Venezuela	206	1,033	726	782	1,731
Subtotal	5,726	6,429	4,057	4,943	5,624
Total	6,226	7,454	4,112	5,118	6,086

1/ Estimated.

percent. But, by the mid- to late-1980's, its market share had rebounded to a 40- to 59-percent range. The resurgence of Japan's market share could be due to that nation's preference for a feed grain which does not color poultry. Japanese reportedly prefer a white meat, while certain proportions of yellow corn in poultry rations could change this color. Other important factors include a favorable price relative to corn and concerns over aflatoxin in corn. This price ratio varies and the Japanese tend to slightly adjust their rations.

EC-12 sorghum imports were 2-2.5 million metric tons in the early 1960's, but dropped to 150,000 to 1.04 million metric tons during 1985-88. The reduced market share of the EC-12 is a result of its policies of (1) guaranteeing EC farmers high prices for their grain by offering to buy it when prices fall below a pre-set level and (2) using import levies to bring the price of imported grain up to the EC's high internal grain prices. The high support prices have stimulated larger EC production of wheat, corn, and barley. EC imports of U.S. coarse grains consistently exceeded 10 million tons prior to 1980/81, but by 1982/83, they were down to 4.2 million. The EC was a net exporter of coarse grains for the first time during 1985. Also important, sorghum and other coarse grains have been displaced by such feed products as soybeans, corn gluten feed, and manioc entering the EC without restrictive import barriers.

As recently as 1978, the centrally planned countries accounted for only about 4 percent of world sorghum imports. By 1980, their market share had jumped to nearly 29 percent, almost entirely as a result of large purchases by the Soviet Union. Prior to 1979, the USSR did not purchase any sorghum, with the exception of small quantities in the early 1970's. After the U.S. suspension of grain sales to the Soviet Union in 1980, the USSR switched from U.S. grains to substitute grains from other countries, such as corn and sorghum from Argentina. In 1980, the

Soviets signed a 5-year grain agreement with Argentina that stipulated a minimum of 4 million tons of corn/sorghum per year. During 1986-87, the Soviets did not import as much sorghum as in 1980, and the global import share of sorghum for centrally planned countries has been about 1 percent. But, during 1988, that share jumped to about 12 percent, probably reflecting a favorable price relative to corn.

The share of world sorghum imports by developing countries has been steadily rising, reflecting increased incomes and growth in domestic livestock production. During 1980-82, their share was over 40 percent, compared with 12-14 percent in the early 1960's. Imports have increased rapidly since the early 1970's, more than doubling between 1973-82. Their share was about 33 percent during 1988. The growth has been concentrated in high-income North African and Middle Eastern countries, Mexico, Central American nations, and the high-income countries of East Asia.

Most of the sorghum imported by the various countries is for feed. World food consumption of sorghum has stagnated during the past quarter century. Sorghum is generally regarded as an inferior grain in many countries. When real per capita incomes rise, consumers from these countries prefer to shift, if available, to other cereals such as corn, rice, or wheat.

Major Competing Exporters

The United States, Argentina, and Australia are the three largest sorghum exporters, accounting for about 90 percent of world sorghum exports (table 10). U.S. exports represented about one-fourth of the average U.S. production during 1985-87. However, these countries accounted for only a third of world production in 1988. India, Mexico, and China accounted for about 36 percent of world sorghum production, but they are not exporters.

Both Australia and Argentina export a larger share of their annual production than does the United States. Thus, they are more dependent on world market developments in their production decisions. In the early 1960's, Australia accounted for less than 1 percent of world sorghum trade. By the early 1970's, its market share had risen to above 10 percent. During 1980-82, Australia's share averaged only around 5 percent, mainly because of the poor 1982 crop. The increased Australian exports over the past two decades were mainly caused by expanded sorghum area, from about 500,000 acres in 1968 to around 1.7 million in 1972. By 1983, harvested area reached 2.1 million acres. Much of the increased area in the 1970's and early 1980's can be tied to restrictions placed on wheat production. Production in the mid- to late-1980's was fairly constant, 1.2-1.4 million metric tons

Table 10--Distribution of world sorghum exports and stocks, October to September years, 1985-89

Country or region	1985/86	1986/87	1987/88	1988/89	1989/90 1/
			Percent 2/		
Export share:					
United States	47.1	63.8	74.4	72.4	68.4
Argentina	25.3	12.5	14.6	9.5	13.7
Australia	12.6	7.5	7.3	5.7	8.4
Others	15.0	15.0	4.7	12.4	9.5
			Million metric tons		
World exports	8.7	8.0	8.2	10.5	9.5
			Percent		
Distribution of ending stocks:					
United States	26.3	18.2	15.6	28.7	37.5
Total foreign	73.7	81.8	84.4	71.3	62.5
			Million metric tons		
World ending stocks	19.8	23.1	19.9	15.0	12.0

1/ Estimated.
2/ Totals may not add to 100 percent due to rounding.

in 1985-88. The majority of the Australian sorghum crop is grown in the northern inland cropping belt where there is favorable summer rainfall. This area generally has good wheat yields and also is the main area for oilseed production.

Argentine sorghum production and exports have expanded sharply during the last two decades. However, from 1985-88, production and exports dropped somewhat because of a shift to more profitable oilseed crops. During the 1980's, harvested area rose by over 4 million acres from 1960's 1.3 million acres. During the same period, Argentina's share of world sorghum exports rose from 8 percent to over 25 percent. Harvested area fluctuated widely in the 1970's; year-to-year changes of 30 percent or more were common. However, exports were more stable and grew from around 1-2 million tons per year in the early 1970's to 4-5 million in the late 1970's. Argentina's share of world exports was around 35 percent in 1980/81. Between 1986-1988, its share was 10-15 percent. Argentina exports nearly half of its crop.

Argentina exported nearly 4 million tons of sorghum to the Soviet Union in 1980/81, 2.6 million tons in 1981/82, and 2.2 million tons in 1982/83. Soviet import demand was tempered by increased coarse grain production, up over 20 percent in 1983/84. Argentina temporarily turned to the traditional U.S. markets of Mexico and Japan to increase sorghum sales, but these sales dropped significantly during 1986-87.

Argentine sorghum is grown in areas that are generally drier than the main corn and soybean regions. Sorghum competes for land with pastures, forage crops, and other cash crops such as sunflowers. Thus, world and domestic prices for coarse grains, oilseeds, and beef greatly influence sorghum production. Cattle raising is important in the sorghum region, and the percentage of sorghum planted area which is harvested for grain also depends on forage needs for cattle.

South Africa, with recurrent drought and economic problems, lost market share during the 1970's and by the 1980's was no longer a major exporter. It costs too much to export and more domestic feeding is occurring. Thailand has expanded its share, but remains a small exporter. Thailand is an important exporter of manioc to the EC. If the EC were to lower barriers to coarse grain imports, manioc would likely be replaced in the EC by greater coarse grain imports. Sugarcane, sorghum, and corn compete with manioc for land in Thailand. Thailand's rising domestic feed use is sure to influence its future coarse grain exports. Sudan is a traditional supplier with potential but is affected by large year-to-year variations because of weather conditions and the profitability of exports. It has benefited from preferential imports by Saudi Arabia in many years. Since 1984 China has become a new exporter as it takes advantage of its transport advantages with neighboring countries.

Implications for U.S. Exports

World demand for feed grains is expected to grow modestly during the next few years, but sorghum is expected to decline from its 1989 trade level. This growth probably will not match the surge of the mid- to late-1970's. Slower growth in consumer incomes and meat demand are the main reasons. Growth in developed countries' consumer incomes is expected to slow down and per capita consumption of livestock products is nearing saturation levels for many of these countries. A number of higher income developing countries still have a debt problem and their income growth is limited.

An important factor for sorghum's demand as an animal feed is how it competes with other grains. Sorghum usually is sold at a discount to other grains to compensate for the larger variation in its composition. For example, it has a larger variation in its chemical composition and protein content, it possesses feeding problems with tannin, it is more complicated to process, and has a lower feed value than corn or wheat. Most competition is usually with corn although when wheat is low in price it too can replace sorghum in the feed mix. Food use of sorghum will probably remain small because of a preference for local varieties when used. Also, as incomes rise, consumers begin to prefer other cereals.

The outlook for sorghum trade in the next several years depends on the world demand for animal feed and sorghum's price relative to other grains. The United States is expected to continue to be the major producer and exporter. Production is expected to

increase in Australia in response to favorable prices. Opportunities continue to exist for those developing countries that are members of the Lome Convention which provides preferential access to the EC market.

Trade competition among exporting countries could intensify during the early 1990's, particularly if world coarse grain trade grows at a slower rate than in the 1970's. Argentina must export in order to meet its debt service obligations. Thus, the government will probably continue to promote crop production and exports, including sorghum. There is no shortage of available land suitable for growing currently produced crops. Australia's expansion of sorghum area during the past two decades has not been as dramatic as Argentina's. Returns from sorghum production in Australia are generally below those for wheat and barley. Sorghum competes with wheat and oilseeds for land, making sorghum production and exports dependent on coarse grain, food grain, and oilseed market conditions. Because sorghum is drought resistant and is planted in the spring (while wheat is planted in the fall), it offers a risk-reduction option to farmers. It is a good alternative if conditions are not favorable for wheat. Also, sorghum is harvested in February-June, so area can be expanded to take advantage of a shortfall in Northern Hemisphere coarse grain crops. Australian sorghum export sales are handled by state marketing boards and no administrative price is set for the domestic market.

Trends in Prices and Producer Returns

Sorghum prices were mostly above the loan rates during 1970-85. Per bushel returns above cash expenses, although improved in 1987, were smaller in recent years than in the late 1970's.

Price Trends

U.S. sorghum support prices were directly linked to corn support prices during the early 1950's. Both were higher relative to production costs and to prices for other crops than during late 1950's and 1960's. Farm prices remained close to support prices until 1972 when prices began responding to the rising world demand for sorghum and other grains (fig. 3).

From 1971/72 to 1974/75, the average sorghum price received by farmers nearly tripled due to increasing trade with the Soviet Union and below-normal production of corn and sorghum in 1970 and 1974. Production rose in response to the higher prices and, by 1975/76, prices began to decline. By 1977/78, prices were a third below the 1974/75 peak, a result of increased feed grain production and a reduction in cattle on feed. Prices rebounded in 1980/81, when drought lowered sorghum production to below 600 million bushels. However, with stagnant domestic demand and sagging exports, the bumper crops in 1981 and 1982 drove sorghum prices down to support levels, grain entered the Government loan programs, and carryover stocks mounted to 55 percent of total use in 1982/83, compared with the 14-percent averaged during the