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Cropping systems for the Southern Great Plains of the United States as influenced by federal policy

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Abstract

The majority of cropland in the rain-fed region of the North Central District of Oklahoma in the US is seeded with winter wheat (*Triticum aestivum*) and most of it is in continuous wheat production. When annual crops are grown in monocultures, weed species and disease agents may become established and expensive to control. For many years prior to 1996, federal policy provided incentives for District producers to grow wheat and disincentives to diversify. In 1996, the Federal Agriculture Improvement and Reform (FAIR) Act (Freedom to Farm Act) was instituted, followed by the Farm Security and Rural Investment Act (FSRIA) in 2002. The objective of this study was to determine the impact of FAIR and FSRIA programs on crop diversity in the North Central District of Oklahoma. The economics of three systems, monoculture continuous winter wheat, continuous soybean (*Glycine max*) and a soybean–winter wheat–soybean rotation, were compared using cash market prices (CASH), CASH plus the effective loan deficiency payments (a yield-dependent subsidy) of the FAIR Act of 1996, and CASH plus the effective loan deficiency payments of the FSRIA of 2002. We found that the loan deficiency payment structure associated with FAIR provided a non-market incentive that favored soybean. However, under provisions of the 2002 FSRIA, the incentive for soybean was adjusted, resulting in greater expected returns for continuous wheat. Due to erratic weather, soybean may not be a good alternative for the region. Research is needed to identify crops that will fit in a rotation with wheat.

Key words: wheat, soybean, crop rotation, FAIR, FSRIA, economics

Introduction

Government programs have influenced crop production in the Southern Great Plains since the 1930s[1]. Voluntary acreage control programs were first implemented for wheat as a result of the Agricultural Adjustment Act of 1933[2]. The Agricultural Adjustment Act of 1938 provided for wheat acreage allotments that were allocated to individual farms based upon planting history. Wheat acreage allotments were included in 1956 and 1961 legislations.

A national wheat referendum was conducted in May 1963. Producers were given the opportunity to vote for a mandatory control program designed to restrict wheat production to a level that would result in relatively high prices and reduced government cost. Some farm organizations and producer groups advocated a 'yes' vote that they argued would benefit family farms and enhance stability. Other organizations encouraged their members to vote 'no'. They argued that a 'no' vote would reduce the role of government and provide farmers the 'freedom to farm'[3]. Over a million producers participated in the 1963 referendum with 48% voting 'yes' for mandatory controls and 52% voting against mandatory controls and for what had been advertised as the 'freedom to farm'. Contrary to what some had expected, the majority 'no' vote did not terminate government involvement in wheat production.

Government involvement continued and many subsidy payments were based upon the farm's wheat base acres and base yield. Base acres were valuable and farmers had an economic incentive to convert as many acres as possible to wheat base. In 1977, legislation changed the acreage base for wheat from historical allotments to a percentage of current plantings. In 1981, the acreage base was reestablished depending upon acres planted in prior years. Over

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time, the government programs provided an incentive for farmers in the Southern Plains to use as much cropland as possible to produce continuous monoculture winter wheat (*Triticum aestivum*).

When an annual crop is grown year after year in the same field, weed species that are adapted to the environment may flourish and become difficult to control. Diseases that infect the crop may become established in the field and become a persistent problem. Furthermore, if crop residue is retained on the soil surface, disease organisms may bridge from old crop residue to the new crop.

Federal farm programs may simultaneously encourage and discourage continuous monoculture wheat. Historically, wheat producers in the Southern Plains used conventional tillage to manage weed and pest problems. When problems became severe, they would use a moldboard plow to bury residue and weed seeds. However, beginning in 1985, the Food Security Act included what became known as the conservation compliance requirement[4,5]. The Act mandated that, by 1995, farmers who farmed land classified as highly erodible were required to implement conservation compliance plans as a condition for retaining eligibility for subsidy payments. To fulfill the conservation compliance requirements, for many soils in the region, farmers were required to maintain some surface residue, a requirement that in effect limited moldboard plowing. Thus, strict adherence to conservation-compliance requirements would exacerbate the weed and disease problems of a monoculture.

Diversification of cropping systems can be achieved by rotating different species over years within a given field. It has been hypothesized, and demonstrated in some locations, that diversity provided by crop rotations may help manage nutrient cycling and reduce weed, insect, pathogen and nematode problems[6]. Young and Painter contend that the genetic diversity that results from crop rotations is an important means to sustainable crop production[7]. Smith and Young found that in at least one region of the country, US agricultural policy might have influenced the level of crop diversification[8].

Throughout the world, crop rotations are used to manage weed and disease problems. For example, in the US Corn Belt corn (*Zea mays*)–soybean (*Glycine max*) rotations are common. Crop rotations enable producers to break weed and disease cycles associated with monocultures. When these cycles are broken, yields may increase and producers may be able to deliver a higher quality crop with less dockage. In long-term studies, scientists have found that when corn is grown in a 2-year rotation with soybean, weed control options are increased and average corn yield per acre increases relative to monoculture corn[9].

The Federal Agricultural Improvement and Reform (FAIR) Act of 1996 permitted farmers greater flexibility in crop selection. Thirty-three years after the 1963 wheat referendum, in which the majority of wheat producers voted for less government involvement, the 'freedom to farm' slogan was revived and became synonymous with the 1996 FAIR Act. It was promoted as legislation that would enable farmers to base planting decisions on market incentives rather than commodity programs. For farmers with base acres, most subsidy payments made after 1996 did not depend upon the crop grown, yield, or market price. This was a major departure from prior legislation. The incentive to build and maintain wheat program base acres was removed and farmers were free to try other crops, including crop rotations on wheat base acres, without jeopardizing subsidies. However, limited historical data were available comparing the economics of alternative crops and cropping systems for the region. In fact, the search for an economical alternative crop to rotate with wheat in the Southern Plains was hampered by government program requirements. Prior to 1996, researchers made little effort to find an alternative because they had little incentive to do so. Moreover, agencies that funded wheat production research had little interest in funding research for a competing crop.

Historical Cropping Patterns

While the agronomic, environmental and aesthetic benefits of species diversification and crop rotation have been espoused, the reality is that the vast majority of cropland in the rain-fed region of the Southern Great Plains is seeded to winter wheat and most of that land is in continuous wheat production. The North Central District is one of nine Agricultural Statistics Districts in Oklahoma, as defined by the United States Department of Agriculture (USDA). It includes approximately 1 million ha of cropland and in most years accounts for more than 35% of the wheat grain produced in the state.

In 1995 approximately 95% of the land seeded to annual crops in the North Central District of Oklahoma was seeded to continuous monoculture winter wheat (Table 1)[10,11]. Table 1 and Figure 1 show cropland use in the North Central District for the years 1995, 1999 and 2002, allowing comparison of cropped acres prior to and after implementation of the 1996 legislation. These data indicate that in 1995, 870,093 ha were seeded to wheat in the District. By 1999, land seeded to wheat declined by 101,174 ha (12%) to 768,919 ha. Land seeded to soybean (*G. max*) and sorghum (*Sorghum bicolor* L. Moench) increased by 71,550 ha. Most of the remaining 30,000 ha, removed from wheat production, were reallocated to the production of hay (12,141 ha), cotton (*Gossypium*) (8033 ha) and rye (*Secale cereale*) (4452 ha).

The Conservation Reserve Program was established in the 1985 Farm Bill. Cropland was removed from production under 10-year contracts for which landowners received an annual rental payment from the federal government. Some of these contracts expired between 1995 and 1999. Most of the 13,700 ha that exited the Conservation Reserve Program during this time period were retained in perennial grass for pasture (Table 1).

Table 1. Cropland use in the North Central District of Oklahoma, USA (Alfalfa, Garfield, Grant, Kay, Major, Noble, Woods and Woodward counties) in 1995, 1999 and 2002 (ha).

Land use	1995	1999	2002
Annual crops			
Wheat (*Triticum aestivum*)	870,093	768,919	728,450
Rye (*Secale cereale*)	21,854	26,305	30,352
Sorghum (*Sorghum bicolor* L. Moench)	16,188	46,945	36,423
Oats (*Avena sativa*)	4,047	4,047	6,070
Soybean (*Glycine max*)	3,723	44,516	20,235
Corn (*Zea mays*)	1,619	3,642	8,296
Cotton (*Gossypium*)	384	8,418	5,342
Total annual crops	917,908	902,792	835,168
Conservation Reserve Program	53,095	39,395	40,633
All hay	72,845	84,986	84,176
Total used for crops, Conservation Reserve Program and hay	1,043,847	1,027,173	959,977
Estimated change in cropland use for pasture	–	16,675	67,195

Source: Oklahoma Agricultural Statistics Service; USDA.

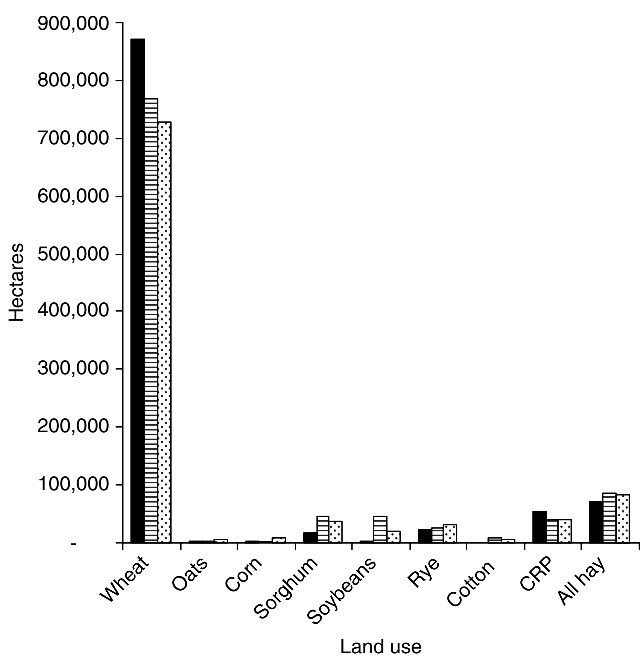

Figure 1. Land used for annual crops, Conservation Reserve Program (CRP) and hay in the North Central District, Oklahoma (Alfalfa, Garfield, Grant, Kay, Major, Noble, Woods and Woodward counties) in 1995 (■), 1999 (▤) and 2002 (▨) (ha).

The data in Table 1 and Figure 1 indicate that farmers in the North Central District responded to a limited extent to the flexibility afforded by the 1996 legislation. It is likely that land marginally suited for winter wheat production was returned to pasture, while a portion of the remaining cropland was planted to soybean and sorghum. Land seeded to soybean increased from 3723 ha in 1995 to 44,516 ha in 1999. However, by 2002 the area seeded to soybean declined to 20,235 ha. It is not clear why this occurred. Producers may have determined that soybeans were not a more profitable alternative for the District, or the relative profitability of soybean may have changed as a result of the 1996 federal legislation.

Most subsidy payments made after 1996 to farmers who have wheat base acres do not depend upon crop grown, yield or market price. Farmers are not required to grow the base crop—hence 'freedom to farm'. The subsidies are based upon the farms' historical base acres and historical base yield. However, there is one exception. Loan deficiency payments depend upon the quantity of crop produced. National average loan rates were set in the farm bill. Loan rates for a given county are established relative to the national rate by the USDA and depend upon marketing patterns and transportation distance from the county to market locations. If the market price of wheat is less than the established loan rate, a producer may apply for and receive a loan deficiency payment, calculated as the difference between the local loan rate and the local market price multiplied by the number of bushels produced. In effect, the loan rate is a price floor on actual production. Under the 1996 FAIR Act, the 2001 national loan rates were \$0.095 kg^{-1} for wheat and \$0.193 kg^{-1} for soybean. Under the 2002 Farm Security and Rural Investment Act (FSRIA), the national loan rate was increased by 8.5% to \$0.103 kg^{-1} for wheat but decreased by 4.9% to \$0.184 kg^{-1} for soybean[12].

The objective of this study was to compare the economics of monoculture continuous winter wheat relative to that of two potential alternatives for the North Central District of Oklahoma, located in the traditional wheat production region of the Southern Great Plains. The two alternatives include continuous soybean and a crop rotation that includes winter wheat and soybean. The economics of the three systems were compared using: (1) cash market prices (CASH), (2) CASH plus the effective loan deficiency payments of the FAIR Act of 1996, and (3) CASH plus the effective loan deficiency payments provided by the FSRIA of 2002. An additional objective was

Table 2. Chronology of field operations for three alternative cropping systems.

Month	Field operation
Continuous wheat	
July	Disk tillage
September	Chisel tillage
	Apply 82-0-0 @ 86 kg ha^{-1}
	9″ Sweep tillage
October	Drill wheat seed @ 101 kg ha^{-1}
February	Apply 33-0-0 @ 56 kg ha^{-1}
March	Apply herbicide [0.04 liter ha^{-1} Amber (triasulfuron) and 1.2 liter ha^{-1} Rhonox (MCPA)]
June	Harvest wheat
Continuous soybean	
March	Disk tillage
May	Field cultivator tillage
June	Drill Roundup Ready (glyphosate resistant) group 5 soybean seed @ 52 kg ha^{-1}
	Apply herbicide [Dual (metolachlor) @ 1.5 liter ha^{-1}]
July	Apply herbicide [Roundup (glyphosate) @ 1.75 liter ha^{-1}]
November	Harvest soybean
Soybean–wheat–soybean (2-growing seasons)	
March	Disk tillage
April	Field cultivator tillage
	Drill Roundup Ready (glyphosate resistant) group 4 soybean seed @ 52 kg ha^{-1}
	Apply herbicide [Roundup (glyphosate) @ 1.75 liter ha^{-1}]
May	Apply herbicide [Roundup (glyphosate) @ 1.75 liter ha^{-1}]
September	Harvest soybean
	Disk tillage
	Apply 82-0-0 @ 86 kg ha^{-1}
	9″ Sweep tillage
October	Drill wheat seed @ 101 kg ha^{-1}
February	Apply 33-0-0 @ 56 kg ha^{-1}
March	Apply herbicide [Express (tribenuron methyl) @ 0.02 liter ha^{-1}]
June	Harvest wheat
	Plant (no-till) Roundup Ready (glyphosate resistant) group 5 soybean seed @ 52 kg ha^{-1}
	Apply herbicide [Roundup (glyphosate) @ 1.75 liter ha^{-1}]
July	Apply herbicide [Roundup (glyphosate) @ 1.75 liter ha^{-1}]
November	Harvest soybean

to determine the impact of FAIR and FSRIA programs on crop diversity in the region.

Materials and Methods

Data were obtained from a study conducted from 1997 through 2000 at the North Central Research Station in the North Central District at Lahoma, Oklahoma, under rain-fed conditions. Four replications of each of the three cropping systems were evaluated: continuous wheat, continuous soybean and a soybean–wheat–soybean 2-year rotation. For the continuously cropped systems, winter wheat was planted in mid-October and harvested in June, while soybeans were planted in May and harvested in November. For the soybean–wheat–soybean rotation, soybeans were planted in April and harvested in September; followed by winter wheat planted in October and harvested the following June; followed by double-crop soybeans planted after wheat harvest, and harvested in November. Table 2 includes a listing of field operations for each of the three systems. Wheat and continuous soybean were planted using conventional tillage, which involved disking, chiseling and field cultivating. Double-crop soybeans were planted with a no-till row crop planter. All yields were measured after threshing and drying to bring the seeds to uniform moisture content. Mean annual yields across replicates are reported in Table 3.

Rainfall in the region is erratic. Total rainfall during the first 2 years of the study was above average. Annual rainfall was 140% of the long-term average in 1998 and 162% of the long-term average in 1999. The weather during the 1998 and 1999 growing seasons was abnormally favorable for soybean production, and yields were above average in both years (Table 3). In 2000, annual rainfall was 107% of the long-term average. However, no rainfall occurred

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Table 3. Yields by cropping system for 1998, 1999 and 2000 (kg ha^{-1}).

Year	Continuous soybean	Continuous wheat	Crop rotation		
			Soybean in rotation	Doublecrop soybean	Wheat in rotation
1998	2297	3742	2912	928	3705
1999	2528	4036	2320	1087	4023
2000	984	3074	1413	397	2986
Average	1936	3617	2215	804	3571

in August and September of 2000, critical months for soybean production, and yields were below the average for the 3-year study (Table 3).

A representative farm approach was used to estimate differences in cost among the various systems, including machinery requirements, ownership and operating costs[13,14]. Enterprise budgeting was used to determine annual revenues, costs and net returns for each of the three systems under the three market (policy) situations. For the CASH situation, it was assumed that a producer received the average CASH for soybeans or winter wheat during the specific harvest month in 1998, 1999 or 2000[15]. This is an obvious simplification, since cash prices paid over the time period were not independent of the FAIR program.

Under the FAIR scenario, it was assumed that producers received the CASH plus the loan deficiency payments that were in effect from 1998 to 2000. Under the FSRIA scenario, the loan deficiency payments set by the FSRIA of 2002 were applied to the actual CASH in the region between 1998 and 2000. In other words, to make comparisons, the loan deficiency payment rates included in the 2002 law were used rather than the loan deficiency payments included in the 1996 law. Effective prices used for budgeting are reported in Table 4.

Table 4. Commodity prices over years and across programs (\$ kg^{-1}).

Year	Wheat	Soybean
Cash (CASH) market prices		
1998	0.10	0.20
1999	0.09	0.17
2000	0.09	0.17
Cash (FAIR) plus loan-deficiency payment		
1998	0.10	0.21
1999	0.09	0.21
2000	0.09	0.21
Cash (FSRIA) plus loan-deficiency payment		
1998	0.10	0.20
1999	0.10	0.19
2000	0.10	0.19

Results and Discussion

Economic comparison of the three rotations evaluated showed mixed results across years. Net returns for each system, year and program scenario are reported in Table 5. The average net return and coefficient of variation are also reported. Greatest net return was realized for soybean–wheat–soybean in 1998, continuous soybean in 1999 and continuous wheat in 2000.

Continuous wheat was the only system that had positive net returns every year for each program scenario. Under all program scenarios, both continuous soybean and the soybean–wheat–soybean rotation outperformed continuous wheat in 1998 and 1999. This is due to the fact that the weather during the 1998 and 1999 growing seasons was abnormally favorable for soybean production. However, both systems that included soybean showed substantial losses in 2000, a year in which rainfall was more consistent with historical averages.

On average, continuous wheat earned \$7 ha^{-1} more than the soybean–wheat–soybean rotation and \$26 ha^{-1} more than continuous soybean under the CASH scenario. Given the FSRIA and CASH scenarios, relative rankings for the three cropping systems were the same. However, average earnings for continuous wheat were \$7 ha^{-1} more than soybean–wheat–soybean and \$33 ha^{-1} more than continuous soybean under FSRIA.

The 1996 FAIR legislation changed the relative economic rankings of the three cropping system alternatives. On average, the soybean–wheat–soybean rotation earned \$10 ha^{-1} more than continuous soybean and \$23 ha^{-1} more than continuous wheat. While the 1996 FAIR legislation was purported to enable farmers to base cropping decisions on market incentives, the loan deficiency payment structure associated with FAIR provided a nonmarket incentive that favored soybean relative to wheat in the District. With the 2002 FSRIA legislation, this nonmarket incentive was removed by increasing the national loan rate by 8.5% for wheat and decreasing the loan rate by 4.9% for soybean.

The variability in net returns, as reflected in the coefficients of variation, is greater for systems that include soybean relative to continuous wheat. Under both the

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Table 5. Net returns to land, labor and management ($ $\$\,ha^{-1}\,yr^{-1}$ $).

System	Program	1998	1999	2000	Average	Coefficient of variation
Continuous soybean	CASH	167	130	−88	70	2.0
	FAIR	183	233	−54	121	1.3
	FSRIA	167	201	−66	101	1.4
Continuous wheat	CASH	132	108	48	96	0.5
	FAIR	132	136	55	108	0.4
	FSRIA	147	173	83	134	0.3
Soybean–wheat–soybean crop rotation	CASH	201	111	−44	89	1.4
	FAIR	219	184	−10	131	0.9
	FSRIA	209	181	−7	127	0.9

CASH and FSRIA scenarios, continuous wheat exhibited greater expected net returns and lower variability than either of the soybean systems. However, under the FAIR scenario, expected net returns were greater for the two systems that included soybean.

Conclusions

The 1996 FAIR Act was promoted as legislation that would allow and encourage farmers to base planting decisions on market incentives rather than government programs. However, since the loan deficiency payments remained coupled to production, it was possible for FAIR to distort market incentives. The results of this analysis indicate that the 1996 FAIR Act promoted crop diversity in the Southern Great Plains by improving the economics of continuous soybean relative to that of continuous wheat. Conversely, the 2002 FSRIA changed the relative economics to favor winter wheat, thereby providing a disincentive to crop diversity in the region. Farmers respond to economic incentives. Smith and Young found that in at least one region of the country, US agricultural policy might have influenced the level of crop diversification[8]. Results of this study corroborate the impact of public policy on cropping patterns.

Historical data indicate that producers responded to the 1996 and 2002 legislation by converting some wheat base acres to permanent pasture. Data are not available to compare the relative economics of continuous wheat with pasture. Additional research would be required to determine if marginal cropland that was in wheat production as a result of federal policies that encouraged base building was converted to pasture.

Monoculture continuous wheat became the dominant cropping system in the North Central District of Oklahoma, in part, because of government programs that provided incentives to build wheat base acres. While the 1996 FAIR Act provided the flexibility and economic incentive for crop diversification and movement away from monoculture wheat, farmers had little information on viable options. Since farmers did not grow alternative crops, and research funds depend to some extent on current cropping patterns, little research had been conducted to evaluate alternatives. This is especially problematic because field studies that include crop rotations are expensive and ideally should be replicated over many years. Due to the erratic weather and current market incentives under the 2002 FSRIA, it appears that soybean is not a good alternative for the region.

Government programs that link subsidy payments to the acres grown of specific crops and to the level of crop production have had a substantial effect on cropping patterns. The 1996 and 2002 programs decoupled most subsidy payments from specific crops. However, the subsidies are still linked to the land input. Benefits from the subsidy programs accrue to land and are reflected in land values and cash rents[16,17]. If the intent of policy makers is to subsidize farm families, basing subsidies on farm family income rather than on land (acres) may be more cost effective.

Decoupling has provided greater flexibility in crop selection and may ultimately enhance rural landscape diversity. However, diversification requires crops or cropping systems that are economically competitive with the current cropping system. Research is necessary to identify economically competitive alternatives. For crop diversification to expand in northern Oklahoma, research is needed to identify a crop or combination of crops that will fit in a rotation with wheat.

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