Characteristics of U.S. Wheat Farming: A Snapshot. By Mir B. Ali, Nora L. Brooks, and Robert G. McElroy. Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Statistical Bulletin No. 968.

Abstract

Wheat growers' choice of production practices and geographic location were the major determinants of their costs of production, according to the findings of a 1994 survey conducted by the U.S. Department of Agriculture. One-fourth of surveyed farms reported using some form of conservation tillage, especially farms in the North Central, Northern Plains, and Southeast regions. On a per-bushel basis, low-cost farms tended to be small in terms of wheat acreage and total farm acreage. Differences in capitalization, tenure, and the use of custom services accounted for nearly 81 percent of the variation in the cost of producing wheat. Most size economies were realized at around 200 to 300 wheat acres.

Keywords: Wheat, input use, production practices, farm characteristics, farm size, costs and returns, regression, low-cost farms, high-cost farms, cumulative distribution, operator budget.

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Summary

A 1994 survey of U.S. wheat farms showed significant differences in the farm and operator characteristics among regions, by size of the wheat enterprise, and among production cost groups. Yields varied dramatically, from 28 bushels per acre in the Northern Plains to 60 bushels in the Pacific region. Farmers rented about half their wheat acreage, and wheat made up only about one-third of their total cropland. While most acres were treated with chemicals, application rates were considerably lower than on most other crops. Conventional tillage practices are still the most common; conservation tillage methods were used on about one-fourth of the total wheat acreage.

Cash costs of growing the 1994 wheat crop ranged from a low of $70 per planted acre in the Northern Plains to $147 in the Pacific, where irrigation was more common. Offsetting the high costs in the Pacific region were higher yields, making the per-bushel costs more comparable. On average, the value of wheat at harvest covered the cash costs of producing the crop in every region. Total economic costs were covered only in the North Central region, where relatively high yields and additional income from wheat straw contributed to positive returns to management and risk.

When the distribution of costs was estimated and ranked based on actual 1994 yields, about 60 percent of surveyed wheat growers had variable costs of production at or below $1.80 per bushel, representing 64 percent of wheat production. Low-cost producers benefited from yields at or above expectations, while high-cost producers tended to have yields much lower than expected. Compared with high-cost farmers, low-cost farmers were more likely to own their cropland rather than to rent it and to use conservation tillage practices, resulting in much lower fuel expenses. Most low-cost farms were in the North Central region, and most high-cost farms were in the Northern Plains. The survey year (1994) was one of abnormally low yields in the Plains. With more typical yields, the concentration of high-cost farms in the Northern Plains would have been substantially less.

A farm's capitalization (as measured by average machinery investment per wheat acre) had the greatest influence on variations in unit costs, explaining 44 percent of the total variance effect between farms. The use of share rental arrangements and custom work accounted for another 15 percent of the variance, while specialization and hired labor had little influence. The analysis was expanded to compare regions. In general, the use of custom service, share-rent, and cash-rent was significantly different in all regions. Capitalization, which was the most significant variable, was also significantly different among all five regions.

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A Snapshot

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Introduction

Wheat is the principal cereal grain crop used for food consumption in the United States and most of the world. In terms of value of production, wheat is usually the Nation's fourth field crop. Only corn, hay, and soybeans have higher marketings. Wheat is an important U.S. export crop, with about 50 percent of total wheat production exported.

U.S. wheat farming involves many different topographic, climatic, and soil situations. On many farming operations, wheat is the sole or primary enterprise, although on most farming operations it is a secondary source of farm and ranch income. The 1997 agricultural census reported that 243,568 farms produced wheat.

The Federal Agriculture Improvement and Reform Act of 1996 severed the connection between program payments and market prices and gave flexibility in making cropping decisions to farm operators, landowners, and managers. At the same time, the rising cost of producing crops, more variability in the market price, and elimination of planting restrictions have pressured farmers to make decisions about which crops and how much to produce. They have to make cropping decisions in response to various production, demand, and price scenarios in both the domestic and international markets. In the absence of commodity support programs and with new planting flexibility, farmers, especially in the high-cost areas, will be looking for new or nontraditional crops with higher net returns than for wheat or for new, more profitable ways to produce wheat. Production information is useful in a variety of ways to consumers concerned about possible effects on retail food prices and the environment, to policymakers considering policies and programs that affect the economic well-being of producers and consumers, as well as to others.

This report compiles information from the U.S. Department of Agriculture's (USDA) 1994 Farm Costs and Returns Survey (FCRS) for wheat. This survey, conducted in the spring of 1995 to obtain 1994 calendar year production and financial data for U.S. wheat farms, is the only available source of such comprehensive nationwide micro-level farm information.

Importance of the Study

ERS published preliminary findings from the FCRS that briefly discussed the regional differences in characteristics and production costs of wheat farms (Ali and McElroy, 1996). An editorial on that report in the Milling and Baking News (June 1997) emphasized that the information derived from these USDA surveys (conducted since about 1975) has more relevance and more importance than before. According to the editorial, ". . . differences in regional costs are especially pertinent in view of another major goal of the 1996 Act . . . . total flexibility. That is why these newly issued wheat production cost data take on special significance for pointing to the areas with the highest production costs and thus with the greatest vulnerability to decisions by producers to grow other crops that have a higher return than wheat. Sectors of the grain-based food industry relying on supplies from the Pacific coast and Southeast, the top cost areas, should follow these relationships to watch cropping decisions." The editorial concluded that any great cost-price discrepancy would stimulate farm organizations and policymakers to examine existing law.

Because of the resulting changes in wheat farming and farm programs that give more planting flexibility and reduce price and income supports, additional knowledge is needed about adjustment opportunities available to farmers relating to farm size, crop mix,

crop and livestock integration, land tenure, and production practices, as well as alternative resources used in wheat production.

Previous Studies

Several studies have documented cost-size relationships as a potential cause of structural change in U.S. agricultural production. (The term "farm structure" in this report simply refers to how farms of different sizes, incomes, assets, and locations organize their natural, financial, labor, and other resources.) More recently, Hallam (1993) provided a comprehensive review of studies on size, methods of analysis, and empirical results related to the structure of U.S. agriculture. However, very few studies focused on the structure of U. S. wheat production. Studies have tended to focus on the supply and demand relationships of the broader wheat industry and the effects of changes in the wheat program (Heid, 1987; Harwood et al., 1989; Hoffman et al., 1995; Schwartz and Just, 1996; and Dahl and Wilson, 1997). Heid (1973) described in detail the characteristics of grain farms in seven parts of the Northern Plains. Lagrone and Krenz (1980) described the production practices, machinery, and input use by wheat type. The Agricultural Resources and Environmental Indicators report (USDA, ERS, 1997) discussed tillage practices, input use, and management in wheat production. Glaze (1993) examined the characteristics and production costs of U.S. wheat farms in 1989. He reported that differences in regional production practices and adverse weather conditions were major influences on wheat production costs and yields. Costs of producing wheat vary considerably across individual farms, primarily associated with differences in yields, farm size, and wheat acreage (Ahearn et al., 1990).

In another study, Ahearn et al. (1993) examined the cost-size relationship for corn, soybeans, and wheat. They found significant differences in average per-bushel economic costs of producing wheat related to several indicators of structure other than size. Older operators (65 years or more) and those who owned the land had significantly higher costs, compared with younger operators and those who rented land. Operators whose major occupation was farming had a significant cost advantage. McBride (1994b and 1994c) developed estimates of costs and returns for farm operators to examine the influences of farm organization and operator characteristics on corn production costs. He found that specialization in corn production, land tenure, irrigation, crop rotation, and corn expense structure were significant determinants of the unit cost of corn production (see Glossary for explanation of "farm structure").

Objectives of the Study

The overall objective of this study was to identify and examine the factors that influence the costs of producing U.S. wheat. Specific objectives were:

(1) To analyze farm and operator characteristics and production practices by classifying wheat farms based on different criteria such as region, cost level, and size of wheat enterprise.

(2) To examine the distribution of production costs and identify key variables that affect farmers' positions on this distribution.

(3) To identify factors that influence the unit cost of wheat production and their variance effects at national and regional levels using regression analysis.

Accomplishing these objectives will provide a valuable addition to the literature. The national survey of wheat growers allows cross-regional comparisons that have been unavailable. This analysis is also one of the first that examines the distribution of production costs in detail and decomposes the variance effects of major variables on the costs of producing wheat. This broad study of the economics of producing U.S. wheat will address issues omitted from earlier studies and will assist policymakers and researchers alike to better understand the major factors that influence production decisions by wheat growers.

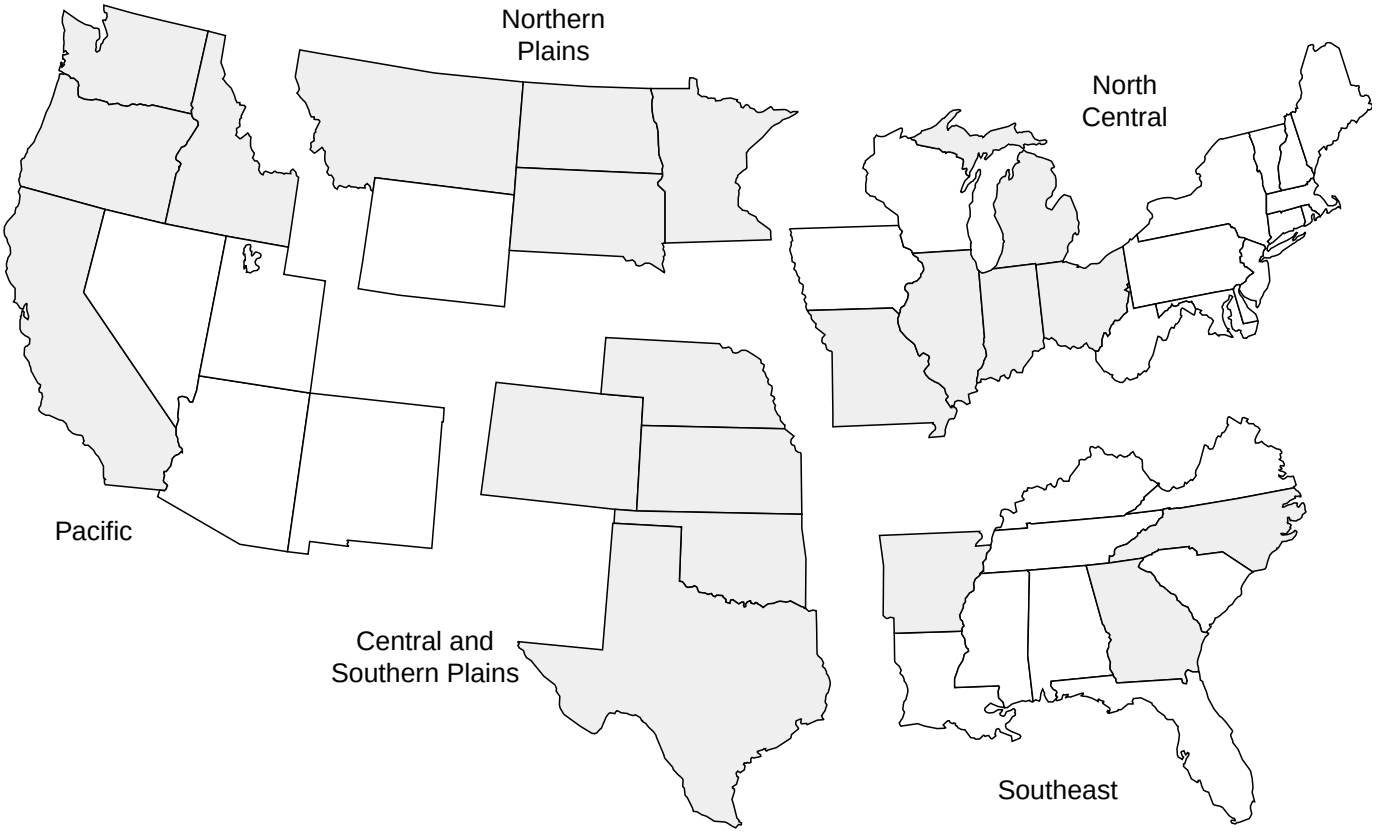
Overview of Wheat Farming

Wheat is raised commercially in nearly every State, but the Great Plains (from Texas to Montana) usually accounts for at least two-thirds of total production, with Kansas as the leader (fig.1). Wheat grown in the United States is either "winter wheat" or "spring wheat" depending on the season it is planted. Winter wheat varieties are sown in the fall and make some preliminary growth before cold weather arrives. The plants lie dormant through the winter. In the spring, they resume growth and grow rapidly until summer harvest. Winter wheat usually accounts for about two-thirds of U.S. production. Spring wheat varieties are planted in the spring, when the ground is workable, and grow continuously until harvest in July-August.

All the many varieties of wheat can be grouped into six basic classes. Each class of wheat is recognized not only by the time of year it is planted but also by the hardness, color, and shape of the wheat kernel. Each class has its own characteristics, especially as related to milling and baking or other food use. They are Hard Red Winter (HRW), Soft Red Winter (SRW), Hard Red Spring (HRS), Hard White (HW), Soft White (SW), and Durum wheat (see Glossary for details).

HRW is the dominant class in U.S. wheat exports and normally accounts for about 40 percent of total U.S. wheat production. HRW is produced in the Great Plains States and used in a wide variety of products, in particular bread and rolls. HRS is dominant among spring wheat classes (Durum and White Spring wheat) and contains the highest percentage of protein, making it an excellent bread wheat with superior milling and baking characteristics. HRS is produced in Montana, North Dakota, South Dakota, and Minnesota and accounts for almost one-fourth of total U.S. wheat production.

Figure 1
U.S. Department of Agriculture's wheat cost of production regions



Unshaded States are not covered in the U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

In 1994, U.S. farmers planted wheat on 70.3 million acres and produced 2,321 million bushels, down 3.1 percent from 1993. The average yield per harvested acre was 37.6 bushels, down 1.8 percent from 1993. Area harvested for grain was estimated at 61.8 million acres, slightly less than the previous year (USDA, NASS, 1995b). Wheat had a farm value of $8 billion that year and about 50 percent of the wheat crop was exported.

Regional Differences in Wheat Production

Two factors dominate any economic analysis of wheat production: location and production practices. The region where the wheat is grown determines the class of wheat produced and reflects conditions affecting yields. Growers' choices of production practices reflect the technology chosen for the operation and affect capital costs and efficiency of field operations. Because of the importance of these two factors, the characteristics of the farms surveyed and the production practices that the surveyed farmers reported on their operations will be presented first.

The most important region in terms of wheat production was the Central and Southern Plains, followed by the Northern Plains (fig. 2). Together these two regions account for about two-thirds of total U.S. wheat production. The region with the least wheat was the Southeast, accounting for less than 5 percent of the total U.S. wheat crop. Of the total wheat farms surveyed in 1994, about one-third were in the Central and Southern Plains and another third were in the North Central region. One-fourth of the wheat farms surveyed were in the Northern Plains; the Southeast and the Pacific had the smallest percentages of wheat farms surveyed. The Plains regions together accounted for 81 percent of wheat acreage; the Pacific and the North Central each had about 8 percent. The Southeast region had the smallest percentage of wheat acreage.

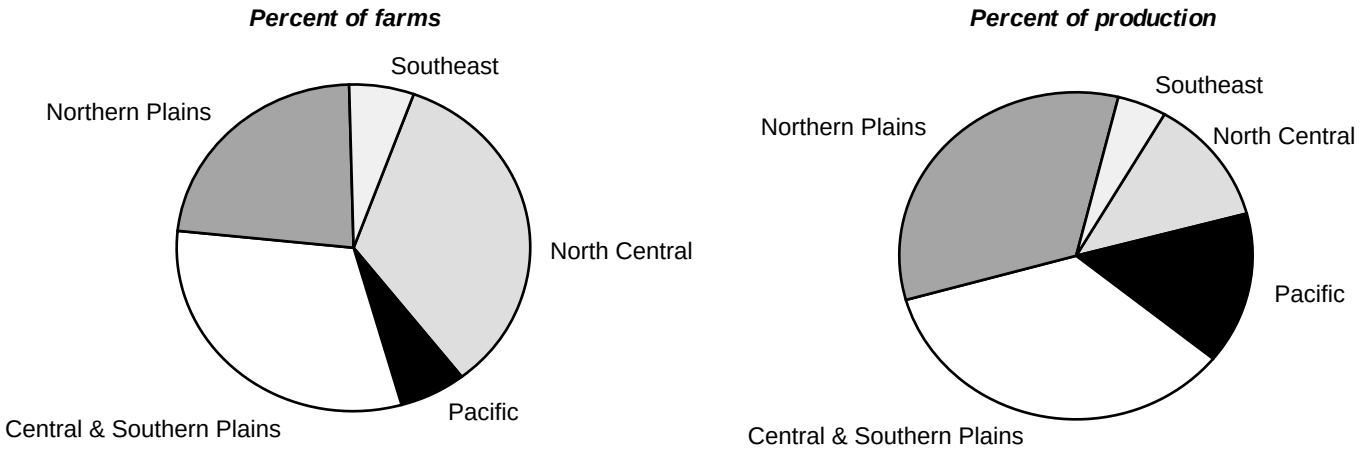
Average Yields

Nationally, wheat yields averaged 33 bushels per planted acre in 1994,[1] ranging from 28 bushels per acre in the Northern Plains to 60 bushels in the Pacific. Wheat farms in the Pacific reported the highest yields due to irrigation. However, among dryland regions, the North Central reported the highest wheat yields because of heavy fertilizer applications and better growing conditions.

[1]Yields reported in this analysis do not correspond to official USDA wheat yields as reported by the National Agricultural Statistics Service for two primary reasons: this analysis reports yields per planted acre rather than per harvested acre; and yields in this analysis are based on this particular survey sample, which is not the same sample used for the official USDA yields. The 1994 Farm Costs and Returns Survey was also based on fewer States than USDA's official estimates, which include all major States.

Figure 2

Geographic share of wheat farms and production, 1994



Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Expected Yields

Actual yields were generally lower in 1994 than growers expected (fig. 3). Wheat growers expected 40 bushels, but harvested 33 bushels of wheat per acre. Regionally, yields in the Plains regions were 7 to 8 bushels below expectations (28 actual bushels versus 36 expected bushels in the Central and Southern Plains, and 28 actual versus 35 expected in the Northern Plains). In the Southeast, growers harvested 47 bushels, slightly above the expected amount, while the North Central growers harvested 53 bushels, the same as their expected amount. Yields in the Pacific were less than 5 bushels short of their expected amount (see Glossary for explanation of "expected yield").

Production Specialty

A useful measure of the importance of wheat to the operation is its production specialty (table 1). Nearly one-third of farms with wheat also raised some livestock, primarily beef cattle. On average, about 60 percent of U.S. wheat farms specialized in cash grain production.[2] Most wheat farms in the Central and Southern Plains and North Central regions specialized in cash grains (67 percent), followed by the Northern Plains (57 percent). Most alternative crops to wheat in these three regions are also cash grains, so one expects most crops to be cash grains. Only 40 percent of the Pacific and Southeast wheat farms specialized in the production of cash grains. Also these regions reported a similar percentage of farms specializing in other crops.[3] The Northern Plains had the largest share of wheat farms specializing in livestock production, and the North Central region had the next largest share. Beef cattle were raised on 35 to 52 percent of wheat farms, followed by hogs and dairy (table 1). Wheat farms in the Plains regions had large inventories of beef cattle, while farms in the North Central region had large inventories of hogs. Dairy inventories were reported more often on the North Central and Northern Plains wheat farms than on other regions' farms.

Land Use and Tenure

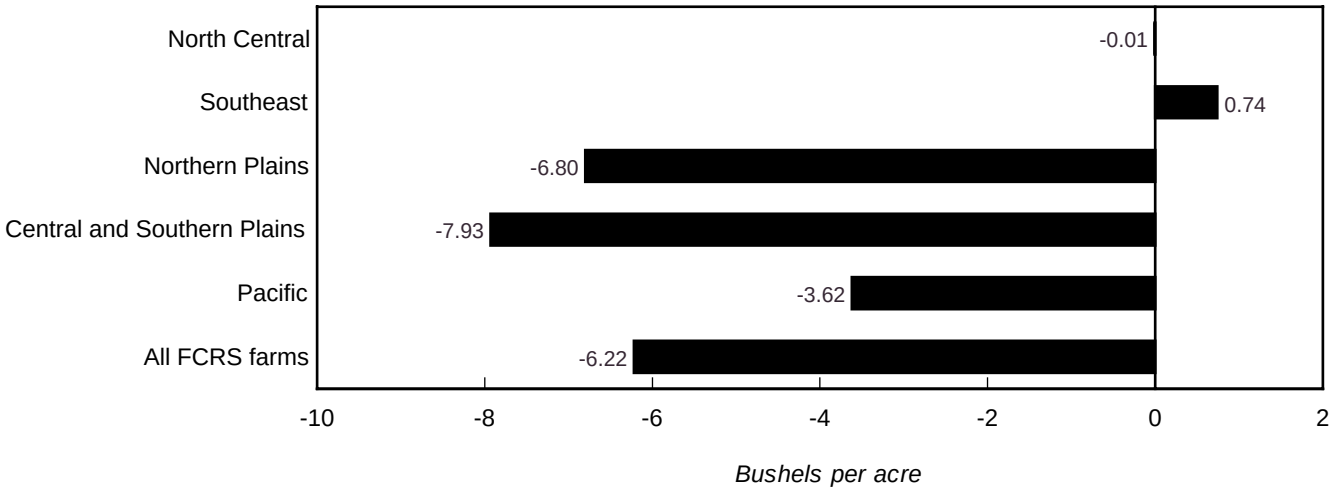
Farm size and land tenure arrangements can influence planning horizons and investment in soil-conserving practices. Small farm size is frequently associated with low-volume production, increased per-unit costs, and low net farm income (Miller et al., 1981). Full-owner operators and landowners with small holdings

[2]Cash grains include corn, sorghum, small grains, flax, soybeans, cowpeas, beans, peas, and rice.

[3]Other crops include cotton, tobacco, peanuts, potatoes, sunflowers, sweet potatoes, sugar cane, popcorn, sugarbeets, mint, hops, seed crops, broomcorn, hay, silage, and forage.

Figure 3

Difference between actual and expected yields, 1994



Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Table 1—Characteristics of wheat farms, by region, 1994

Item	Unit	North Central	Southeast	Northern Plains	Central and Southern Plains	Pacific	All FCRS farms
FCRS wheat farms	*Number*	90,037	15,763	60,915	82,300	16,230	265,245
FCRS share--							
Wheat acreage	*Percent*	8	*	40	41	8	100
Wheat production	*Percent*	13	*	33	35	15	100
Size:							
Operated	*Acres*	542	653	1,608	1,260	1,284	1,062
Planted wheat	*Acres*	49	114	370	281	293	214
Harvested wheat	*Acres*	48	109	362	252	292	202
Sales class:							
$49,999 or less	*Percent of farms*	36	17	35	40	26	35
$50,000-$99,999	*Percent of farms*	17	11	24	20	16	19
$100,000-$499,999	*Percent of farms*	42	58	39	38	44	41
$500,000 or more	*Percent of farms*	5	14	*	*	14	5
Value of production:							
Wheat production value	*Dollars per farm*	7,616	16,883	35,835	25,724	63,336	23,675
Farm production value	*Dollars per farm*	197,795	366,054	117,402	111,675	398,810	174,910
Wheat tenure:							
Owned	*Percent of acres*	50	31	44	34	33	39
Cash-rented	*Percent of acres*	24	46	37	16	10	25
Share-rented	*Percent of acres*	26	23	19	50	57	35
Production practices:							
Winter wheat	*Percent of acres*	100	100	13	100	86	64
Spring wheat	*Percent of acres*	0	0	87	0	14	36
Irrigated	*Percent of acres*	0	0	0	5	25	*
Double-cropped	*Percent of acres*	21	78	0	*	*	6
Fallow	*Percent of acres*	*	5	33	31	53	31
Straw	*Percent of acres*	36	7	*	*	9	6
Grazing	*Percent of acres*	0	0	0	20	*	9
Previous crop:							
Barley/oats	*Percent of farms*	10	*	10	0	13	7
Corn	*Percent of farms*	14	29	15	*	*	11
Soybeans	*Percent of farms*	68	37	19	8	0	32
Wheat	*Percent of farms*	0	*	12	46	10	18
Fallow	*Percent of farms*	3	5	28	30	35	19
Crop rotation:							
Continuous wheat	*Percent of farms*	0	0	9	38	*	14
Fallow-wheat	*Percent of farms*	0	0	17	21	20	12
Fallow-other	*Percent of farms*	3	5	9	5	5	5
Corn-soybeans	*Percent of farms*	6	14	*	*	0	*
Corn-other	*Percent of farms*	8	16	11	*	*	7
Soybeans-soybeans	*Percent of farms*	17	16	*	*	0	7
Soybeans-corn	*Percent of farms*	45	*	10	0	0	18
Production specialty:							
Cash grains	*Percent of farms*	67	37	57	67	39	61
Other crops	*Percent of farms*	0	44	*	9	33	8
Livestock	*Percent of farms*	33	17	43	24	16	30
Livestock:							
Hogs	*Percent of farms*	30	19	13	*	*	16
Beef cattle	*Percent of farms*	48	35	52	50	39	48
Dairy cattle	*Percent of farms*	20	6	10	*	*	10
Wheat for farm use	*Percent*	6	*	*	*	*	*
Participated in wheat program	*Percent of farms*	57	45	81	84	69	71
Operator characteristics:							
Individual farm organization	*Percent of farms*	82	81	85	92	72	85
Partnership	*Percent of farms*	11	15	13	*	20	10
Farming as major occupation	*Percent of farms*	84	86	92	79	92	85
Under 50 years of age	*Percent of farms*	43	49	44	46	44	44
Completed college	*Percent of farms*	31	40	35	58	66	43

* = 0.1 to less than 5 percent. Totals may not add to 100 percent due to omission of a category or rounding error.
Estimated t-statistics are in the appendix.

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

have been shown to use minimum tillage less often than other landownership groups (Lee and Stewart, 1983). The recent study by Soule et al. indicated (1999) that cash renters were significantly less likely than owner-operators to use conservation tillage, while share renters behaved much like owner-operators in their use of conservation tillage practices.

The average size of all FCRS wheat farms surveyed in 1994 was 1,062 acres, of which 50 percent was cropland (table 2). Farmers owned half the land they operated. The remainder was rented equally on a cash- and share-rent basis where landlords may be sharing input costs. On average, one-third of the cropland was harvested for wheat. Other crops harvested on farms producing wheat were, chiefly, corn, soybeans, and hay.

Double-Cropping and Fallow

Two other production practices that showed wide variation among regions were summer fallow and double-cropping. Much U.S. wheat is grown in moisture-deficient areas. One of the most common moisture-conserving practices is summer fallow. About 20 percent of wheat farms reported using summer fallow, accounting for one-third of the total wheat acreage. Pacific wheat growers planted 53 percent of their wheat on previously fallowed land, compared with 31 to 33 percent in the Plains regions. Less than 5 percent of wheat was planted on previously fallowed land in the eastern regions, where double-cropping was more common. In the Southeast, 78 percent of the wheat was double-cropped, usually with soybeans. In the North Central region, 21 percent of the wheat was double-cropped. Less than 5 percent of wheat acres were double-cropped in the Central and Southern Plains and Pacific regions. No double-cropping was reported by farmers in the Northern Plains.

Irrigation

Wheat is especially adaptable to extreme weather conditions, but yields generally improve if irrigation is used. Areas that commonly use irrigation showed higher wheat yields than predominantly dryland areas. In most parts of the country, however, irrigation is a relatively high-cost practice to incorporate into a farm's production plan. The income potential of irrigating a crop is dependent on the relative profitability of different cropping systems with and without irrigation. Only 5 percent of FCRS wheat acreage was irrigated. The Pacific region had a large percentage of wheat acres under irrigation (25 percent). Some irrigation was reported in the Central and Southern Plains (5 percent of wheat acres).

Table 2—Land use on wheat farms, by region, 1994

Item	North Central	Southeast	Nothern Plains	Central and Southern Plains	Pacific	All FCRS farms
			Acres			
Operated acres	542	653	1,608	1,260	1,284	1,062
Harvested cropland	483	561	845	494	580	580
			Percent			
Land tenure:						
Owned	47	34	62	40	36	47
Cash rent	29	38	26	30	18	28
Share rent	24	28	12	32	46	25
Crops harvested:						
Wheat	10	19	43	51	51	35
Corn	38	9	10	14	*	19
Soybeans	35	37	7	*	*	16
All hay	6	*	18	10	15	12
Cotton	7	7	*	9	*	*
Rice	*	12	*	*	*	*
Sorghum	*	*	*	11	*	*
Sunflowers	*	*	7	*	*	*
Barley	*	*	7	*	11	*
Others	8	8	*	*	13	*

* = 0.1 to less than 5 percent. Totals may not add to 100 percent due to omission of a category or rounding error.
Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Fertilizer and Chemical Use

Most surveyed wheat farms applied nitrogen. Sixty-seven percent of the farms applied phosphorus, while 40 percent used potassium. Wheat growers, on average, applied 57 pounds of nitrogen, 22 pounds of phosphorus, and 8 pounds of potassium per acre. The quantity of nitrogen applied varied among regions, ranging from 50 pounds per acre in the Northern Plains to 85 pounds per acre in the North Central region. Fertilizers were generally applied at higher rates in the eastern regions because of double-cropping and the large amount of wheat acreage harvested for straw. Eastern growers also applied more manure than growers in other regions. Heavy fertilizer applications were reported in the Pacific due to irrigation. The Central and Southern Plains had the lowest fertilizer use among regions. Fertilizer application rates were based on rates per planted acre and averaged over all acres planted to wheat, regardless of whether all acres received treatment. Others often report fertilizer application rates only for acres that actually received treatment (USDA, ERS, 1997b). For this reason and the fact that the samples may differ, application rates for some fertilizers (like potash) may differ since potash is needed only for some fields, and the carryover effect of potash requires it to be applied only every 2 to 3 years.

Generally, wheat is one of the least chemical-intensive crops (USDA, NASS, ERS, 1995). In 1994, herbicides were applied on 43 percent of the wheat farms. Regions that had spring wheats, including Durum, received more herbicide treatments because of more intense weed pressure. More than 85 percent of the wheat farms in the Northern Plains and Pacific regions applied herbicides to their wheat crop, compared with about 20 percent in the North Central region. Thirty-eight percent of the wheat farms in the Central and Southern Plains and Southeast treated wheat with herbicides. North Central growers used considerably fewer chemicals than growers in other regions.

The most widely used herbicide on wheat land was MCPA, followed by 2,4-D and Glyphosate. However, the type of herbicide used on wheat acreage varied among regions. The most widely used herbicide was Chlorosulfuron in the Central and Southern Plains, MCPA in the Northern Plains and in the Pacific, 2,4-D in the North Central, and Harmony in the Southeast (see the Top five herbicides used on regional wheat acreage box).

Top five herbicides used on regional wheat acreage

North Central:	2,4-D, Harmony, Glyphosate, MCPA, and Landmaster
Southeast:	Harmony, 2,4-D, Karmex, Hoelon, and Glyphosate
Northern Plains:	MCPA, 2,4-D, Glyphosate, Banvel, and Harmony
Central and Southern Plains:	Chlorosulfuron, 2,4-D, Metribuzin, Glyphosate, and MCPA
Pacific:	MCPA, Glyphosate, Harmony, Metribuzin, and 2,4-D
All FCRS wheat farms:	MCPA, 2,4-D, Glyphosate, Banvel, and Harmony

Less than 5 percent of surveyed farms used insecticides and fungicides on wheat. Regionally, insecticide and fungicide use was relatively higher in the Southeast, followed by the Pacific and Central and Southern Plains regions. Among insecticides, Methomyl was widely used, followed by Chloropyrifos, Dimethoate, and Parathion. Tilt was the most commonly used fungicide on the 1994 wheat crop.

Field operations. Typically, a farm's cost effectiveness in producing wheat will be heavily affected by the choice and number of field operations. For this analysis, each field operation was measured in times over (field passes), which is the acreage covered in the operation divided by the total acreage planted to wheat (table 3). The total times over required for all field operations was lower in the eastern regions (North Central and Southeast) than in other regions. The Pacific had the highest times over due to more harrowing and fertilizer or chemical applications than in other regions. Tillage accounted for 50 percent of

the times over for all field operations. Most differences between one region and another were in plowing, disking, and harrowing operations.

Tillage ranges from preparing the seedbed to plowing and cultivating. Tillage systems may be used for many reasons, such as incorporating residues and fertilizers; improving soil physical properties to control soil erosion, reduce water loss, or to control insects, diseases, and weeds; and enhancing seed placement. The type of tillage system employed in the production of wheat influences the levels of chemicals, fertilizers, fuel, and labor (see the 1994 FCRS of U.S. Wheat Farming box for details). Variation in the type

Table 3—Field operations in wheat production, by region, 1994[1]

Item	North Central	Southeast	Nothern Plains	Central and Southern Plains	Pacific	All FCRS farms
			Times-over			
All field operations	5.44	5.36	7.20	6.96	7.88	6.97
Tillage:						
Plowing	0.08	0.40	1.13	1.80	0.79	1.27
Disking	0.72	1.06	0.23	1.24	0.80	0.75
Cultivation	0.18	0.25	0.99	0.76	0.78	0.79
Harrowing	0.16	0.21	0.40	0.52	1.82	0.54
Other tillage[2]	0.12	0.09	0	0.06	0.11	0.05
Fertilizer and chemical application	1.28	1.17	2.03	1.00	1.62	1.49
Seeding	0.99	0.94	0.98	0.94	0.94	0.96
Harvesting	0.92	0.87	1.22	0.58	0.91	0.90
Mowers and balers	0.43	0.10	0.07	0.01	0.03	0.07
Other implements	0.58	0.28	0.14	0.08	0.07	0.15

[1]Excludes custom operations.
[2]Includes bedders, shapers, and packers.
Source: U.S. Department of Agriculture's 1994 Costs and Returns Survey.

1994 Farm Costs and Returns Survey of U.S. Wheat Farming

The 1994 FCRS of U.S. wheat farming reveals that production practices, such as crop rotation, fallow, and inputs varied greatly by region. Notable differences include:

- About 50 percent of U.S. wheat acres in 1994 were owned, with the remaining acres evenly split among cash- and share-rent.
- Spring wheat was more commonly grown in the Northern Plains, while winter wheat was more common in the Central and Southern Plains and the eastern regions.
- Wheat is seldom irrigated. The only region with enough samples to study was the Pacific region.
- Letting land lie fallow (no crop harvested in the previous 12 to 21 months) was a common rotation that helps conserve moisture.
- One-fourth of surveyed farms reported using some form of conservation tillage, most commonly in the Northern Plains, North Central, and Southeast.
- More than 80 percent of wheat growers in the Pacific region used custom operations, with custom fertilizer or chemical applications most common. Custom harvesting and hauling were also important in the Central and Southern Plains and the Pacific regions.

of tillage system used in producing spring wheat may be partly due to weather-soil relationships and the use of fallow in the areas producing spring wheat, while a gradual increase in no-till and conventional tillage without the moldboard plow has occurred in winter wheat production since 1988 (USDA, ERS, 1997b).

Conventional tillage without a moldboard plow was the most common practice for producing wheat (mainly chisel and disk). Twenty-eight percent of the wheat farms reported conservation tillage systems (table 4). Among regions, conservation tillage was most common in the Northern Plains and the North Central regions (36 percent), followed by the Southeast (26 percent). In the Pacific and Central and Southern Plains, about 15 percent of the wheat farms used conservation tillage. The type of conservation tillage practiced varied greatly among regions. A no-till system was common in the North Central, while a mulch-till system was common in other regions, particularly in the Northern Plains (fig. 4).

Custom operations. The decision to custom-hire some field operations depends on several factors, such as size of farm and machines, availability of capital and labor, importance of timely operations, and weather-related factors. The use of custom work influences wheat production costs by reducing the costs of operating and owning the machines and labor, while increasing the costs of custom operations. Sixty percent of U.S. wheat farms used custom operations, with custom fertilizer or chemical applications the most common, followed by custom harvesting and land preparation (fig. 5). The percentage of farms reporting custom operations ranged from 83 percent in the Pacific region to 50 percent in the North Central. Between 60 and 75 percent of wheat farms used custom operations in the Southeast and Plains regions. Custom harvesting and hauling were most common in the Central and Southern Plains and Pacific regions (about 35 percent of the farms), followed by the Southeast (27 percent). The North Central region had the lowest percentage of farms using custom harvesting (13 percent). The Pacific region wheat farms also had more custom land preparation or cultivation than other regions.

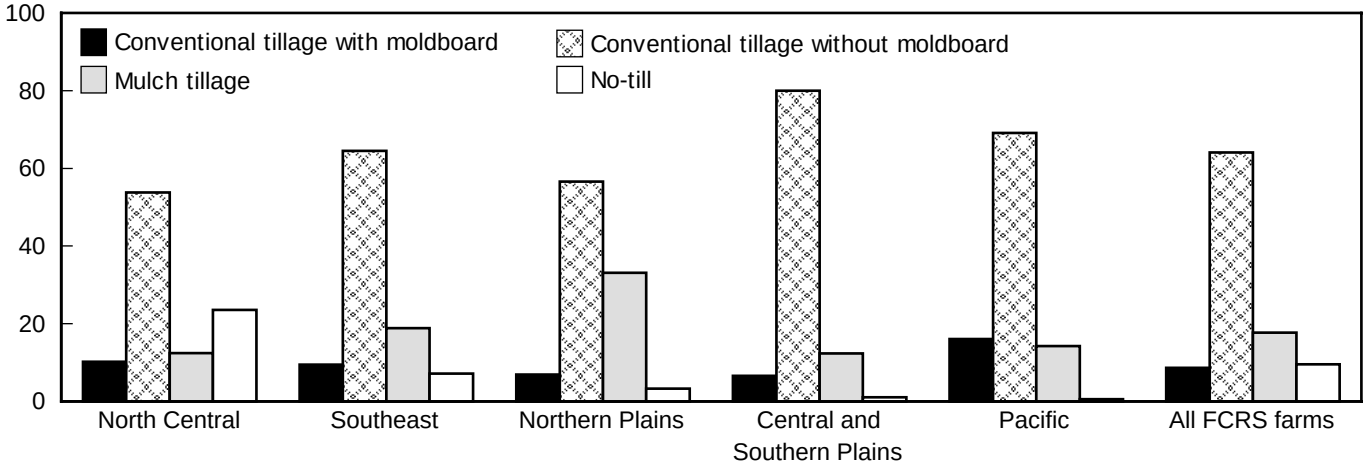
Size Distribution of Wheat Farms

Earlier analyses of farm businesses and commodity production indicate that the size of the wheat enterprise may affect the costs of producing wheat. Much has been written about economies of size in agriculture (Hallam, 1993). Costs have been shown to decline as the size of enterprise increases (Ahearn, 1993; Helmers et al., 1989; and Madden, 1967). There comes a point, however, when economies of size have been achieved and costs level off or begin to increase (Olson and Lohano, 1999; and Miller et al., 1981). Analysis of the size distribution of wheat farms will identify cost

Figure 4

Tillage system, by region, 1994

Percent



Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Table 4—Input use of wheat production operations, by region, 1994

Item	Unit	North Central	Southeast	Northern Plains	Central and Southern Plains	Pacific	All FCRS farms
Wheat yield:							
Actual yield	*Bushels/acre*	53.44	47.03	27.85	28.46	59.96	33.40
Expected yield	*Bushels/acre*	53.45	46.79	34.65	36.39	63.58	39.62
Seed:							
Rate (one time)	*Bushels/acre*	2.02	2.07	1.59	1.10	1.40	1.42
Acres reseeded	*Percent of acres*	*	0	*	5	*	*
Home-grown seed	*Percent of seed*	29	19	54	49	23	45
Fertilizer use:							
Any fertilizer	*Percent of farms*	100	99	89	83	95	92
Nitrogen	*Percent of farms*	100	92	89	83	94	91
Phosphorus	*Percent of farms*	87	51	79	44	44	70
Potassium	*Percent of farms*	81	58	28	6	13	40
Manure	*Percent of farms*	*	11	10	*	*	5
Fertilizer application rate:							
Nitrogen	*Pounds/acre*	84.88	74.07	50.47	52.44	72.58	56.56
Phosphorus	*Pounds/acre*	58.99	27.10	22.48	15.31	12.89	21.75
Potassium	*Pounds/acre*	66.18	44.15	3.06	1.25	2.19	8.48
Manure	*Tons/acre*	0.11	0.24	0.05	0.01	0.09	0.05
Chemical use:							
Any chemicals	*Percent of farms*	19	46	85	38	94	46
Herbicides	*Percent of farms*	19	39	85	35	94	45
Insecticides/fungicides	*Percent of farms*	*	10	*	8	9	*
Herbicide	*Acre treatments*	0.18	0.55	1.23	0.36	1.27	0.77
Insecticides/fungicides	*Acre treatments*	0	0.17	0.01	0.09	0.01	0.05
Tillage system:							
Conventional with moldboard plow	*Percent of farms*	10	10	7	7	16	9
Conventional without moldboard plow	*Percent of farms*	54	65	57	80	69	64
Mulch tillage	*Percent of farms*	12	19	33	12	14	18
No-till	*Percent of farms*	24	7	*	*	*	10
Custom operations:							
Any custom operations	*Percent of farms*	50	75	57	70	83	61
Land preparation/cultivation	*Percent of farms*	*	7	21	14	33	13
Planting	*Percent of farms*	*	7	*	6	8	*
Fertilizer/chemical application	*Percent of farms*	44	67	44	50	70	49
Harvesting/hauling	*Percent of farms*	13	27	19	36	34	23
Fuel use:							
Diesel	*Gallons/acre*	2.99	4.17	4.13	5.41	7.82	4.87
Gasoline	*Gallons/acre*	2.73	2.43	2.42	2.58	2.80	2.55
LP gas	*Gallons/acre*	0	0.04	0.11	0.20	0.13	0.14
Natural gas	*1,000 cubic feet/acre*	0	0	0	0.59	0	0.24
Electricity	*Kilowatt hours/acre*	0	0	0	0.02	1.61	0.14
Labor use:							
Unpaid labor	*Hours/acre*	1.36	1.12	0.95	1.52	2.03	1.31
Paid labor	*Hours/acre*	0.43	0.63	0.25	0.34	1.13	0.39

* = 0.1 to less than 5 percent. Totals may not add to 100 percent due to omission of a category or rounding error.
Estimated t-statistics are in the appendix.
Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

differences (and sources of cost variation) among producers.

Four size classes were developed according to planted wheat acreage: fewer than 50 acres, 50 to 199 acres, 200 to 399 acres, and 400 or more acres. Three-fourths of FCRS farms had fewer than 200 wheat acres, but these farms accounted for only one-fourth of total wheat acreage and production (table 5). The highest number of wheat farms was in the group with fewer than 50 wheat acres (42 percent). Roughly two-thirds of production and acreage came from the 17 percent of farms with 400 wheat acres or more (fig. 6).

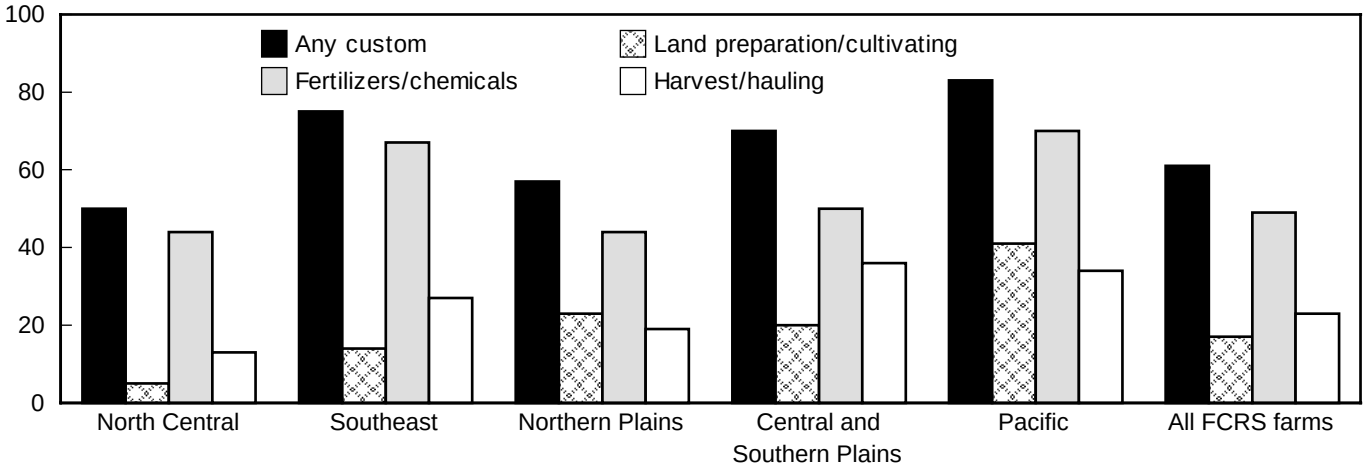
Several characteristics varied according to enterprise size:

Wheat sales — On the smallest farms, wheat contributed 2 percent of the average farm value of production and 5 percent of total acreage. In contrast,

Figure 5

Farms using custom operations, by region, 1994

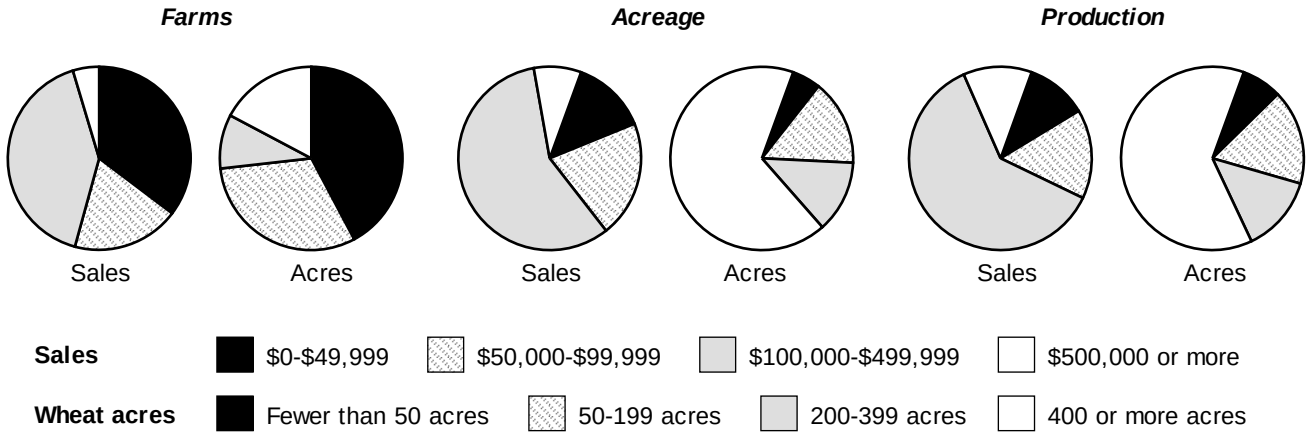
Percent of farms



Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Figure 6

Share of wheat farms, acreage, and production, by size, 1994



Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Table 5—Characteristics of wheat farms, by enterprise size, 1994

Item	Unit	Fewer than 50 wheat acres	50-199 wheat acres	200-399 wheat acres	400 or more wheat acres
FCRS wheat farms	*Number*	111,977	82,230	25,260	45,778
FCRS share of--					
Wheat acreage	*Percent*	5	15	13	67
Wheat production	*Percent*	7	17	14	63
Size:					
Operated	*Acres*	563	1,019	1,175	2,296
Planted wheat	*Acres*	26	104	285	830
Harvested wheat	*Acres*	24	96	268	792
Sales class:					
$49,999 or less	*Percent of farms*	48	36	30	6
$50,000-$99,999	*Percent of farms*	14	23	23	21
$100,000-$499,999	*Percent of farms*	34	37	39	65
$500,000 or more	*Percent of farms*	*	*	7	8
Value of production:					
Wheat production value	*Dollars per farm*	3,501	12,409	33,384	87,903
Farm production value	*Dollars per farm*	161,973	155,222	174,804	241,980
Wheat tenure:					
Owned	*Percent of acres*	64	47	36	36
Cash-rented	*Percent of acres*	19	22	21	28
Share-rented	*Percent of acres*	17	31	43	36
Production practices:					
Winter wheat	*Percent of acres*	84	73	75	58
Spring wheat	*Percent of acres*	16	27	25	42
Irrigated	*Percent of acres*	5	5	*	*
Double-cropped	*Percent of acres*	10	12	11	*
Fallow	*Percent of acres*	14	24	23	35
Straw	*Percent of acres*	34	16	*	*
Grazing	*Percent of acres*	*	8	10	9
Previous crop:					
Barley/oats	*Percent of farms*	*	*	*	*
Corn	*Percent of farms*	12	16	7	*
Soybeans	*Percent of farms*	46	29	24	5
Wheat	*Percent of farms*	5	17	29	40
Fallow	*Percent of farms*	13	19	26	27
Crop rotation:					
Continuous wheat	*Percent of farms*	*	14	22	35
Fallow-wheat	*Percent of farms*	7	9	22	23
Fallow-other	*Percent of farms*	5	8	*	*
Corn-soybeans	*Percent of farms*	*	6	*	*
Corn-other	*Percent of farms*	8	9	6	*
Soybeans-soybeans	*Percent of farms*	12	5	7	0
Soybeans-corn	*Percent of farms*	26	20	8	*
Production specialty:					
Cash grains	*Percent of farms*	56	51	77	82
Other crops	*Percent of farms*	8	10	6	*
Livestock	*Percent of farms*	35	37	17	14
Livestock:					
Hogs	*Percent of farms*	24	11	*	9
Beef cattle	*Percent of farms*	52	51	48	34
Dairy cattle	*Percent of farms*	18	6	*	*
Wheat for farm use	*Percent*	10	*	*	*
Participated in wheat program	*Percent of farms*	54	75	83	97
Operator characteristics:					
Individual farm organization	*Percent of farms*	88	85	89	77
Partnership	*Percent of farms*	7	14	*	15
Farming as major occupation	*Percent of farms*	82	83	92	91
Under 50 years of age	*Percent of farms*	47	37	43	51
Completed college	*Percent of farms*	38	37	42	65

* = 0.1 to less than 5 percent. Totals may not add to 100 percent due to omission of a category or rounding error.
Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

wheat contributed 36 percent of farm value of production and total acreage for the largest size group.

Tenure — Two-thirds of wheat acreage on the smallest farms was owned, compared with one-third owned on the largest farms. The proportion of wheat acreage share-rented also increased with size—from 17 percent on the smallest farms to more than 30 percent on large farms.

Previous crop — Wheat was grown before wheat by 40 percent of farms with more than 400 wheat acres, while soybeans was the most common crop grown prior to wheat by farms with fewer than 50 wheat acres.

Fallow — Thirty-five percent of wheat acres were previously fallowed on the largest farms, compared with 14 percent on the smallest farms.

Chemical use — One-third of the growers with fewer than 50 wheat acres applied herbicides versus three-fourths of growers with more than 400 wheat acres.

Custom — As size increased, custom operations, particularly land preparation or cultivation, fertilizer or chemical application, and harvesting, became more common.

Production costs — Relationships between production costs per acre and farm size were not as clear for wheat as they were in earlier studies of other crops such as corn (McBride, 1994a). Total economic costs decreased from $181 per acre for farms with fewer than 50 wheat acres to $151 per acre for those with 400 or more acres (table 6). However, farms with 50 to 199 and 200 to 399 wheat acres had similar costs averaging $158 per acre.

For actual 1994 yields, farms with fewer than 50 wheat acres had the lowest production costs: $3.88 per bushel compared with $4.84 per bushel for farms with more than 400 acres. Note that although farms with 50 wheat acres or less had higher per-acre costs, their higher yields gave them the lowest per-bushel costs. When expected yields were used, both of the smallest acreage classes had per-bushel costs of $3.62, the lowest for all classes. However, there was little difference among the classes using expected yields: $3.75 per bushel for farms planting 200 to 399 acres of wheat and $3.68 per bushel for farms planting 400 or more acres. These expected yield costs are slightly understated, since there is no way to add in the additional harvesting expenses had farmers realized their expected yields.

Fertilizer expense was the single most important cost item in wheat production, followed by repairs and fuel. These cost items together accounted for an average of 60 to 67 percent of variable cash expenses in each size group. Fertilizer expense was negatively related to size, varying from $25 per acre for farms with fewer than 50 acres of wheat to $14 per acre for farms with 400 acres or more (fig. 7). This is because smaller farms are located in regions with good rainfall. Total variable and fixed cash expenses accounted for 78 percent of the gross value of production on the largest acreage, compared with 58 percent on the smallest acreage. While the gross value of production exceeded cash expenses for all size classes, high capital replacement and land charges caused residual returns to management and risk to be negative across all size groups (table 6). Residual returns per acre were less negative on small farms, however, than on large farms. This is due to a high straw/grazing value on smaller farms.

Regional and Size Differences in Costs

Regional differences in production practices, input use, and irrigation were reflected in farmers' cash costs. Total cash costs ranged from a low of $70 per acre in the Northern Plains to $147 in the Pacific. The highest costs, which were in the Pacific region, were due to irrigation-related expenses. Fertilizer, repairs, and fuel combined accounted for 58 to 70 percent of variable cash expenses across the regions (fig. 8). Input costs varied widely among regions, reflecting differences in acreage covered and application rates. Seed costs varied because of differences in seeding rates, replanting, and use of home-grown seed. Seeding rates were much higher in the Southeast. Although initial quantities of seed used for planting in the Southeast were higher, Southeast wheat growers did not report reseeding, but growers in the other regions did (table 4).

Total economic costs ranged from $137 per acre in the Central and Southern Plains to $271 per acre in the Pacific region (table 7). This wide range illustrates the differences in cash expenses, replacement costs, and allocated costs (such as land), which are a result of irrigation and other cropping practices and rental arrangements (fig. 9).

Table 6a—Wheat production cash costs and returns per planted acre, by enterprise size, 1994

Item	Wheat acres planted: Fewer than 50 acres	50-199 acres	200-399 acres	400 or more acres	All FCRS farms
			Dollars per planted acre		
Gross value of production:					
Wheat grain	139.85	113.72	110.04	100.38	105.64
Wheat straw/grazing	29.61	8.03	2.80	2.19	4.55
Total, gross value of production	169.46	121.75	112.84	102.56	110.19
Cash expenses:					
Seed	11.98	9.10	7.01	6.83	7.46
Fertilizer	24.72	21.01	20.60	14.38	16.70
Chemicals	2.36	3.55	4.87	6.58	5.69
Custom operations	7.45	5.47	4.93	5.76	5.70
Fuel, lube, and electricity	7.80	6.91	10.01	8.70	8.55
Repairs	9.41	10.05	12.54	12.08	11.69
Hired labor	2.31	2.80	4.06	4.14	3.83
Purchased water and baling	1.62	0.78	0.16	0.21	0.36
Total, variable cash expenses	67.66	59.67	64.18	58.68	59.99
General farm overhead	8.87	7.01	5.49	4.70	5.36
Taxes and insurance	15.69	10.56	8.96	8.58	9.29
Interest	6.66	6.41	7.91	8.24	7.84
Total, fixed cash expenses	31.22	23.98	22.36	21.52	22.49
Total, cash expenses	98.88	83.65	86.54	80.20	82.48
Gross value of production less cash expenses	70.58	38.10	26.30	22.37	27.71
			Dollars per bushel		
Harvest-period price	3.00	3.07	3.10	3.22	3.16
			Bushels per planted acre		
Yield	46.63	37.03	35.54	31.17	33.40

Table 6b—Wheat production economic costs and returns per planted acre, by enterprise size, 1994

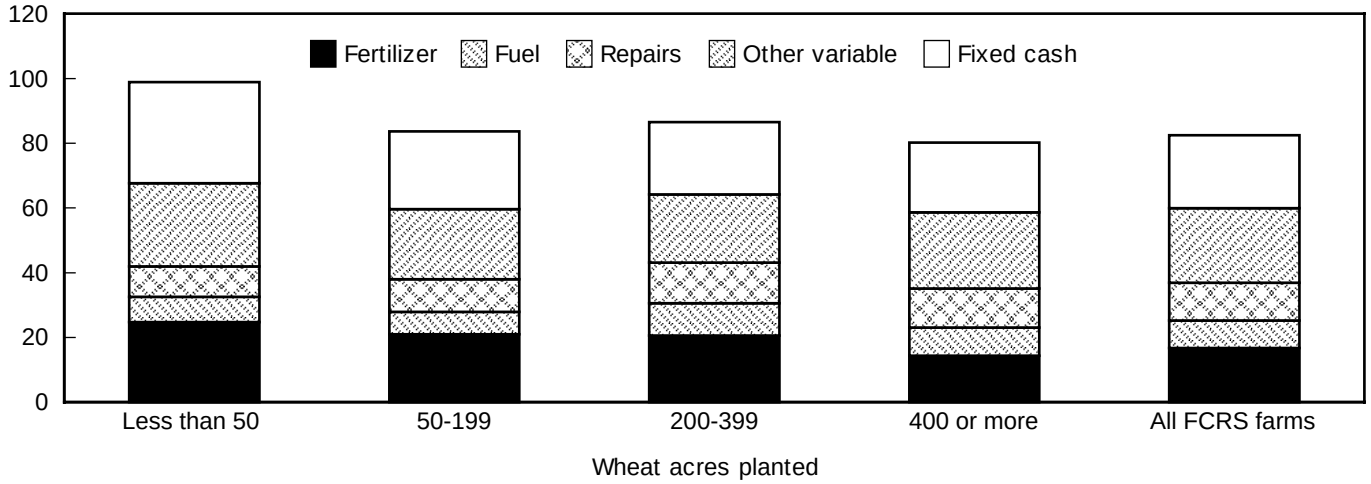
Item	Wheat acres planted: Fewer than 50 acres	50-199 acres	200-399 acres	400 or more acres	All FCRS farms
			Dollars per planted acre		
Gross value of production:					
Wheat grain	139.85	113.72	110.04	100.38	105.64
Wheat straw/grazing	29.61	8.03	2.80	2.19	4.55
Total, gross value of production	169.46	121.75	112.84	102.56	110.19
Economic (full-ownership) costs:					
Variable cash expenses	67.66	59.67	64.18	58.68	59.99
General farm overhead	8.87	7.01	5.49	4.70	5.36
Taxes and insurance	15.69	10.56	8.96	8.58	9.29
Capital replacement	19.42	19.70	22.63	22.41	21.87
Operating capital	1.58	1.39	1.50	1.37	1.40
Other nonland capital	13.60	11.89	12.22	11.15	11.52
Land	39.83	37.67	34.02	37.06	36.91
Unpaid labor	14.31	10.66	9.10	7.02	8.20
Total, economic costs	180.96	158.54	158.11	150.95	154.54
Residual returns to management and risk	-11.50	-36.79	-45.27	-48.39	-44.35
			Dollars per bushel		
Harvest-period price	3.00	3.07	3.10	3.22	3.16
			Bushels per planted acre		
Yield	46.63	37.03	35.54	31.17	33.40

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Figure 7

Components of cash costs, by enterprise size, 1994

Dollars per planted acre

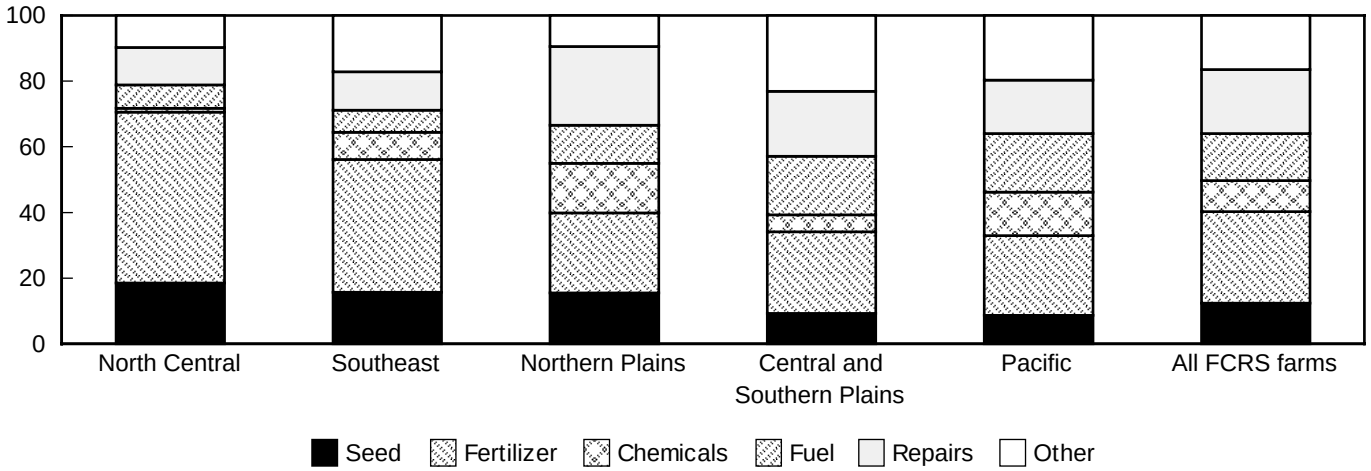


Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Figure 8

Major components of variable cash expenses, by region, 1994

Percent



Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

On a per-bushel basis, cash costs varied greatly among regions, ranging from $1.94 in the North Central region to $2.67 in the Central and Southern Plains; the differences in per-bushel costs arise because of differences in yields. Economic costs ranged from $3.24 in the Southeast to $5.14 per bushel in the Northern Plains. Although the Plains growers had lower per-acre costs, compared with growers in the other regions, they had the highest per-bushel costs due to poor yields. Northern Plains producers reported that yields were 25 percent less than expected at planting. Here again, it is important to look at costs based on expected yields for more understanding of the wheat industry from a long range perspective. There was little difference between total costs per expected and actual bushel in the North Central, Southeast, and Pacific regions. However, in the Northern Plains and Central and Southern Plains, expected per-bushel total costs were down 25 and 29 percent from actual per-bushel total costs, respectively.

Table 7a—Wheat production cash costs and returns per planted acre, by region, 1994

Item	North Central	Southeast	Nothern Plains	Central and Southern Plains	Pacific	All FCRS farms
			Dollars per planted acre			
Gross value of production:						
Wheat grain	155.73	135.88	92.33	87.20	200.48	105.64
Wheat straw/grazing	27.25	4.97	0.60	4.56	1.95	4.55
Total, gross value of production	182.98	140.85	92.92	91.76	202.43	110.19
Cash expenses:						
Seed	13.42	12.78	7.83	5.09	9.62	7.46
Fertilizer	37.50	32.90	12.25	13.70	26.95	16.70
Chemicals	0.86	6.76	7.61	2.82	14.68	5.69
Custom operations	4.49	6.67	2.54	8.62	7.18	5.70
Fuel, lube, and electricity	5.15	5.52	5.82	9.80	19.79	8.55
Repairs	8.17	9.53	12.07	10.85	18.06	11.69
Hired labor	1.84	6.95	2.17	4.03	11.49	3.83
Purchased water and baling	0.73	0.30	0.03	0.06	3.11	0.36
Total, variable cash expenses	72.14	81.41	50.31	54.97	110.90	59.99
General farm overhead	8.13	3.91	4.18	5.22	9.67	5.36
Taxes and insurance	15.55	11.39	7.83	8.01	15.81	9.29
Interest	7.57	4.52	7.61	7.75	10.86	7.84
Total, fixed cash expenses	31.25	19.82	19.62	20.98	36.34	22.49
Total, cash expenses	103.41	101.22	69.93	75.95	147.23	82.48
Gross value of production less cash expenses	79.58	39.63	23.00	15.81	55.20	27.71
			Dollars per bushel			
Harvest-period price	2.91	2.89	3.31	3.06	3.34	3.16
			Bushels per planted acre			
Yield	53.44	47.03	27.85	28.46	59.96	33.40

Table 7b—Wheat production economic costs and returns per planted acre, by region, 1994

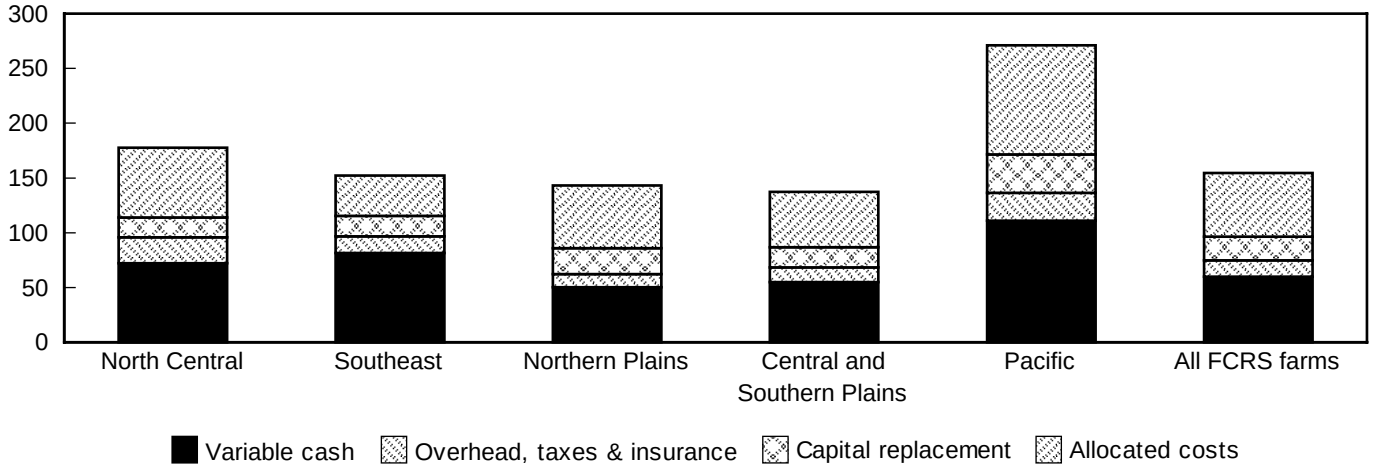
Item	North Central	Southeast	Nothern Plains	Central and Southern Plains	Pacific	All FCRS farms
			Dollars per planted acre			
Gross value of production:						
Wheat grain	155.73	135.88	92.33	87.20	200.48	105.64
Wheat straw/grazing	27.25	4.97	0.60	4.56	1.95	4.55
Total, gross value of production	182.98	140.85	92.92	91.76	202.43	110.19
Economic (full-ownership) costs:						
Variable cash expenses	72.14	81.41	50.31	54.97	110.90	59.99
General farm overhead	8.13	3.91	4.18	5.22	9.67	5.36
Taxes and insurance	15.55	11.39	7.83	8.01	15.81	9.29
Capital replacement	18.19	18.60	23.41	18.63	35.02	21.87
Operating capital	1.68	1.90	1.17	1.28	2.58	1.40
Other nonland capital	10.39	10.37	13.14	9.62	14.60	11.52
Land	42.99	18.06	37.37	30.14	69.12	36.91
Unpaid labor	8.60	6.61	5.79	9.55	13.37	8.20
Total, economic costs	177.68	152.23	143.19	137.43	271.07	154.54
Residual returns to management and risk	5.30	-11.38	-50.27	-45.67	-68.64	-44.35
			Dollars per bushel			
Harvest-period price	2.91	2.89	3.31	3.06	3.34	3.16
			Bushels per planted acre			
Yield	53.44	47.03	27.85	28.46	59.96	33.40

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Figure 9

Components of economic costs, by region, 1994

Dollars per planted acre



Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Analyzing per-bushel costs or returns for the 1994 wheat crop can describe conditions in that year, but 1994 yields were lower than expected for many wheat growers, particularly in the Northern Plains. In the 1994 survey, farm operators were also asked to give their expected yields, around which most planting decisions and early input applications were made. These expected or normal yields can be used to estimate per-bushel costs and returns and will give additional information better suited to indicate long-term conditions and trends.

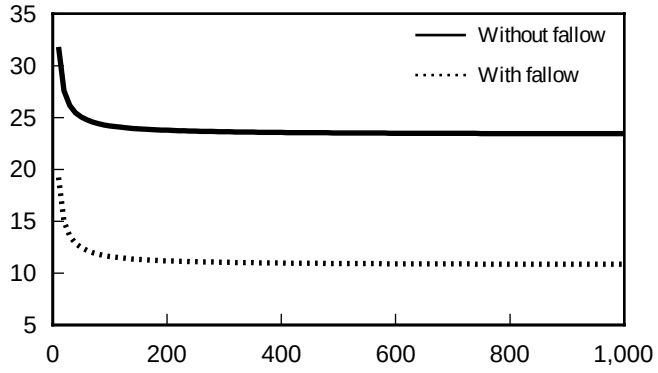
On average, the value of wheat at harvesttime covered the cash costs in every region, while it covered cash costs plus capital replacement in all regions except the Central and Southern Plains. Total economic costs were covered only in the North Central region, giving this region's wheat growers positive returns to operator-supplied management and risk. Relatively higher grain yields there and a large portion of wheat acreage harvested for straw, which has a high value as a secondary product, contributed to the positive returns.

Size-cost relationships indicate that most economies in use of fertilizers, fuels, hired labor, and custom services are realized at a relatively small wheat acreage (see the Estimated Relationship Between Size of Dryland Wheat Enterprise and ... box). The per-acre costs for these inputs level out at around 100 acres of wheat. Chemical costs, however, tend to increase until about 1,500 wheat acres. Machinery and repair costs follow the same pattern as chemicals, but total variable, fixed, and economic costs show that most economies have been obtained at 200 to 400 wheat acres. These cost-size relationships can, of course, vary among regions.

Estimated relationship between size of dryland wheat enterprise and. . .

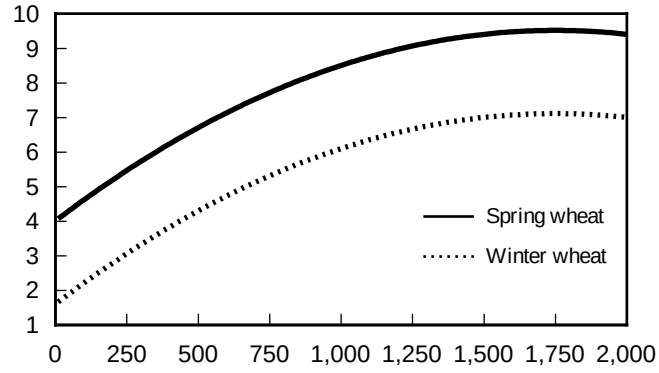
Fertilizer expenses

Dollars per acre



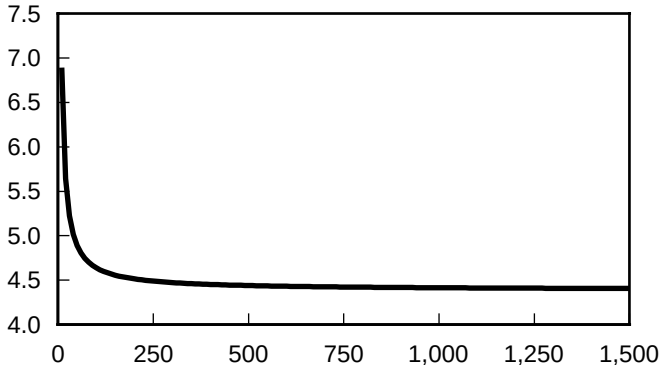
Chemical expenses

Dollars per acre



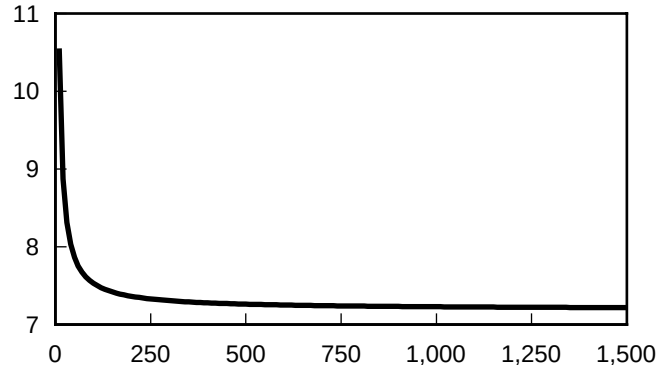
Fuel expenses

Dollars per acre



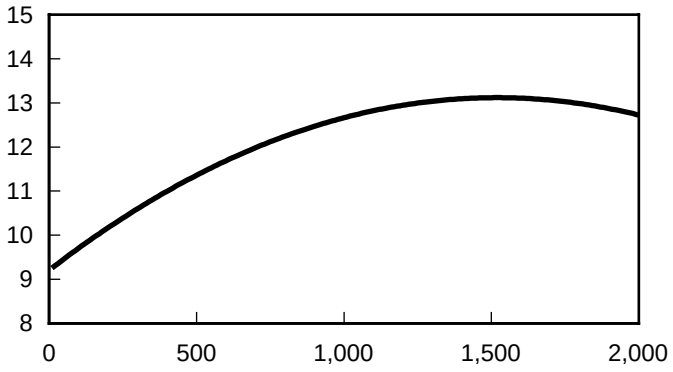
Custom expenses

Dollars per acre



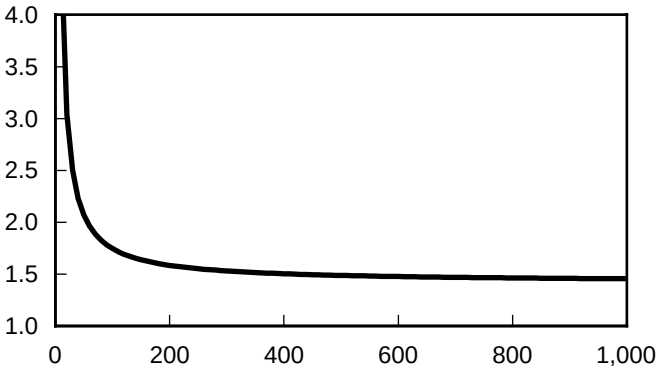
Repair expenses

Dollars per acre



Total labor hours

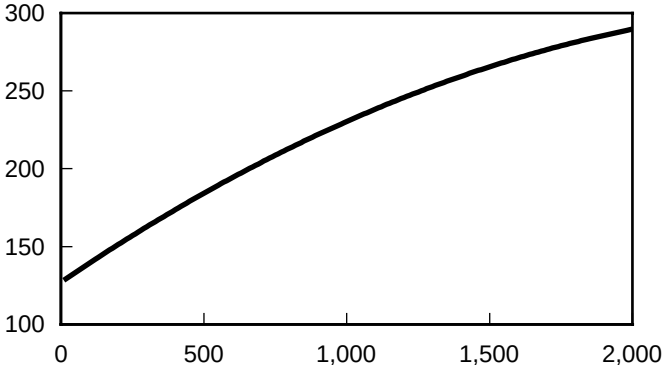
Hours per acre



Estimated relationship between size of dryland wheat enterprise and. . . (continued)

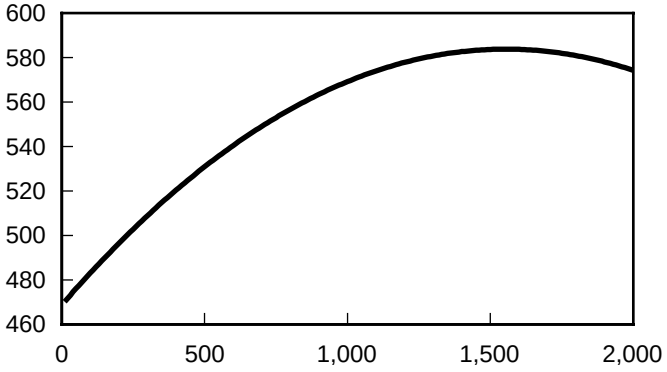
Horsepower of largest tractor

Horsepower



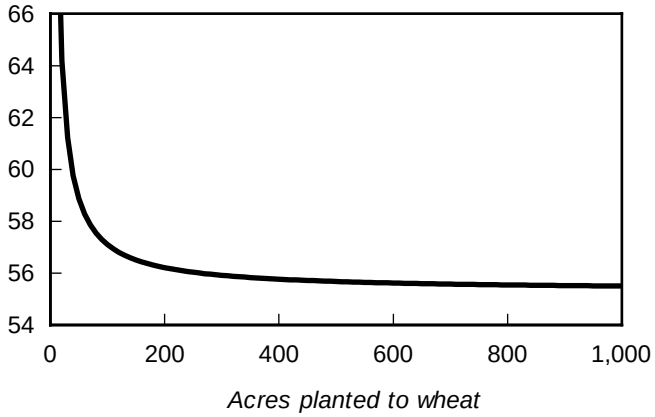
Machinery value

Dollars per acre



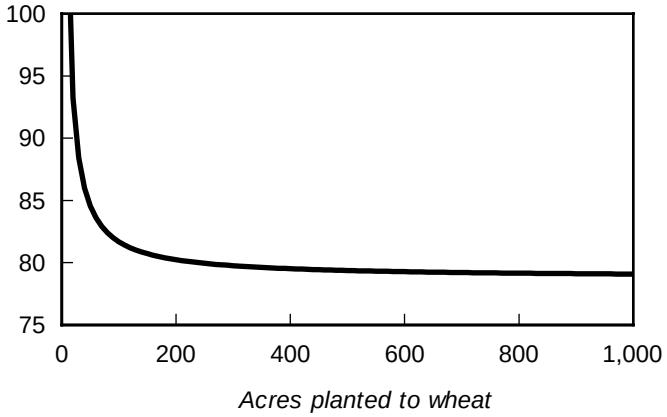
Variable cash expenses

Dollars per acre



Total cash expenses

Dollars per acre

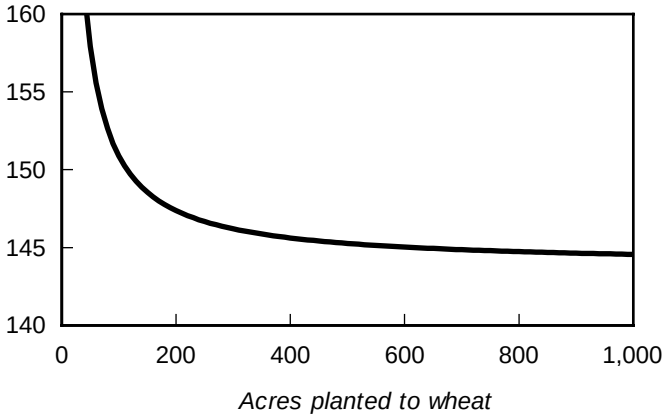


Ratio of fixed to cash expenses

Ratio

Economic costs

Dollars per acre



Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Distribution of Wheat Production Costs

Average costs of production represent a single point on the distribution of production costs and provide only limited information about the economic performance of U.S. wheat farms. Considerable variability in production costs exists among wheat growers. Analysis of the entire cost-of-production distribution enables the identification of sources of cost differences among producers, such as the effects of various farm characteristics and management practices.

To identify factors affecting production costs, wheat farms were grouped into low-, mid-, and high-cost groups. For this purpose, estimated variable cash costs were converted to a per-bushel basis (actual yield) and ranked from lowest to highest to form a weighted cumulative distribution of farms and production. The low-cost group was the 25 percent of farms with the lowest variable costs, and the high-cost group was the 25 percent of farms with the highest variable cash costs (fig. 10).

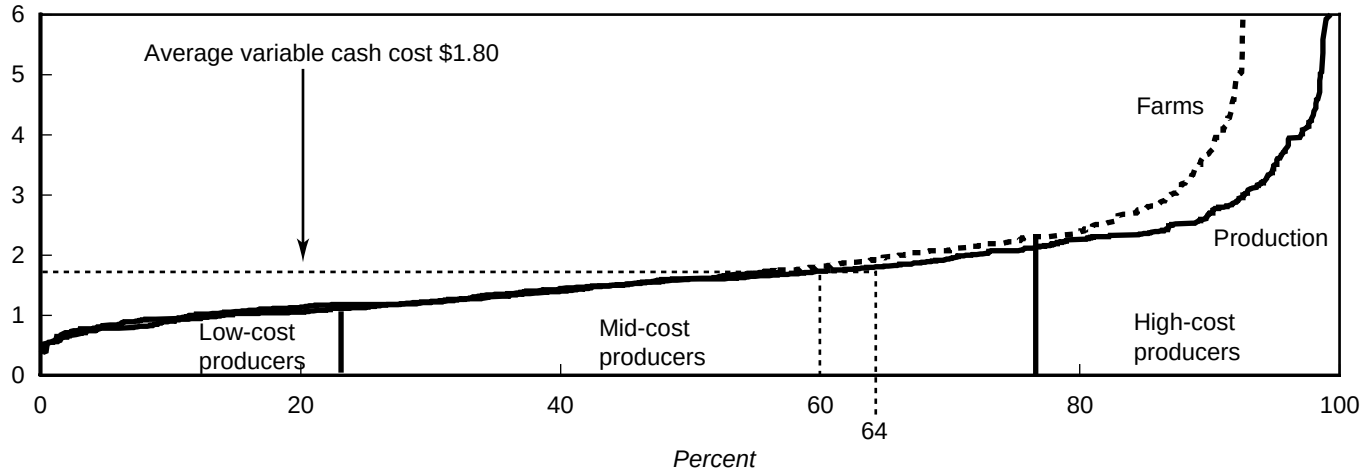
The low-cost group of farms had per-bushel variable costs of $1.12 or less and accounted for 20 percent of total production and 15 percent of wheat acreage planted in 1994. Most low-cost farms were in the North Central region (fig. 11). At the other end of the distribution, the high-cost group of farms had variable costs of $2.22 or more per bushel and accounted for 21 percent of wheat production and 33 percent of wheat acreage. Three-fourths of these high-cost growers were in the Plains regions. Note, however, that farms in the Plains regions had the largest deviation in actual yield from expected yield.

Differences between low- and high-cost farms in 1994 were attributable to yield differences, farm location, and enterprise size. Low-cost farms had average variable cash costs of $40 per planted acre, compared with $69 per acre for high-cost farms (table 8). Variable costs varied greatly among cost groups, ranging from an average $0.93 per bushel for low-cost producers to $3.21 per bushel for high-cost producers due to differences in expected and actual yields. On average, high-cost growers expected 37 bushels, but harvested 22 bushels of wheat per acre. Low-cost growers harvested an average 44 bushels per acre, 3 bushels more than they expected (table 9). Only 28 percent of the gross value of production was needed to cover variable cash costs on low-cost farms. By comparison, high-cost farms needed nearly all of their gross value of production to cover their variable cash and overhead expenses. There was not enough to cover the additional fixed cash expenses.

Figure 10

Cumulative distribution of wheat variable cash costs, 1994

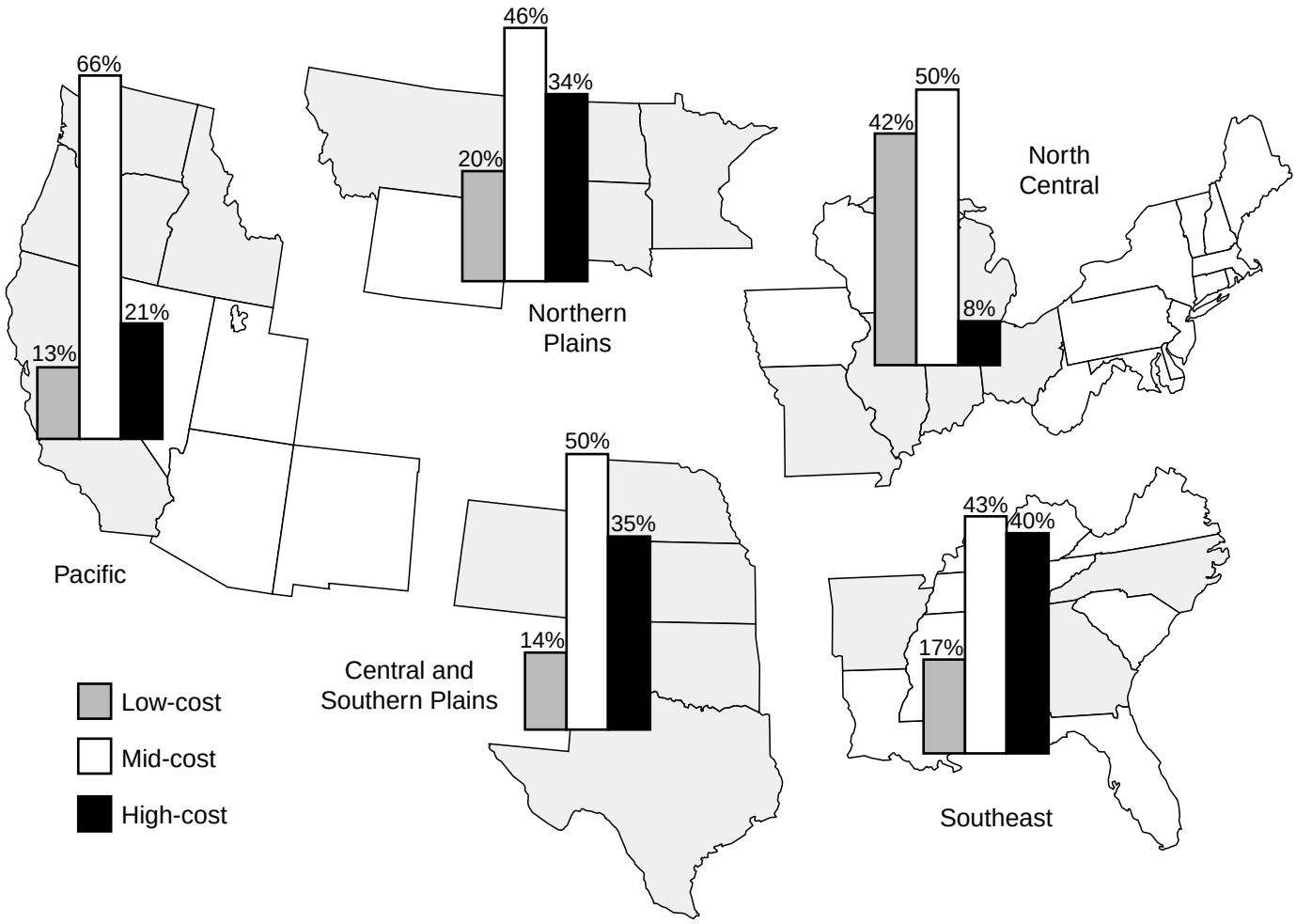
About 60 percent of Farm Costs and Returns Survey wheat farms, representing 64 percent of wheat production had variable cost at or below the average cost of $1.80 per bushel.



Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Figure 11

Distribution of farms by variable cash costs group, by region, 1994



Unshaded States are not covered in the Farm Costs and Returns Survey.
Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

As before, per-bushel costs based on actual 1994 yields provide a realistic picture of conditions in 1994. For longrun implications, however, it is better to use expected yields. Expected yields show that the Pacific region has the highest total economic costs of production, followed by the Northern Plains, Central and Southern Plains, North Central, and Southeast. When the costs are ordered from lowest to highest, per-bushel costs based on actual yields are higher than those based on expected yields. At the 1994 average variable cost of $1.43 per bushel, had expected yields been realized, 56 percent of farms producing 56 percent of U.S. wheat would have had variable costs below the average. Using expected yields, the low-cost growers would have had an average total cost of production of $2.54 per bushel, the mid-cost growers, $3.70, and the high-cost growers, $5.25. There was little difference between per-bushel costs among the different size classes of wheat acreage.

Enterprise and farm size also differed between low- and high-cost wheat farms. The average low-cost farm had less acreage overall in wheat than the average high-cost farm (table 10). Because high-cost farms were more diversified than low-cost farms, wheat contributed less to their total farm income. Only 49 percent of high-cost farms considered themselves cash grain farms, compared with 62 percent of low-cost farms. Roughly 15 percent of high-cost farms considered themselves specialized in other crops, compared with less than 5 percent of low-cost farms. About one-third of farms in both groups considered

Table 8a—Wheat production cash costs and returns per planted acre, by variable cost group, 1994

Item	Low-cost farms	Mid-cost farms	High-cost farms	All FCRS farms
		Dollars per planted acre		
Gross value of production:				
Wheat grain	135.65	120.10	69.17	105.64
Wheat straw/grazing	9.04	3.31	4.49	4.55
Total, gross value of production	144.68	123.41	73.66	110.19
Cash expenses:				
Seed	6.64	7.41	7.90	7.46
Fertilizer	10.99	18.33	16.69	16.70
Chemicals	2.36	5.51	7.47	5.69
Custom operations	3.01	5.62	7.02	5.70
Fuel, lube, and electricity	5.84	7.11	12.05	8.55
Repairs	10.17	11.88	12.07	11.69
Hired labor	1.17	3.59	5.41	3.83
Purchased water and baling	0.26	0.46	0.26	0.36
Total, variable cash expenses	40.44	59.92	68.88	59.99
General farm overhead	6.63	5.86	4.00	5.36
Taxes and insurance	9.86	9.75	8.30	9.29
Interest	8.54	8.96	5.75	7.84
Total, fixed cash expenses	25.03	24.57	18.05	22.49
Total, cash expenses	65.48	84.49	86.93	82.48
Gross value of production less cash expenses	79.21	38.93	-13.27	27.71
		Dollars per bushel		
Harvest-period price	3.09	3.17	3.21	3.16
		Bushels per planted acre		
Yield	43.93	37.88	21.55	33.40

Table 8b—Wheat production economic costs and returns per planted acre, by variable cost group, 1994

Item	Low-cost farms	Mid-cost farms	High-cost farms	All FCRS farms
		Dollars per planted acre		
Gross value of production:				
Wheat grain	135.65	120.10	69.17	105.64
Wheat straw/grazing	9.04	3.31	4.49	4.55
Total, gross value of production	144.68	123.41	73.66	110.19
Economic (full-ownership) costs:				
Variable cash expenses	40.44	59.92	68.88	59.99
General farm overhead	6.63	5.86	4.00	5.36
Taxes and insurance	9.86	9.75	8.30	9.29
Capital replacement	20.80	21.82	22.44	21.87
Operating capital	0.94	1.40	1.60	1.40
Other nonland capital	11.91	11.58	11.26	11.52
Land	46.74	41.14	25.76	36.91
Unpaid labor	8.25	9.01	6.90	8.20
Total, economic costs	145.58	160.47	149.15	154.54
Residual returns to management and risk	-0.89	-37.06	-75.48	-44.35
		Dollars per bushel		
Harvest-period price	3.09	3.17	3.21	3.16
		Bushels per planted acre		
Yield	43.93	37.88	21.55	33.40

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Table 9—Input use of wheat production operations, by variable cash cost group, 1994

Item	Unit	Low-cost farms	Mid-cost farms	High-cost farms	All FCRS farms
Wheat yield:					
Actual yield	*Bushels/acre*	43.93	37.88	21.55	33.40
Expected yield	*Bushels/acre*	40.92	40.72	37.30	39.62
Seed:					
Rate-one time	*Bushels/acre*	1.31	1.40	1.49	1.42
Acres reseeded	*Percent of acres*	0.16	1.26	5.28	2.42
Home-grown seed	*Percent of seed*	36	47	47	45
Fertilizer use:					
Any fertilizer	*Percent of farms*	91	97	83	92
Nitrogen	*Percent of farms*	90	97	82	91
Phosphorus	*Percent of farms*	68	72	55	67
Potassium	*Percent of farms*	47	42	31	40
Manure	*Percent of farms*	*	*	7	5
Fertilizer application rates:					
Nitrogen	*Pounds/acre*	43.46	59.20	58.27	56.56
Phosphorus	*Pounds/acre*	27.40	22.49	18.04	21.75
Potassium	*Pounds/acre*	14.44	9.45	4.26	8.48
Manure	*Tons/acre*	0.04	0.05	0.06	0.05
Chemical use:					
Any chemicals	*Percent of farms*	31	50	54	46
Herbicides	*Percent of farms*	31	49	50	45
Insecticides/fungicides	*Percent of farms*	*	*	8	*
Herbicide	*Acre treatments*	0.66	0.77	0.83	0.77
Insecticides/fungicides	*Acre treatments*	0	0.04	0.08	0.05
Tillage system:					
Conventional with moldboard plow	*Percent of farms*	11	6	11	9
Conventional without moldboard plow	*Percent of farms*	58	69	62	64
Mulch tillage	*Percent of farms*	17	15	23	18
No-till	*Percent of farms*	15	10	*	10
Custom operations:					
Any custom operations	*Percent of farms*	41	69	66	61
Land preparation/cultivation	*Percent of farms*	6	13	17	13
Planting	*Percent of farms*	*	*	8	*
Fertilizer/chemical application	*Percent of farms*	33	58	47	49
Harvesting/hauling	*Percent of farms*	10	25	33	23
Fuel use:					
Diesel	*Gallons/acre*	3.98	4.82	5.36	4.87
Gasoline	*Gallons/acre*	2.25	2.58	2.62	2.55
LP gas	*Gallons/acre*	0.01	0.09	0.27	0.14
Natural gas	*1,000 cubic feet/acre*	0.06	0.04	0.64	0.24
Electricity	*Kilowatt hours/acre*	0.02	0.08	0.29	0.14
Labor use:					
Unpaid labor	*Hours/acre*	1.35	1.42	1.13	1.31
Paid labor	*Hours/acre*	0.27	0.38	0.44	0.39

* = 0.1 to less than 5 percent. Totals may not add to 100 percent due to omission of a category or rounding error.
Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Table 10—Characteristics of wheat farms, by variable cost group, 1994

Item	Unit	Low-cost farms	Mid-cost farms	High-cost farms	All FCRS farms
FCRS wheat farms	*Number*	66,524	132,167	66,553	265,245
FCRS share--					
Wheat acreage	*Percent*	15	52	33	100
Wheat production	*Percent*	19	59	21	100
Size:					
Operated	*Acres*	998	959	1,329	1,062
Planted wheat	*Acres*	126	224	280	214
Harvested wheat	*Acres*	126	222	238	202
Sales class:					
$49,999 or less	*Percent of farms*	42	30	39	35
$50,000-$99,999	*Percent of farms*	13	21	22	19
$100,000-$499,999	*Percent of farms*	39	45	35	41
$500,000 or more	*Percent of farms*	6	5	*	5
Value of production:					
Wheat production value	*Dollars per farm*	18,148	28,498	19,623	23,675
Farm production value	*Dollars per farm*	199,545	174,140	151,818	174,910
Wheat tenure:					
Owned	*Percent of farms*	53	37	37	39
Cash-rented	*Percent of farms*	18	21	36	25
Share-rented	*Percent of farms*	29	42	27	35
Production practices:					
Winter wheat	*Percent of acres*	69	65	60	64
Spring wheat	*Percent of acres*	31	35	40	36
Irrigated	*Percent of acres*	*	*	8	
Double-cropped	*Percent of acres*	6	6	5	6
Fallow	*Percent of acres*	40	37	17	31
Straw	*Percent of acres*	10	7	*	6
Grazing	*Percent of acres*	*	6	15	9
Previous crop:					
Barley/oats	*Percent of farms*	0	*	*	*
Corn	*Percent of farms*	16	8	11	11
Soybeans	*Percent of farms*	44	34	12	31
Wheat	*Percent of farms*	6	15	32	17
Fallow	*Percent of farms*	17	21	15	19
Crop rotation:					
Continuous wheat	*Percent of farms*	5	13	24	14
Fallow-wheat	*Percent of farms*	9	13	12	12
Fallow-other	*Percent of farms*	*	7	*	5
Corn-soybeans	*Percent of farms*	*	6	*	4
Corn-other	*Percent of farms*	13	*	11	7
Soybeans-soybeans	*Percent of farms*	13	7	*	7
Soybeans-corn	*Percent of farms*	25	21	6	18
Production specialty:					
Cash grains	*Percent of farms*	62	67	49	61
Other crops	*Percent of farms*	*	7	13	8
Livestock	*Percent of farms*	35	24	37	30
Livestock:					
Hogs	*Percent of farms*	24	15	9	16
Beef cattle	*Percent of farms*	52	46	49	48
Dairy cattle	*Percent of farms*	18	7	9	10
Wheat for farm use	*Percent*	4	*	6	*
Participated in wheat program	*Percent of farms*	57	76	75	71
Operator characteristics:					
Individual farm organization	*Percent of farms*	79	87	88	85
Partnership	*Percent of farms*	16	8	8	10
Farming as major occupation	*Percent of farms*	89	84	84	85
Under 50 years of age	*Percent of farms*	43	47	42	44
Completed college	*Percent of farms*	40	46	40	43

* = 0.1 to less than 5 percent. Totals may not add to 100 percent due to omission of a category or rounding error.
Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

themselves livestock farms. However, a larger share of low-cost farms reported hogs than did high-cost farms (24 percent versus 9 percent). High-cost farms grazed 15 percent of wheat acreage, as opposed to less than 5 percent for low-cost farms.

Low-cost producers reported using less nitrogen (43 pounds per acre) than high-cost producers (58 pounds). Low-cost producers applied 27 pounds of phosphorus and 14 pounds of potassium per acre, about 10 pounds more of both nutrients per acre than the high-cost farms. Lower nitrogen use on low-cost farms was due to natural buildup of nitrogen on land previously fallowed. Forty percent of wheat acreage was previously fallowed on low-cost farms, compared with only 17 percent on high-cost farms. This resulted in a lower fertilizer expense ($11 versus $17 per acre).

Chemicals were used more on high-cost farms. Fifty-four percent of the high-cost farms used chemicals, compared with 31 percent of the low-cost group. As a result, chemical expenses on the high-cost farms were three times those of the low-cost group ($2.36 versus $7.47 per acre).

Differences in yield, location, enterprise, and input use were distinguishing characteristics of low- and high-cost farms. Low yields, combined with heavier input use, raised per-bushel costs on high-cost farms considerably (table 9).

Characteristics Significantly Different Between Low- and High-Cost Farms

Landownership: On low-cost farms, the average operator owned more wheat acreage and rented less acreage on a cash basis than did high-cost farms.

Irrigation: Low-cost farms irrigated less wheat acres than did high-cost farms.

Specialization: High-cost farms were less specialized in cash grains but more specialized in other crops.

Acreage abandoned: About 13 percent of acreage on high-cost farms was abandoned (after incurring some production expenses), thereby raising per-bushel variable costs; low-cost farms reported no abandoned acreages.

Crop rotation: Growing continuous wheat was dominant on the high-cost farms, in contrast to wheat-soybean-corn rotation on the low-cost farms.

Seed: Low-cost farms had lower seeding rates but used less home-grown seed.

Fuel expense: Fuel expenses per acre for high-cost farms were twice as high as on the low-cost farms ($12 versus $6 per acre).

Labor: High-cost farms had more hired help. Per-acre labor expenses were about five times higher than for the low-cost farms.

Custom operations: The use of custom operations, particularly for fertilizer and chemical application, harvesting, and land preparation, was more common on high-cost farms. Custom costs on the high-cost farms totaled $7 per acre, compared with $3 per acre on the low-cost farms.

Measuring Unit Cost Variation Among Wheat Growers

Variation in production costs arises from several sources. Some are interrelated, while others are beyond the operators' control. In this report, sources of cost variation can be divided into four categories: (1) random cost variations that vary by year and location; (2) quality of the resources used; (3) input prices, and (4) farm and operator characteristics.

Wheat production is subject to a significant amount of variation in factors beyond the farm operators' control. The most influential factor is weather. As noted earlier, most of the 1994 wheat crop was produced on dryland under a variety of weather and soil conditions. The effects of weather on wheat yields can be substantial in any given year depending on location and type of wheat grown, and thus result in a major source of cost variation among farm operators. The variability in yields is also influenced by the differences in farm resources used in production. For example, the difference in land quality is a major source of cost variation. Wheat grown on irrigated land has less cost variation than that on dryland due to less variability in access to water during the growing season. Differences in production practices (such as double-cropping and fallow) and fluctuations in input prices may affect the mix and level of inputs used.

Costs also vary by farm characteristics, such as size, production specialty, land tenure, and availability of capital. Operator characteristics (age and educational level of operator) affect costs some, but affect management decisionmaking more.

Farm Operator Costs and Returns Accounts

To measure the influence of different variables on the cash costs of growing wheat, we must depart from traditional USDA enterprise cost and return accounting (Morehart et al., 1992). Estimates discussed thus far have included the operators' and landlords' costs and returns. Production costs paid by a landlord as part of the rental arrangement are added to the operator's costs and subtracted from the rental value of land. These traditional accounts treat all resources used in production as if the operation fully owned them and charged an opportunity cost for their use. For example, the cost of land used in the production of a commodity is charged the income that could be earned by renting the land to another producer. An opportunity cost is also charged for resources such as capital and unpaid labor at a rate they could have earned in alternative uses. Government program costs and returns are not included in the estimates.

Because USDA's accounts include economic costs and returns to resources regardless of ownership, the enterprise cost-of-production account is called a "sector account." This implies that the account includes only the costs of having these resources invested in the farm sector and production of a specific commodity rather than elsewhere in the economy (USDA, ERS, 1997a).

Enterprise budgets developed to provide a wheat production sector perspective may not be appropriate for other data users analyzing a specific situation. For an analysis of a specific situation, the enterprise cost account developed will likely require different details and structure. The traditional account includes imputed opportunity costs to nonland capital, land, and unpaid labor, using State or regional average prices. However, each farmer has a unique combination of resources and faces somewhat unique economic conditions, such as land quality, labor skill, and local job opportunities, not reflected in State averages. Consequently, the enterprise economic costs may not be appropriate to analyze individual farms according to costs, efficiency, or other criteria. Also,

Comparison of Farm-Operator and Sectoral Approaches

The farm-operator approach differs from the sectoral approach in two important respects. In the farm-operator approach, only farm operators' costs and returns are considered, while landlords' contributions are excluded. (On share-rented acreage, only the farm operator's share of input costs and returns is included.)

The assumption of full resource ownership is removed:

Farm operators are charged only the costs incurred for using the resources in production. (Landownership costs include only real estate taxes and interest on real estate debt.)

Cash-rented land is charged according to the amount of cash-rent paid.

comparisons among farm operators cannot be examined without knowing the landownership and rental cost relationships between operator and landlord and their shares in costs and returns.

To analyze farm operators' production costs and examine farm and operator characteristics as sources of cost variation, an alternative approach to the traditional USDA accounting method has been developed that focuses only on production costs and returns of farm operators (McBride, 1994b). This approach was first used by McBride in an analysis of production costs for corn producers (McBride, 1994c). This estimation methodology has since been used to develop estimates of farm operator costs and returns for barley producers (Ali and Brooks, 1996).

Wheat Farm Operator Production Costs and Returns

The average operator's variable cash cost of producing wheat was about $58 per acre, while total cash and noncash costs were $107 per acre. Production costs at the regional level varied from $92 per acre for wheat operators in the Central and Southern Plains to $178 per acre for operators in the Pacific region. The operator cost accounts showed that U.S. farm operators received an average of 29 bushels from a total yield of 33 bushels per planted acre (table 11). The remaining 4 bushels of wheat per acre were the landlord share.

On a per-bushel basis, the average farm operator's cost was $3.74, which was above the value of wheat at harvesttime. Farm operators in the North Central region had the lowest costs at $2.71 per bushel, while the highest per-bushel costs were estimated for the Central and Southern Plains operators, at $4.03.

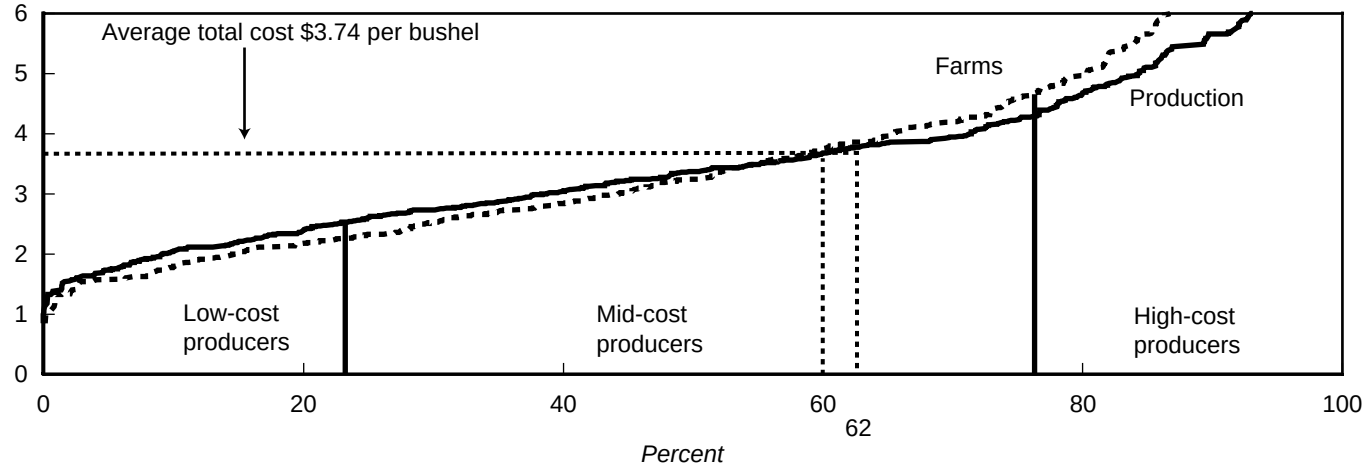
Farm operators' residual returns to equity, unpaid labor, risk, and management were positive only in the eastern regions. The highest positive residual returns were estimated for the North Central region at $36 per acre due to relatively higher wheat yields and high straw value. Wheat operators in the Pacific region reported negative residual returns at minus $11 per acre, while, in the Plains region, residual returns averaged minus $17 per acre.

Estimated farm operator total costs (cash and noncash) were converted to a per-bushel basis and ranked from lowest to highest to construct a weighted, cumulative distribution of farms and production (fig. 12). Twenty-five percent of wheat farm operators had total costs of $2.33 or less per bushel. These low-cost operators planted wheat on 12 percent of total farm acreage and produced about 18 percent of U.S. wheat production. At the other end of the distribution, 25

Figure 12

Cumulative distribution of wheat operators and production, by total costs, 1994

About 60 percent of Farm Costs and Returns Survey wheat farm operators, representing 62 percent of wheat production, had total costs at or below the average cost of $3.74 per bushel.



Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

percent of farm operators produced wheat at a cost of $4.59 or more. High-cost operators accounted for about 34 percent of total planted acreage and 21 percent of wheat production.

Differences in actual and expected yields determine whether farm operators are low- or high-cost wheat producers (table 12). The expected yield reported by producers in the Farm Costs and Returns Survey is the yield on which production and input decisions were made. U.S. wheat farm operators expected 35 bushels per acre in 1994. They made their decisions about level and mix of production inputs based on these expected yields and on their unique resource and management skills. Low-cost operators, however, harvested an average 43 bushels per acre, about 5 bushels more than they expected because of favorable weather and good management decisions. Operators in the high-cost group expected 32 bushels, but harvested only 17 bushels of wheat per acre. As a result, high-cost operators produced wheat at $6.55 per bushel, compared with $1.91 per bushel for low-cost operators.

Influence of Farm and Operator Characteristics

Linear regression analysis (weighted least squares) was used to examine the statistical association between the per-unit production costs and several farm and operator characteristics (for details, see the Sources of Variation in Production Costs box). To measure the

Table 11—Farm operator wheat production cash costs and returns per planted acre, by region, 1994

Item	North Central	Southeast	Nothern Plains	Central and Southern Plains	Pacific	All FCRS farms
			Percent			
Number of farm operators	33.90	5.90	23.00	31.00	6.10	100.00
			Bushels per planted acre			
Yield	53.44	47.03	27.85	28.46	59.96	33.40
Farm operator's share	46.99	43.62	25.86	22.72	49.47	28.77
			Dollars per planted acre			
Gross value of production:						
Wheat grain	137.06	125.58	85.74	69.61	165.10	91.09
Wheat straw/grazing	26.81	4.97	0.60	4.33	1.76	4.40
Total, gross value of production	163.86	130.56	86.34	73.93	166.86	95.49
Cash expenses:						
Seed	12.34	12.48	7.77	5.00	9.20	7.26
Fertilizer	34.58	32.03	12.00	11.55	24.54	15.27
Chemicals	0.81	6.74	7.49	2.45	13.82	5.42
Custom operations	4.34	6.66	2.54	8.43	7.06	5.60
Fuel, lube, and electricity	5.14	5.52	5.82	9.59	19.68	8.46
Repairs	8.17	9.53	12.07	10.83	17.82	11.66
Hired labor	1.77	6.49	2.02	3.77	10.98	3.61
Purchased water and baling	0.73	0.30	0.03	0.05	2.84	0.34
Fixed cash expenses:						
General farm overhead	8.17	4.03	4.13	5.13	9.01	5.26
Real estate and property taxes	6.43	3.03	2.14	1.78	3.49	2.47
Insurance	3.32	2.44	3.16	2.73	5.52	3.17
Interest	7.52	4.64	7.56	7.56	10.53	7.72
Land rent	15.88	16.86	13.02	3.79	7.52	9.14
Noncash expenses:						
Replacement	18.19	18.60	23.41	18.63	35.02	21.87
Hired labor benefits	0.07	0.46	0.15	0.26	0.51	0.23
Summary of expenses:						
Variable cash	67.89	79.75	49.74	51.68	105.94	57.61
Fixed cash	41.32	31.00	30.01	20.99	36.08	27.75
Noncash	18.26	19.05	23.55	18.89	35.53	22.10
Total	127.47	129.80	103.30	91.56	177.55	107.46
Residual returns to equity, unpaid labor, management, and risk	36.40	0.75	-16.96	-17.62	-10.68	-11.97

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

extent to which each characteristic influenced production costs, the sample variation of production costs per unit was decomposed into the portion attributable to each characteristic (see Kmenta, 1971, p. 410). Also given are coefficients of separate determination accounted for by each variable in the regression.

Wheat production costs were expressed on per-bushel of expected-yield basis. Expected yields were reported in the survey. Expressing costs per unit of expected yield reduces the effects of factors during the growing season that are beyond the operator's control, such as weather and weed and pest infestations. Also farmers plan based on their expected yield, given the unique resource capabilities of individual farm operations and the selected input mix. Because production costs include only that portion paid by farm operators, expected yield on share-rented acreage includes only the portion of production received by the farm operator.

Several factors affecting the unit cost among U.S. wheat farmers are given in table 13. Size of the wheat enterprise, as measured by planted acreage, is expected to be inversely related to unit cost, because, as

Table 12—Farm operator wheat production cash costs and returns per planted acre, by total cost group, 1994

Item	Total cost group		
	Low-cost operators	Mid-cost operators	High-cost operators
		Percent	
Number of farm operators	25.00	50.00	25.00
		Dollars per planted acre	
Gross value of production:			
Wheat grain	132.24	104.77	55.37
Wheat straw/grazing	12.22	2.79	4.20
Total, gross value of production	144.47	107.56	59.58
Cash expenses:			
Seed	6.68	7.45	7.17
Fertilizer	14.07	16.13	14.34
Chemicals	2.71	5.41	6.38
Custom operations	6.81	6.20	4.23
Fuel, lube, and electricity	4.82	8.00	10.43
Repairs	8.54	11.72	12.66
Hired labor	1.81	3.51	4.39
Purchased water and baling	0.34	0.50	0.09
Fixed cash expenses:			
General farm overhead	4.92	5.49	5.03
Real estate and property taxes	4.29	2.51	1.76
Insurance	2.65	3.42	2.97
Interest	5.84	8.23	7.56
Land rent	2.00	8.98	11.86
Noncash expenses:			
Replacement	17.19	21.72	23.74
Hired labor benefits	0.06	0.21	0.30
Summary of expenses:			
Variable cash	45.78	58.91	59.69
Fixed cash	19.70	28.63	29.17
Noncash	17.25	21.93	24.04
Total	82.73	109.47	112.91
Residual returns to equity, unpaid labor, management, and risk	61.74	-1.91	-53.33
		Dollars per bushel	
Total costs:			
Actual yield	1.91	3.33	6.55
Expected yield	2.26	3.08	3.58

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

demonstrated previously, large farms can spread the cost of fixed inputs, such as machinery and equipment, over more units of output (also see Madden, 1967). Price discounts are also offered to farm operators who purchase inputs in large quantities (see Smith et al., 1984 and 1986).

Specialization in wheat production, as measured by the proportion of operated acreage planted to wheat, is also expected to relate inversely to production costs. Operators of more specialized farms are expected to develop greater managerial skills and be more aware of cost-saving production techniques unique to that particular commodity than less specialized operators.

The effect of land tenure, measured as a proportion of wheat acreage cash- and share-rented, could be positive or negative depending on the relative costs of landownership and rental arrangements. Farmers with a large proportion of their acreage irrigated are expected to have high total production costs due to intensive use of inputs. However, unit cost may

Sources of Variation in Production Costs Used in This Report

Attributes of Wheat Production	Unit	Variable name
Wheat acres planted	*Hundreds*	APL
Winter wheat acres	*Percent of acreage*	PCTWW
Irrigation	*Percent of acreage*	PCTIRR
Summer fallow	*Percent of acreage*	PCTFAL
Double-cropping	*Percent of acreage*	PCTDC
Rotation	*1 = other crops; 0 = otherwise*	ROTATOH
Home-grown seed	*Percent of seed*	PCTHG
Nitrogen use	*Pounds per acre*	QNAC
Tillage and planting	*Hours per acre*	TLHRAC
Custom harvest	*Percent of acreage*	PCTCUH
No-till	*Percent of acreage*	PCTNTL
Labor use	*Hours per acre*	LHRAC
Farm Characteristics		
Cash-rented	*Percent of acreage*	PCTCRE
Share-rented	*Percent of acreage*	PCTSRE
Specialization	*Percent of operated acres in wheat*	PCTWHT
Capitalization	*Value of machines per acre, in 100*	MCHVAC
Debt-to-asset	*Ratio*	DA
Farm Operator Characteristics		
Major occupation	*1 = farming; 0 = otherwise*	OCUP
Age	*1 = 50 years of age or more; 0 = otherwise*	AGE
Education	*1 = high school education; 0 = otherwise*	EDCL

The variables which had the greatest influence on variations in per-bushel production costs were:

Value of machines per acre
Share-rent
Custom harvest
Irrigation
Cash-rent

Together these five variables accounted for 90 percent of the variation in per-bushel production costs. Machine value per acre alone explained 44 percent of the variation.

Variance effects for the variables used are shown in table 15.

Table 13—Mean and coefficient of variation of the sample variable, U.S. wheat farm operators, 1994

Variable name	Unit	Mean	Coefficient of variation
			Percent
EXTCBU	*Total cost per bushel of expected yield*	2.997	2.47
APL	*Wheat acres (Hundreds)*	*2.136*	*6.73*
ROTATOH	*1 = rotation with other crops, 0 = otherwise*	0.829	2.34
PCTHG	*Percent of home-grown seed*	0.296	8.24
QNAC	*Pounds of nitrogen per acre*	60.922	4.37
TLHRAC	*Tilling/planting hours per acre*	0.767	25.57
PCTCUH	*Percent of custom acres*	17.482	12.11
LHRAC	*Labor hours per acre*	2.442	9.92
PCTIRR	*Percent of irrigated acres*	4.512	14.15
PCTFAL	*Percent of fallow acres*	20.529	11.33
PCTDC	*Percent of double-cropped acres*	9.297	12.29
PCTNTL	*Percent of no-till acres*	12.143	13.86
PCTWW	*Percent of winter wheat acres*	77.730	3.18
PCTSRE	*Percent of share-rented acres*	26.999	8.35
PCTCRE	*Percent of cash-rented acres*	19.706	10.15
PCTWHT	*Percent of operated acres in wheat*	22.280	5.64
MCHVAC	*Machine value per acre*	5.279	2.42
DA	*Ratio*	0.174	7.72
AGE	*1 = 50 years or more of age, 0 = otherwise*	0.555	5.86
EDCL	*1 = high school education, 0 = otherwise*	0.570	5.38
OCUP	*1 = major occupation is farming, 0 = otherwise*	0.850	2.52

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

decline if yield increases more than costs. Producers who rotate wheat with other crops are expected to have low unit costs. Reductions in costs due to crop rotation depend on the type of crop grown. For example, planting wheat after soybeans (a legume crop) will reduce nitrogen fertilizer use, while rotating wheat with row crops like corn will reduce chemical use due to the break in pest and insect life cycles. Farm operators using a large proportion of home-grown seed are expected to have lower costs than those using purchased seed. Usually, extensive use of inputs, such as nitrogen, machinery, and labor, can be positively related to unit cost. The practice of double-cropping may increase unit costs through supplying inputs to two crops. Planting wheat on fallow land may lower the input costs mainly because of less need for nitrogen and chemical use. Among custom operations, harvesting will have a measurable influence on unit cost.

The effects of financial conditions on unit costs were also examined. We used: (1) degree of capitalization, as measured by the average value of machines invested in wheat production; and (2) farm debt-to-asset ratio as our measure of financial condition of the farm. We expected all financial measures to be positively related to unit cost (as degree of capitalization or debt-asset ratio increases, unit costs are expected to increase as well).

Farm operator characteristics include major occupation, age, and education. Major occupation is defined as the job, farming or otherwise, on which the operator spent most of his/her time during 1994. Farm

operators whose major occupation was farming are expected to have lower production costs than others. The influence of age on unit production costs is difficult to examine. Younger producers may be more willing to try new cost-saving production techniques because of their long-planning horizon that makes them more likely to be risk-takers than their older counterparts. However, younger farmers more often require debt financing, which increases unit cost. Education is expected to be negatively related to unit production costs, measured as those who graduated from high school or college and otherwise (Khaldi, 1975; and Rahm and Huffman, 1984). More educated farmers tend to invest in cost-reducing technologies and to allocate inputs more efficiently, thereby reducing production costs.

Table 13 shows the means and coefficient of variation of variables used in the regression at the U.S. level. As discussed earlier in this report, location is a major source of cost variation that influences land quality, production practices, type of wheat grown, and input use.

The relationship between costs per bushel of expected yield and several farm and operator characteristics was estimated for wheat farm operators. While the estimated coefficients in table 14 describe the change in wheat production cost per bushel from a unit change in each variable, the t-statistics suggest which estimated coefficients are significantly different from zero. The R-squared of 0.33 suggests that explanatory variables used in the regression explained 33 percent of the variation in the unit cost of wheat farm operators. Among the farm structural characteristics, land tenure, irrigation, custom harvesting, and capitalization were significant determinants of unit production cost.

As expected, land-tenure, capitalization, and custom harvesting were positively associated with unit cost. Planting wheat on either share- or cash-rented land resulted in higher unit cost than on owned land. Unit costs were higher on share-rented land than on cash-rented land. Increasing the wheat acreage custom-harvested by 1 percent raised the unit cost by 1 cent. Use of irrigation significantly lowers the unit cost. The coefficient on irrigation suggested that unit costs will decrease by 1.51 cents for every percentage-point increase in irrigated acres. Use of home-grown seed was not significant and was negatively related to unit cost. Coefficients on nitrogen use, tillage hours, labor hours, and planting wheat on fallow and double-cropped land are not significant, but all are positively related to the unit cost. Coefficient on no-till is negatively related to unit cost, implying that operators using no-till had lower unit costs than those using conventional tillage.

Operator characteristics were not significantly related to unit cost (table 14). The coefficient on the age variable suggests that age was positively related to unit cost, which also implies that operators older than 50 years have a higher unit cost than younger operators. Operators' major occupation and education level were negatively related to unit cost, meaning that those whose major occupation was farming and those who had the most education had lower unit costs.

To examine how each variable used in the regression contributed to the variation in the unit costs, decomposition of unit cost variation and coefficient of separate determination that contributed to each variable used in the regression are given in tables 15 and 16. Variance effects suggest how much variation in unit cost can be attributed solely to each explanatory variable. The percentage of total variance effects for each variable suggests each variable's contribution to unit cost variation in relation to other variables.

Among all variables, capitalization (average machine investment per wheat acre) had the greatest influence on unit cost variation, explaining 44 percent of total variance effects. Share-rent and custom harvest were next (accounting for 15 percent), followed by cash-rent and irrigation (accounting for 8 to 10 percent of variance effect). Specialization, labor, and debt-to-asset ratio accounted for 1 to 3 percent of the variance effects. Size, tillage, type of wheat, fallow, double-cropping, and operator's occupation and education had little influence on the unit cost (explaining less than 1 percent of the variance effect).

Table 16 shows the results relating to the coefficient of separate determination for variables influencing the unit cost of U.S. wheat production. Based on this statistic, capitalization is the most important variable explaining the variation in the unit cost (0.158). The coefficients of separate determination on share-rented land, custom harvesting, irrigation, and cash-rent are at 0.0792, 0.0349, 0.0285, and 0.0209, respectively, showing measurable influence on the unit cost of wheat production.

Table 14—Regression estimates of the unit cost for U.S. wheat farm operators, 1994

Variable	Coefficient estimates	t-statistics
INTERCEPT	1.0863 ***	3.08
APL	-0.0086	-0.59
ROTATOH	0.0253	0.15
PCTHG	-0.1319	-1.13
QNAC	0.0011	0.73
TLHRAC	0.0164	0.21
PCTCUH	0.0101**	4.20
LHRAC	0.0547	1.54
PCTIRR	-0.0151***	-3.63
PCTFAL	0.0012	0.73
PCTDC	0.0025	1.40
PCTNTL	-0.0017	-1.22
PCTWW	-0.0007	-0.59
PCTSRE	0.0097***	5.42
PCTCRE	0.0076***	5.67
PCTWHT	0.0043	1.17
MCHVAC	0.2339***	6.34
DA	0.5261	1.61
AGE	0.0483	0.41
EDCL	-0.0790	-0.68
OCUP	-0.1977	-0.89
F-statistic	9.37	
R-squared	0.33	

** = Significant at the 5-percent level.
*** = Significant at the 1-percent level.
Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Regional Differences in Unit-Cost Variation

Weighted least-squares regression analysis is also used to examine and test the relationship between unit cost of production and selected variables on farm and operator characteristics in each region. For this purpose, the unit cost equation estimated in each region includes only factors important to all regions. Factors specific to a particular region, such as irrigation in the Pacific, fallow in the Pacific and Northern Plains, double-cropping in the Southeast, and no-till in the Southeast and North Central regions are excluded (table 17). The sample variation of unit cost is also decomposed into the portion attributable to each variable (table 18). The coefficients of separate determination for each variable in the regression are given in table 19. Differences in several attributes of wheat production in the regions are identified by testing for differences in coefficients estimated for each region. For this purpose, a t-statistic for testing

Table 15—Contribution of factors to the unit cost variation for wheat operators, 1994

Variable	Variance effect	Percent of variance effect
APL	0.0009	0.10
ROTATOH	0	0.01
PCTHG	0.0032	0.34
QNAC	0.0024	0.26
TLHRAC	0.0006	0.06
PCTCUH	0.1424	14.91
LHRAC	0.0287	3.01
PCTIRR	0.0915	9.58
PCTFAL	0.0022	0.24
PCTDC	0.0047	0.50
PCTNTL	0.0031	0.33
PCTWW	0.0008	0.09
PCTSRE	0.1447	15.15
PCTCRE	0.0734	7.69
PCTWHT	0.0089	0.94
MCHVAC	0.4164	43.59
DA	0.0234	2.46
AGE	0.0005	0.06
EDCL	0.0015	0.16
OCUP	0.0050	0.52
Total	0.9555	100.00

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

the equivalence of two regressions is used to measure significant differences (see the appendix).

Usually unit cost is significantly different between the Northern Plains and Central and Southern Plains and the North Central and Southeast. The unit cost in the Central and Southern Plains region is significantly lower from the unit cost in the Pacific and Southeast regions, but not significantly different from that of the Northern Plains. The North Central region usually has a significant cost advantage over the Southeast.

Regression coefficients and their significance levels by region are given in table 17. Table 20 provides t-statistics that test for significant differences between the regions. These t-statistics suggest whether the estimated coefficients in a region are different from the estimated coefficients in other regions. For example, the t-statistic between the Pacific and Southeast regions for the coefficients on rotation shows a significant difference. Also this shows that the influence of rotation on unit cost is different in the Pacific region than in the Southeast. Rotation with

Table 16—Coefficient of separate determination for factors affecting farm operators' unit cost, 1994

Variable	Coefficient of separate determination
APL	-0.0026
ROTATOH	-0.0002
PCTHG	0
QNAC	0.0032
TLHRAC	0.0006
PCTCUH	0.0349
LHRAC	0.0146
PCTIRR	-0.0285
PCTFAL	0.0032
PCTDC	0.0015
PCTNTL	0.0036
PCTWW	0.0002
PCTSRE	0.0792
PCTCRE	0.0209
PCTWHT	0.0129
MCHVAC	0.1586
DA	0.0199
AGE	-0.0017
EDCL	0.0033
OCUP	0.0039
Total	0.3280
Unexplained	0.6719

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

other crops in the Southeast reduced unit costs, because wheat is usually rotated with soybeans.

Capitalization is the only variable that had a significant influence on the unit cost in all regions. However, its effect on unit cost is significantly more in the Northern Plains and North Central, accounting for 39 percent of the variation in unit costs, compared with 15 to 25 percent in other regions.

Coefficients on share-rent, cash-rent, and custom harvest suggest that they have measurable influence on unit cost in all regions except the Pacific region. In the Plains regions, share-rent alone explained 22 to 35 percent of the variation in the unit cost. Custom harvest is the most influential factor in the Southeast, followed by Northern Plains (31 and 19 percent variation in the unit cost, respectively).

Table 17—Regression estimates of the unit cost for wheat farm operators, by region, 1994

Variable	North Central	Southeast	Northern Plains	Central and Southern Plains	Pacific
INTERCEPT	0.0271	3.5882 ***	0.8374	0.6478	3.3034 ***
APL	0.0623	0.0716	-0.0040	-0.0013	0.0055
ROTATOH	0.1799	-2.3248 ***	0.2672	0.0888	0.6579 *
PCTHG	-0.0685	-0.0714	-0.1216	-0.4109 **	0.4196 *
QNAC	0.0001	0.0018	-0.0007	0.0062 **	-0.0028 *
TLHRAC	0.0129	-0.0870	0.2441	0.6729 *	-0.9112 ***
PCTCUH	0.0122 **	0.0107 ***	0.0126 ***	0.0086 **	0.0018
LHRAC	0.0865 ***	-0.0566	-0.0764	0.1117	-0.0251
PCTSRE	0.0046 **	0.0088 **	0.0139 ***	0.0128 ***	0.0017
PCTCRE	0.0124 ***	0.0056 **	0.0082 ***	0.0040 *	0.0046
PCTWHT	0.0103	-0.0157 *	0.0025	0	0.0023
MCHVAC	0.3673 ***	0.1936 **	0.2749 ***	0.1386 ***	0.0864 ***
DA	1.7166 ***	0.4794	0.0628	0.2711	0.8903*
AGE	0.6209 ***	-0.1422	-0.3692 **	0.0493	-0.3945
EDCL	-0.1289	0.2787	-0.1130	-0.1663	0.5640 **
OCUP	-0.6196 *	0.3817	0.1202	0.1814	-1.0150 *
F-statistic	7.4300	42.7100	8.5600	4.6900	7.4700
R-squared	0.5800	0.3100	0.5600	0.3300	0.3000

* = Significant at the 10-percent level.
** = Significant at the 5-percent level.
*** = Significant at the 1-percent level.
Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Nitrogen fertilization and tillage hours per acre are important factors in the Central and Southern Plains and Pacific regions. However, their influence on the unit cost is different. An increase in nitrogen application appears to increase the unit cost in the Central and Southern Plains, while reductions in the unit cost in the Pacific region are due to irrigation.

Labor has significant influence on the unit cost only in the North Central region, suggesting that efficiency in labor will significantly lower the unit cost more in the North Central region than in other regions.

Rotation with other crops has a significant influence on the unit cost in the Pacific and Southeast regions. Rotating wheat with other crops significantly reduces the unit costs in the Southeast, while increasing the unit cost in the Pacific region. Note that wheat is usually rotated with soybeans in the Southeast, a legume crop that builds soil nitrogen and, consequently, is beneficial to a wheat crop.

Financial position, measured as the debt-to-asset ratio, had measurable influence and was positively related to unit cost in the North Central and Pacific regions. Among operator characteristics, farming as a major occupation in the North Central and Pacific regions, age in the North Central and Northern Plains, and education in the Pacific region had measurable influences on unit cost.

Table 18—Contribution of factors to the unit cost variation for wheat farm operators, by region, 1994

Variable	North Central	Southeast	Northern Plains	Central and Southern Plains	Pacific
APL	0.14	2.02	0.04	0	0.11
ROTATOH	0.01	5.51	0.92	0.22	6.24
PCTHG	0.06	0.12	0.39	4.15	3.53
QNAC	0	1.57	0.10	5.20	4.76
TLHRAC	0.10	0.18	0.90	4.30	22.68
PCTCUH	7.26	30.92	19.42	17.46	1.00
LHRAC	11.72	3.26	0.99	4.29	3.06
PCTSRE	2.53	13.15	22.46	34.96	0.92
PCTCRE	15.91	9.58	10.89	2.19	3.96
PCTWHT	0.70	8.37	0.45	0	0.31
MCHVAC	38.68	15.18	38.79	24.27	19.31
DA	8.34	3.39	0.02	1.51	3.87
AGE	9.25	0.83	4.14	0.07	6.37
EDCL	0.35	3.06	0.36	0.76	11.85
OCUP	4.97	2.86	0.13	0.62	12.02
Total	100.00	100.00	100.00	100.00	100.00

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Table 19—Coefficient of separate determination for factors affecting unit cost for wheat farm operators, by region, 1994

Variable	North Central	Southeast	Northern Plains	Central and Southern Plains	Pacific
APL	0.0011	0.0048	-0.0032	0	0.0036
ROTATOH	0	0.0280	-0.0007	0.0011	0.0175
PCTHG	-0.0020	0.0042	0.0008	0.0122	0.0056
QNAC	0	0.0098	-0.0083	0.0262	0.0018
TLHRAC	0.0024	0.0067	0.0080	0.0223	0.0983
PCTCUH	0.0206	0.0924	0.0510	0.0197	-0.0073
LHRAC	0.0848	0.0150	0.0117	0.0268	0.0109
PCTSRE	0.0115	0.0382	0.1610	0.1136	0.0043
PCTCRE	0.0772	0.0599	0.0642	-0.0062	0.0189
PCTWHT	0.0061	0.0201	0.0208	0	0.0091
MCHVAC	0.2615	-0.0134	0.1842	0.0961	0.0472
DA	0.0495	0.0182	0.0016	0.0114	0.0114
AGE	0.0188	0.0125	0.0653	-0.0007	0.0309
EDCL	-0.0001	0.0011	0.0082	0.0060	-0.0024
OCUP	0.0471	0.0125	-0.0002	0.0004	0.0494
Total	0.5788	0.3107	0.5647	0.3291	0.2997
Unexplained	0.4211	0.6892	0.4352	0.6708	0.7002

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Table 20—Estimated t-statistics on regression coefficients on factors affecting operator's unit costs, by region, 1994

Variable	Central and Southern Plains & Northern Plains	Central and Southern Plains & Pacific	Central and Southern Plains & North Central	Central and Southern Plains & Southeast	Northern Plains & Pacific
REG	-0.26	-2.51**	0.85	-3.39***	-2.24**
APL	0.09	-0.25	-0.74	-1.37	-0.37
ROTATOH	-0.56	-1.22	-0.23	4.26***	-0.90
PCTHG	-1.24	-2.77***	-1.13	-1.15	-1.86*
QNAC	1.71*	2.54**	1.65*	1.15	0.68
TLHRAC	0.92	3.36***	1.82*	1.83*	2.70***
PCTCUH	-0.88	1.50	-0.61	-0.44	2.69***
LHRAC	1.28	1.13	0.20	1.34	-0.58
PCTSRE	-0.25	2.72***	2.07**	0.80	3.28***
PCTCRE	-1.16	-0.15	-2.31**	-0.45	0.84
PCTWHT	-0.36	-0.30	-0.99	1.55	0.02
MCHVAC	-2.15**	0.94	-3.24***	-0.61	3.49***
DA	0.45	-1.15	-2.55**	-0.41	-1.44
AGE	1.53	1.32	-1.92*	0.59	0.08
EDCL	-0.20	-2.16**	-0.14	-1.60	-2.03**
OCUP	0.12	1.77*	1.60	-0.34	1.66*

Variable	Northern Plains & North Central	Northern Plains & Southeast	Pacific & North Central	Pacific & Southeast	North Central & Southeast
REG	1.04	-3.01***	2.95***	-0.23	-3.86***
APL	-0.77	-1.43	-0.65	-1.25	-0.09
ROTATOH	0.25	4.78***	0.98	4.60***	4.27 ***
PCTHG	-0.18	-0.17	1.39	1.42	0
QNAC	-0.26	-0.76	-1.15	-1.71*	-0.59
TLHRAC	0.77	0.91	-2.97***	-2.20**	0.47
PCTCUH	0.07	0.46	-1.88*	-2.13**	0.27
LHRAC	-1.79*	-0.21	-3.19***	0.75	2.92***
PCTSRE	2.59***	1.08	-0.87	-1.54	-0.93
PCTCRE	-1.05	0.64	-1.81*	-0.24	1.67*
PCTWHT	-0.70	1.66*	-0.69	1.57	1.93*
MCHVAC	-1.32	0.90	-4.48***	-1.26	1.82*
DA	-2.76***	-0.76	-1.24	0.66	1.93*
AGE	-4.04***	-0.83	-3.23***	-0.74	2.55**
EDCL	0.06	-1.45	2.07**	0.82	-1.51
OCUP	1.46	-0.45	-0.56	-1.85*	-1.68*

* = Significant at the 10-percent level.
** = Significant at the 5-percent level.
*** = Significant at the 1-percent level.

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Methods and Procedures

As noted earlier in this report, the Farm Costs and Returns Survey (FCRS) is a multi-frame, stratified survey conducted annually by USDA's Economic Research Service (ERS) and National Agricultural Statistics Service (NASS). Each year there are multiple versions of the survey: an in-depth, whole-farm version, and commodity cost-of-production (COP) versions. While all versions have questions about whole-farm expenses and income, each COP version gathers detailed information about input use, field operations, and production costs of that crop. Not all commodities produced are surveyed because of budget constraints. The survey usually covers each commodity about every 4 or 5 years.

NASS maintains a list of farms, from which are drawn the farms to be surveyed. This list consists of a list frame of medium to large farms and a complementary area frame. The list frame is stratified into groups of farms believed to be alike with respect to expenses or production of a commodity. Because not all farms are on the list, the area frame consisting of small land areas stratified by suspected land use is used to ensure complete coverage of the target population.

The box shows the number of contacts and usable questionnaires obtained from the wheat version of the 1994 FCRS. There are many reasons a contact would result in an unusable questionnaire, some of which include:

- A farm that regularly grows wheat in its rotation is not growing wheat in the survey year.
- The farm planted wheat in the survey year but was unable to give enough information to complete the questionnaire.
- The farm never grew wheat and should not be on the list.
- Refusals.

Structure of Accounts

ERS annually estimates production costs and returns of major field crops and livestock and dairy (USDA, ERS, 1997a). The crop estimates are calculated on a per-planted-acre basis and include operator and landlord costs and returns unless explicitly stated otherwise. Costs are for the acreage planted with the intention of being harvested for grain. Cost and return estimates exclude the direct effects of Government programs so that policymakers may be informed as to production costs and returns in the absence of programs. However, exclusion of certain effects of Government programs, such as indirect effects on input prices, is not possible.

Cost-of-production estimates reflect average production practices, yields, and prices paid and received by farmers. Per-acre costs vary widely among farmers due in part to differences in production practices (such as input use and type and size of machinery used). This variability means that costs and returns for individual farmers may differ considerably from the average estimates presented in this report. Consequently, users should understand the objectives and procedures of the ERS estimates. Also note that

Wheat Cost-of-Production, 1994 Farm Costs and Returns Survey

The Wheat Cost-of-Production version of the 1994 Farm Costs and Returns Survey was enumerated in 21 States. The number of contacts and usable questionnaires obtained from those contacts are as follows:

State	Contacts	Usables
Arkansas	90	28
California	48	12
Colorado	75	27
Georgia	87	35
Idaho	138	76
Illinois	117	41
Indiana	105	24
Kansas	351	138
Michigan	66	28
Minnesota	120	26
Missouri	75	28
Montana	75	44
Nebraska	108	25
North Carolina	144	71
North Dakota	96	75
Ohio	132	41
Oklahoma	180	65
Oregon	66	29
South Dakota	96	23
Texas	201	53
Washington	117	40

while the differences between costs and returns determine the profitability of a given enterprise, they are not an adequate measure of the well-being of farms producing more than one commodity.

This report explains two different cost and return accounts. The structure of these accounts and the estimating procedures are slightly different because they have different objectives. The structure of each account is shown in the box, "Structures of the Sectoral and Farm Operator Accounts." The estimating procedures are outlined below:

The traditional sector account conforms to the ERS definitions and structure of accounts. Production cost and return estimates are presented as a commodity account, which lists gross value of production, variable cash expenses, fixed cash expenses, economic costs, and two measures of returns.

The farm-operator account is an estimate of gross value of production, variable cash expenses, fixed cash expenses, noncash expenses, and one measure of returns. This account includes only the operator's share of costs and returns and excludes landlords' contributions. Farm operators are charged only the costs incurred from using the resources in production, and the full resource ownership assumption is removed.

Major components of the accounts

Value of production is estimated by multiplying the harvest-period price times planted-acre yield. Harvest-period prices, rather than season-average prices, are used since season-average prices reflect marketing factors, like storage, which is not a production cost (USDA, NASS, 1995a). Harvest-period prices are specified at the State level. In the farm-operator accounts, only the farm operator's share of production is included.

Variable cash expenses are those incurred only if production takes place. Expense items in this category are seed, fertilizers, chemicals, custom operations and technical services, hired labor, fuel, electricity, lubrication, repairs, purchased irrigation water, and baling.

Fixed expenses must be paid regardless of whether a crop is produced. Fixed expenses include general farm overhead, taxes, insurance, and interest on loans. Overhead costs consist of expenses for utilities (excluding water and electricity for irrigation), farm shop and office equipment and supplies, accounting and legal fees, blanket insurance policies, fence maintenance and repairs, motor vehicle registration, chemicals applied to maintain farm roads and ditches, and other general expenses attributable to the entire farm business. Taxes are only on real estate and personal property and do not include Federal or State income taxes. Insurance is only for crops and livestock insurance, other than Federal crop insurance, and the farm share of motor vehicle liability and blanket insurance policies. Interest expenses include the cash finance charges and service fees actually reported in the survey and paid for loans on machinery, the farm share of motor vehicles, purchases of inputs, land contracts, mortgages, and other loans secured by real estate.

In the farm-operator accounts, land rent is the actual expense reported by the operator for cash-rented wheat acreage.

Economic costs are long-term costs that reflect the production situation as if the operation fully owned all production inputs. An opportunity cost is calculated for all capital inputs and land, whether owned, rented, or financed. Economic costs include variable cash expenses, general farm overhead, taxes and insurance, capital replacement, an imputed cost of capital invested in the production process, unpaid labor, and land. Capital replacement cost represents a portion of the value of the machinery and equipment used up during the year in the production of a crop, and an additional cost required to bring these items to the same level of quality that they were at the beginning of the period.

Opportunity costs are imputed for values of capital, land, and unpaid labor in alternative uses. The cost of operating capital is the expense of carrying input expenses from the time they are used until harvest. ERS imputes this cost at the 6-month U.S. Treasury bill rate. The cost of having capital invested in farm machinery and equipment (nonland capital) is measured using the longrun rate of return to agricultural production assets from current income. ERS values land in cost-of-production accounts at its rental value. The land rental rates are a composite of share (valued at the harvest-period price) and cash rental rates for a particular crop, minus real estate taxes (already included in other taxes and the value of

Structures of the Sectoral and Farm Operator Accounts

Sectoral account, excluding Government programs	**Farm-operator account,** excluding Government programs
Gross value of production:	Gross value of production:
Wheat	Wheat
Wheat straw and grazing	Wheat straw and grazing
Total, gross value of production	Total, gross value of production
Cash expenses:	Variable cash expenses:
Seed	Seed
Fertilizer	Fertilizer
Chemicals	Chemicals
Custom operations	Custom operations
Fuel, lube, and electricity	Fuel, lube, and electricity
Repairs	Repairs
Hired labor	Hired labor
Purchased water and baling	Purchased water and baling
Total, variable cash expenses	Total, variable cash expenses
General farm overhead	General farm overhead
Taxes and insurance	Real estate and property taxes
	Insurance
Interest	Interest
	Land rent
Total, fixed cash expenses	Total, fixed cash expenses
Total, cash expenses	
Gross value of production, less cash expenses	Noncash expenses:
	Capital replacement
	Hired labor benefits
Economic (full-ownership) costs:	Total costs:
Variable cash expenses	Variable cash expenses
General farm overhead	Fixed cash expenses
Taxes and insurance	Noncash expenses
Capital replacement	
Operating capital	
Other nonland capital	
Land	
Unpaid labor	
Total, economic (full-ownership) costs	Total costs
Residual returns to management and risk	Residua1 returns to equity, unpaid labor, management, and risk
Yield *(Bushels per planted acre)*	Yield *(Bushels per planted acre)*
	Farm operator's share *(Bushels per acre)*

inputs supplied by the landlord). ERS imputes the value of unpaid labor (hired labor is a variable cash expense) at the wage rate for agricultural workers. Additional value of unpaid labor, such as for management and entrepreneurial skill, is treated as a residual return.

Noncash costs are estimated for farm-operator accounts rather than economic costs. Noncash costs include capital replacement and noncash benefits provided for hired labor, such as meals, housing, and vehicles.

Two returns are included in each sector account. Gross value of production less cash expenses is the *net cash return* that measures the shortrun cash-flow position. Net cash return is an indication of the minimum return needed from a crop to keep it in production. Gross value of production less economic costs is the *residual return to management and risk* that measures the longrun position of the enterprise. This returns measure is useful for assessing relative returns among commodities.

The farm-operator account includes one measure of returns. Returns to equity, unpaid labor, management, and risk are included in the operator's account as a residual, and as such, are estimated as the gross value of production, including the value of the secondary crop, less the total cash and noncash costs.

Estimation procedures

Procedures used to derive an estimate for a particular component of costs or returns are constrained by available data. Four general approaches were used to estimate production costs: direct costing, allocation of whole-farm costs, valuing of input quantities, and indirect costing (see the Approaches Used to Estimate the Wheat Cost of Production Components box).

Direct costing is achieved by summarizing survey responses to questions about the dollar amount paid for each item on a particular crop. This method is best suited for estimating components of variable costs such as seed, fertilizers, chemicals, custom operations, baling, hired labor, purchased irrigation water, and technical services.

Allocating whole-farm expenses occurs for inputs not specifically associated with production of a commodity. For example, expenses for overhead items, interest, taxes, and insurance cannot be directly attributed to the production of an individual farm commodity. Survey data on production, along with secondary price data, are used to determine each farm's total value of production. Expenses incurred by the whole farm for a particular input are then allocated to an enterprise based on the enterprise's share of the operation's total value of production.

Valuing quantities of inputs requires survey data of the physical quantities of inputs used in production. This approach is used for seed and unpaid labor. Costs are estimated by multiplying survey input quantities by State-level prices.

Indirect costing involves the combination of survey information and engineering formulas. Detailed information is collected on the survey for the machinery complement used in production. The data collected are for acreage covered, type and size of

Approaches Used to Estimate the Wheat Cost of Production Components

Direct costing	Allocating whole-farm expenses	Valuing quantities of inputs	Indirect costing	Some combination of approaches
Fertilizers	General farm overhead	Seed	Fuel, lubrication, and electricity	Operating capital
Chemicals	Interest	Unpaid labor	Repairs	Other nonland capital
Custom operations	Taxes and insurance		Capital replacement	Land
Hired labor				
Purchased irrigation water				
Baling				

machine, and type of fuel used. This information is used to support equations of technical relationships that describe fuel consumption, repair requirements, and replacement costs. Engineering formulas are modified to reflect technological advances as they occur. Components of economic costs (operating capital, nonland capital, and land) are estimated using a combination of these approaches. Operating capital cost is the sum of variable expenses times the 6-month U.S. Treasury bill rate. Nonland capital is the average machinery value times the longrun rate of return to farm-sector assets. Land cost includes a combination of cash rental rates and landlords' returns from share rental arrangements less landlords' expenses and real estate tax.

Statistical Reliability of Wheat Cost Estimates, 1994

Production cost data presented in this report include an estimate of the coefficient of variation for each item. The coefficient of variation (C.V.) is a measure of relative dispersion suggesting the variability of the estimated sample mean. It takes into account the variation in each cost item and the variation in the expanded number of wheat farms estimated from the sample. The C.V. is defined as the standard deviation of the estimate divided by its mean and expressed as a percentage of the estimate. In general, the smaller the C.V. the greater the reliability of the estimate. Note that survey results can also be influenced by nonsampling errors not measurable or known. Nonsampling errors can be introduced by enumerators, respondents, or survey design. Efforts to reduce the effect of nonsampling error included: training of enumerators; reviewing and editing survey data; and analyzing of data for comparability and consistency.

Constructing confidence intervals around the mean is a method for examining the precision of the estimate. For example, the mean total cash costs of producing wheat are $82.48 per acre with a coefficient of variation of 4.25. The 95-percent confidence interval for this estimate is $75.61 to $89.35 per acre. We are 95-percent confident that this interval contains the true population mean of total cash costs for producing an acre of wheat. Among all groups, confidence intervals narrow as sample size increases (table 21).

Statistical Procedures

Testing for a statistical difference of group means. The statistical difference between mean estimates for selected variables among groups is tested using a t-statistic. The null and alternative hypotheses to be tested are:

$$H_O: \mu_1 = \mu_2$$
$$H_A: \mu_1 \neq \mu_2,$$

Table 21--Statistical reliability of wheat production costs per planted acre, 1994

	95-percent confidence interval					
	Cash costs			Economic costs		
Item	Lower	Mean	Upper	Lower	Mean	Upper
	Dollars per planted acre					
All FCRS farms	75.61	82.40	89.35	142.42	154.54	166.66
Wheat region:						
North Central	93.90	103.40	112.92	163.82	177.68	191.54
Southeast	94.28	101.20	108.16	142.12	152.23	162.34
Northern Plains	62.51	69.90	77.35	123.72	143.43	163.14
Central and Southern Plains	71.81	75.90	80.09	130.75	137.43	144.11
Pacific	115.80	147.20	178.66	232.44	271.07	309.70
Variable cash cost group:						
Low-cost	57.57	65.40	73.39	117.07	145.58	174.09
Mid-cost	80.85	84.40	88.13	154.09	160.47	166.85
High-cost	69.93	86.90	103.93	124.16	149.15	174.14
Enterprise size group:						
Less than 50 acres	78.05	86.90	95.81	167.52	180.96	194.40
50-199 acres	75.83	83.60	91.47	147.01	158.54	170.07
200-399 acres	77.33	86.50	95.75	146.21	158.11	170.01
400 or more acres	70.64	80.20	89.76	134.20	150.95	167.70

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

where μ_1 is the population mean of group 1 and μ_2 is the population mean of group 2. Evidence allowing rejection of the null hypothesis indicates a significant difference between population means of farms in the two groups. The t-statistic used for hypothesis testing is (see Kmenta, 1971, pp. 137 and 145):

$$t \sim \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{VAR(\bar{X}_1) + VAR(\bar{X}_2)}},$$

where $\bar{X}_1$ and $\bar{X}_2$ are sample means, and $VAR(\bar{X}_1)$ and $VAR(\bar{X}_2)$ are variance estimates of the sample means. If the estimated t-statistic exceeds the critical t-value for the chosen level of significance, then the null hypothesis can be rejected and the group means are deemed significantly different. At a 5-percent level of significance, this means that from infinite samples of both populations the estimates would lead to an incorrect rejection of the null hypothesis only 5 percent of the time. For the sample sizes used in this study, the critical t-values are 2.58 for a 1-percent level of significance, 1.96 for a 5-percent level, and 1.65 for a 10-percent level.

Test of the equivalency of two regressions. Statistical testing for a difference between coefficients of two regressions is used to compare the unit-cost equation estimated for each region. Separate regressions are estimated for each region with the model:

$$Y = \alpha_0 + \sum_{k=1}^{m} \alpha_k X_k + \varepsilon,$$

where the α are parameters to be estimated, ε is the error term, and *m* is the number of explanatory variables. Data for farms in these two regions are then combined. A dummy variable *D* is constructed with *D=1* if the farm is located in the first region, *D=0* otherwise. The regression model is then specified as:

$$Y = \alpha_0 + \sum_{k=1}^{m} \alpha_k X_k + \delta_0 D + \sum_{k=1}^{m} \delta_k X_k D + \varepsilon,$$

where the α and δ are parameters to be estimated, ε is the error term, and *m* is the number of explanatory variables. Coefficients estimated with the dummy variables, δ_0 through δ_m, measure the difference of the intercept (δ_0) and the slope estimate of each variable $(\delta_1 - \delta_m)$ of the two regions. Therefore, t-statistics on the estimated coefficients indicate whether the estimated coefficients on each variable in the separate regressions for each region are significantly different.

Decomposing cost variation. To measure the extent to which each explanatory variable influences the variation of production costs, the sample variation is decomposed into its various components and expressed using the coefficient of separate determination (Burt and Finley, 1968). The components of unit-cost variation are:

$$\begin{aligned}
\sigma_y = \; & \alpha_1^2\sigma_{11} + \alpha_1\alpha_2\sigma_{12} + \ldots + \alpha_1\alpha_k\sigma_{1k} + \\
& \alpha_2\alpha_1\sigma_{21} + \alpha_2^2\sigma_{22} + \ldots + \alpha_2\alpha_k\sigma_{2k} + \\
& \ldots \\
& \ldots \\
& \alpha_k\alpha_1\sigma_{k1} + \alpha_k\alpha_2\sigma_{k2} + \ldots + \alpha_K^2\sigma_{kk} + \sigma_\varepsilon,
\end{aligned}$$

where σ_{ii} and $\sigma_{ij}(i \neq j)$ are the variance of X_i and covariance of X_i and X_j, respectively. Calculation of the coefficients of separate determination effectively allocates the explained variation of the regression model among the independent variables. Thus, these coefficients are computed as:

$$\begin{aligned}
C_1 &= (\alpha_1^2\sigma_{11} + \alpha_1\alpha_2\sigma_{12} + \ldots + \alpha_1\alpha_k\sigma_{1k}) / \sigma_y \\
C_2 &= (\alpha_2\alpha_1\sigma_{21} + \alpha_2^2\alpha_{22} + \ldots + \alpha_2\alpha_k\sigma_{2k}) / \sigma_y \\
. &= \ldots \ldots \ldots \ldots \\
. &= \ldots \ldots \ldots \ldots \\
C_k &= (\alpha_k\alpha_1\sigma_{k1} + \alpha_k\alpha_2\sigma_{k2} + \ldots + \alpha_k^2\sigma_{kk}) / \sigma_y.
\end{aligned}$$

Each coefficient represents the portion of the variation in the dependent variable explained by each independent variable alone (variance effects) and the interaction among variables (covariance effects). The sum of these coefficients equals the R^2 goodness-of-fit measure, which is equivalent to:

$$R^2 = \sum_{j=1}^{k} C_j = \Omega / \sigma_Y,$$

where *j* indicates the j^{th} coefficient of separate determination. The unexplained variation in unit cost is, therefore, equal to $1\text{-}R^2$. Coefficients of separate determination were used to examine determinants of the profitability of dairy by El-Osta and Johnson (1998); and of change in livestock production by McBride (1997).

Glossary

Allocated returns another term used for the opportunity costs for owned inputs identified in the definition of total economic costs.

Conservation tillage any tillage system that maintains 30 percent or more of the soil surface with crop residue, after planting, to reduce soil erosion by water. Where soil erosion by wind is the primary concern, the term refers to any system that maintains at least 1,000 pounds per acre of flat, small grain residue equivalent on the surface throughout the critical wind erosion period. Two key factors influencing crop residue are: (1) the type of crop, which establishes the initial residue amount and its fragility, and (2) the type of tillage operations before and during planting (Bull, 1993; and Conservation Tillage Information Center, 1996).

Conservation tillage systems:

> ***No-till*** soil left undisturbed from harvest to planting except for nutrient injection. Planting or drilling is accomplished in a narrow seedbed or slot created by coulters, row cleaners, disk opener, in-row chisels, or roto-tillers. Weed control is accomplished primarily with herbicides. Cultivation may be used for emergency weed control.
>
> ***Ridge-till*** soil left undisturbed from harvest to planting except for nutrient injection. Planting, however, is completed in a seedbed prepared on ridges with sweeps, disk openers, coulters, or row cleaners. Residue is left on the surface between ridges. Weed control is accomplished with herbicides and/or cultivation. Ridges are built during cultivation.
>
> ***Mulch-till*** soil is disturbed prior to planting. Tillage tools such as chisels, field cultivators, disks, sweeps, or blades are used. Weed control is accomplished with herbicides and cultivation.

Conventional tillage (less than 15-percent residue) any tillage that leaves less than 15-percent residue cover after planting or less than 500 pounds per acre of small grain residue equivalent throughout the critical wind erosion period. This generally includes plowing or other intensive tillage. Weeds are controlled with herbicides and cultivation.

Conventional tillage systems (as defined in the Cropping Practices Survey):

> ***Conventional tillage with moldboard plow*** any tillage system that includes the use of a moldboard plow.
>
> ***Conventional tillage without moldboard plow*** any tillage system that has less than 30 percent remaining residue and does not use a moldboard plow.

Crop rotation alternating production of winter or spring wheat with another crop or fallow.

Debt-asset ratio calculated by dividing total liabilities by total assets.

Durum wheat the hardest of all U.S. wheats, seeded in the spring, and contains a high amount of protein, which is good for pasta products (macaroni, spaghetti, and other noodles), grown in the same northern area as Hard Red Spring wheat—mainly in North Dakota. Subclasses are Hard Amber Durum, Amber Durum, and Durum wheats.

Economic class an economic classification of farm size. The classification is based on the farm operator's gross receipts, including gross annual sales of crops; livestock, poultry, and products; miscellaneous agricultural products; and all Government payments.

Enterprise size one of four categories: farms with fewer than 50 wheat acres, 50 to 199 wheat acres, 200 to 399 wheat acres, and 400 or more wheat acres.

Expected yield a term designating wheat yield per acre that farmers report that they expect on their operation at the time of planting. Most operators budget for the crop season based on an expected yield per acre for each crop they grow (FCRS Interviewer's Manual, in the survey package).

Farm structure no single, widely accepted definition. Concept involves many components. Land, labor, capital, and management collectively are the fundamentals around which farm structure is constructed and the basic mechanisms through which structural change occurs (Stanton, 1993). "Structure" in this report simply refers to how farms of different

sizes, incomes, assets, and locations organize and manage their natural, financial, labor, and other resources.

Hard Red Spring wheat contains the highest percentage of protein, making it an excellent bread wheat, with superior milling and baking characteristics; chiefly grown in Montana, North Dakota, South Dakota, and Minnesota; seeded in the spring, and may have a hard or soft endosperm. Subclasses are Dark Northern Spring, Northern Spring, and Red Spring wheats.

Hard Red Winter wheat the class of wheat used mostly for bread and all-purpose flour; seeded in the fall; ranges from medium to high in protein; may have either a hard or soft endosperm; accounts for more than 40 percent of the U.S. wheat crop and more than half of U.S. wheat exports; produced in the Great Plains, a large interior area extending from the Mississippi River west to the Rocky Mountains, and from Dakotas and Montana down to Texas. Wide range of protein, good milling and baking characteristics. Used to produce bread, rolls and, to a lesser extent, sweet goods and all-purpose flour.

Hard White wheat the newest white class of wheat to be grown in the United States. Closely related to red wheats (except for color genes), this wheat has a milder, sweeter flavor, equal fiber, and similar milling and baking properties. Used in yeast breads, hard rolls, bulgur, tortillas, and oriental noodles. Used in domestic markets, and exported in limited quantities. No subclasses.

High-cost producers the 25 percent of U.S. wheat producers with the highest per-bushel total variable cash expenses.

Low-cost producers the 25 percent of U.S. wheat producers with the lowest per-bushel total variable cash expenses.

Major occupation the occupation that the operator identified as his/her major occupation. Operators were asked to select from farm and ranch work, hired manager, or some other occupation.

Previous crop crops planted in 1993 on wheat land.

Production specialty the farm production classification that represents the largest portion of gross commodity receipts from the farm operation.

Protein any of a large class of naturally occurring complex combinations of amino acids. In wheat, protein is important in determining baking and nutritional qualities.

Reduced tillage (15 to 30 percent residue) tillage types that leave 15 to 30 percent residue cover after planting, or 500 to 1,000 pounds per acre of small grain residue equivalent throughout the critical wind erosion period. Weeds are controlled with herbicides and cultivation.

Soft Red Winter wheat seeded in the fall, has low to medium protein content, with a soft endosperm; and is used in making cakes, pastries, flat breads, and crackers. Grown in the eastern third of the United States, east of the Mississippi River. It has a high yield, but relatively low protein. No subclasses.

Soft White wheat used in much the same way as Soft Red Winter (for bakery products other than bread). Grown mainly in the Pacific Northwest, and to a lesser extent in California, Michigan, Wisconsin, and New York, of low protein, but high yield. Produces flour for cakes, crackers, cookies, pastries, quick breads, muffins, and snack foods. Subclasses are Soft White, White Club, and Western White wheats.

Spring wheat a general term for wheat that is planted in the spring and harvested in summer or fall.

Total economic costs long-term costs that account for all production inputs, without regard to the ownership or equity position of farm operators. These costs are variable cash expenses, general farm overhead, taxes and insurance, and capital replacement, as well as opportunity costs for owned inputs (operating capital, nonland capital, land, and unpaid labor).

Variable cash expenses the amount of money spent during wheat production for inputs used. Variable cash expenses consist of seed, fertilizer, chemicals, custom operations, fuel, lubrication, electricity, repairs, hired labor, purchased irrigation water, and baling.

Value of production an estimate of the total value of all farm products produced on a farm, excluding the value of intermediate products, such as corn fed to livestock. For the wheat operation, the value of production is wheat grain, wheat straw, and grazing.

Wheat farms farm operations that planted wheat with the intention of harvesting grain, particularly those

selected in the 1994 Farm Costs and Returns Survey, Wheat Costs of Production version.

Wheat production regions groups of States with common cultural practices in wheat production. The North Central consists of Illinois, Indiana, Michigan, Missouri, and Ohio; Southeast is Arkansas, Georgia, and North Carolina; Northern Plains contains Minnesota, Montana, North Dakota, and South Dakota; Central and Southern Plains is Colorado, Kansas, Nebraska, Oklahoma, and Texas; Pacific region is California, Idaho, Oregon, and Washington.

Winter wheat a general category describing wheats seeded in the fall, lie dormant in the winter, and are harvested the following spring or summer.

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Appendix Tables

Appendix table 1—Estimated t-statistics on characteristics of wheat farms among regions, 1994

Item	Unit	North Central & Southeast	North Central & Northern Plains	North Central & Central and Southern Plains	North Central & Pacific	Southeast & Northern Plains
Size:						
Operated	*Acres*	0.76	1.93**	5.66***	3.00***	1.69*
Planted wheat	*Acres*	2.91***	3.60***	8.11***	3.95***	2.84***
Harvested wheat	*Acres*	2.73***	3.52***	7.52***	3.97***	2.81***
Sales class:						
$49,999 or less	*Percent of farms*	3.63***	0.10	0.61	1.65	1.80*
$50,000-$99,999	*Percent of farms*	0.52	0.76	0.32	0.06	1.59
$100,000-$499,999	*Percent of farms*	1.34	0.18	0.37	0.19	1.64*
$500,000 or more	*Percent of farms*	1.94*	1.24	0.95	2.15**	2.96***
Value of production:						
Wheat production value	*Dollars per farm*	2.23*	2.87**	5.37***	2.63***	1.85*
Farm production value	*Dollars per farm*	2.27*	1.94*	2.66***	0.77	3.29***
Wheat tenure:						
Owned	*Percent of acres*	1.97**	0.38	1.74*	1.65*	1.10
Cash-rented	*Percent of acres*	1.64*	1.04	0.91	1.53	0.74
Share-rented	*Percent of acres*	0.19	0.65	2.36**	2.66***	0.59
Production practices:						
Winter wheat	*Percent of farms*	0	11.86***	1.83*	5.54***	11.86***
Spring wheat	*Percent of farms*	0	0	0	0	0
Irrigated	*Percent of farms*	0.26	1.18	4.2***	2.58***	1.04
Double-cropped	*Percent of farms*	4.95***	0	2.68***	2.75***	0
Fallow	*Percent of farms*	0.47	4.28***	7.67***	6.29***	3.57***
Grazing	*Percent of farms*	0.02	0.26	8.73***	2.83***	0.40
Previous crop:						
Barley/oats	*Percent of farms*	0	0	0	0	0.81
Corn	*Percent of farms*	3.04***	0.03	3.41***	3.17***	1.28
Soybeans	*Percent of farms*	4.21***	7.46***	11.64***	0	1.29
Wheat	*Percent of farms*	0.49	1.56	11.15***	3.60***	1.51
Fallow	*Percent of farms*	0.85	4.81***	5.28***	4.29***	4.36***
Crop rotation:						
Continuous wheat	*Percent of farms*	0	0	0	0	0
Fallow-wheat	*Percent of farms*	0	0	0	0	0
Fallow-other	*Percent of farms*	0.85	2.15**	0.88	0.88	1.40
Corn-soybeans	*Percent of farms*	2.55**	1.23	3.47***	0	3.47***
Corn-other	*Percent of farms*	1.88*	0.26	2.01**	1.70*	0.39
Soybeans-soybeans	*Percent of farms*	0.16	4.54***	4.31***	0	1.95**
Soybeans-corn	*Percent of farms*	8.03	5.70***	8.88***	0	1.93**
Production speciality:						
Cash grains	*Percent of farms*	2.61***	0.78	0.05	2.40**	1.81*
Other crops	*Percent of farms*	0	0	0	0	8.44***
Livestock	*Percent of farms*	1.52	0.74	0.80	1.65*	2.71***
Livestock:						
Hogs	*Percent of farms*	1.07	1.70*	2.68***	2.92***	1.57
Beef cattle	*Percent of farms*	1.20	0.38	0.23	0.74	2.11**
Dairy cattle	*Percent of farms*	2.77***	1.70*	3.60***	3.14***	1.62
Wheat for farm use	*Percent*	2.01**	2.74***	2.05**	3.24***	0.14
Participation in wheat program	*Percent of farms*	0.96	1.66*	2.72***	1.14	2.74***
Operator characteristics:						
Individual farm organization	*Percent of farms*	0.05	0.21	1.10	0.96	0.30
Partnership	*Percent of farms*	0.32	0.09	0.78	0.84	0.15
Farming as major occupation	*Percent of farms*	0.24	1.90*	1.36	1.73	0.69
Under 50 years of age	*Percent of farms*	0.61	0.05	0.34	0.15	0.46
Completed college	*Percent of farms*	1.11	0.38	4.11***	4.16***	0.58

See footnotes at the end of this table.

Continued—

Appendix table 1—Estimated t-statistics on characteristics of wheat farms among regions, 1994--Continued

Item	Unit	Southeast & Central and Southern Plains	Southeast & Pacific	Northern Plains & Central and Southern Plains	Northern Plains & Pacific	Central and Southern Plains & Pacific
Size:						
Operated	*Acres*	3.47***	2.30**	0.62	0.54	0.09
Planted wheat	*Acres*	5.36***	2.84***	0.97	0.73	0.18
Harvested wheat	*Acres*	4.84***	2.93***	1.20	0.65	0.62
Sales class:						
$49,999 or less	*Percent of farms*	5.13***	1.75*	0.44	0.86	2.50**
$50,000-$99,999	*Percent of farms*	1.12	0.68	0.87	1.58	0.84
$100,000-$499,999	*Percent of farms*	2.36**	1.58	0.15	0.44	0.90
$500,000 or more	*Percent of farms*	2.91***	0.02	0.60	3.32***	3.38***
Value of production:						
Wheat production value	*Dollars per farm*	2.00**	2.17**	1.02	1.19	1.77*
Farm production value	*Dollars per farm*	3.59***	0.12	0.16	1.08	1.10
Wheat tenure:						
Owned	*Percent of acres*	0.67	0.31	0.85	0.89	0.22
Cash-rented	*Percent of acres*	3.35***	4.02***	2.73***	3.49***	1.76*
Share-rented	*Percent of acres*	3.61***	3.56***	5.43***	4.61***	1.01
Production practices:						
Winter wheat	*Percent of farms*	1.83*	5.54***	11.84***	9.37***	5.47***
Spring wheat	*Percent of farms*	0	0	13.47***	10.07***	5.47***
Irrigated	*Percent of farms*	4.18***	2.58***	3.87***	2.55**	2.06**
Double-cropped	*Percent of farms*	7.93***	7.91***	0	0	0.55
Fallow	*Percent of farms*	5.11***	5.53***	0.23	1.94*	2.55**
Straw	*Percent of farms*	4.48***	0.32	0.68	0.91	1.03
Grazing	*Percent of farms*	8.77***	2.88***	8.72***	2.80***	6.52***
Previous crop:						
Barley/oats	*Percent of farms*	0	2.21**	0	2.00**	0
Corn	*Percent of farms*	7.26***	6.68***	1.10	1.13	0.25
Soybeans	*Percent of farms*	2.92***	0	2.39**	0	0
Wheat	*Percent of farms*	10.99***	3.43***	3.80***	0.21	7.08***
Fallow	*Percent of farms*	4.80***	3.89***	0.26	0.10	0.35
Crop rotation:						
Continuous wheat	*Percent of farms*	0	0	3.44***	0.73	9.12***
Fallow-wheat	*Percent of farms*	0	0	0.61	0.43	0.14
Fallow-other	*Percent of farms*	0.02	0.11	1.39	1.23	0.09
Corn-soybeans	*Percent of farms*	5.19***	0	1.83*	0	0
Corn-other	*Percent of farms*	5.04***	4.16***	0.81	0.80	0.03
Soybeans-soybeans	*Percent of farms*	1.87*	0	0.47	0	0
Soybeans-corn	*Percent of farms*	3.52***	0	3.06***	0	0
Production specialty:						
Cash grains	*Percent of farms*	3.91***	0.23	0.97	1.60	3.53***
Other crops	*Percent of farms*	5.27***	1.41	1.89*	5.83***	3.48***
Livestock	*Percent of farms*	1.69*	0.43	1.88*	2.83***	1.90*
Livestock:						
Hogs	*Percent of farms*	4.83***	5.46***	3.19***	3.92***	1.43
Beef cattle	*Percent of farms*	2.45**	0.64	0.24	1.43	1.49
Dairy cattle	*Percent of farms*	2.93***	1.21	3.16***	2.29**	1.64
Wheat for farm use	*Percent*	0.13	0.85	0.01	1.43	1.07
Participated in wheat program	*Percent of farms*	4.97***	2.64***	0.29	0.94	2.38**
Operator characteristics:						
Individual farm organization	*Percent of farms*	2.52**	1.43	0.65	1.07	3.47***
Partnership	*Percent of farms*	2.95***	0.95	0.71	0.59	3.11***
Farming as major occupation	*Percent of farms*	0.90	0.73	2.84***	0.11	2.60***
Under 50 years of age	*Percent of farms*	0.34	0.43	0.22	0.08	0.15
Completed college	*Percent of farms*	2.61***	3.01***	2.93***	3.30***	1.02

* = Significant at the 10-percent level.
** = Significant at the 5-percent level
*** = Significant at the 1-percent level.

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Appendix table 2—Estimated t-statistics on input use of wheat production operations among regions, 1994

Item	Unit	North Central & Southeast	North Central & Northern Plains	North Central & Central and Southern Plains	North Central & Pacific	Southeast & Northern Plains
Wheat yield:						
Actual yield	*Bushels/acre*	1.81*	12.03***	11.28***	1.03	6.31***
Expected yield	*Bushels/acre*	4.02***	7.78***	11.41***	1.97**	5.05***
Seed:						
Seed rate-one time	*Bushels/acre*	0.40	3.58***	25.30***	5.93***	3.63***
Acres reseeded	*Percent of acres*	3.68***	1.72*	2.92***	1.60	2.21**
Home-grown seed	*Percent of seed*	1.35	2.60**	3.52***	0.69	3.53***
Fertilizer use:						
Any fertilizer	*Percent of farms*	0.81	3.97***	5.27***	1.16	3.72***
Nitrogen	*Percent of farms*	3.98***	3.99***	5.30***	1.45	0.93
Phosphorus	*Percent of farms*	5.00***	1.18	7.30***	6.23***	3.30***
Potassium	*Percent of farms*	3.02***	8.85***	19.79***	12.54***	3.50***
Manure	*Percent of farms*	3.67***	2.17**	2.80***	0.86	0.64
Fertilizer application rate:						
Nitrogen	*Pounds/acre*	1.52	4.55***	7.04***	1.44	2.67***
Phosphorus	*Pounds/acre*	4.82***	5.54***	9.52***	8.95***	0.66
Potassium	*Pounds/acre*	2.36**	10.89***	11.31***	11.15***	5.53***
Manure	*Tons/acre*	2.71***	1.83*	4.16***	0.32	4.02***
Chemical use:						
Any chemicals	*Percent of farms*	2.55**	4.70***	1.83*	8.21***	3.20***
Herbicides	*Percent of farms*	1.83*	4.71***	1.53	8.12***	3.65***
Insecticides/fungicides	*Percent of farms*	2.34**	2.04**	5.40***	4.46***	1.98**
Herbicides	*Acre treatments*	3.73***	10.36***	2.35**	9.23***	5.75***
Insecticides/fungicides	*Acre treatments*	0	0	0	0	1.99**
Tillage systems:						
Conventional with moldboard plow	*Percent of farms*	0.15	0.64	0.77	1.12	0.73
Conventional without moldboard plow	*Percent of farms*	0.89	0.22	2.53**	1.34	0.72
Mulch tillage	*Percent of farms*	1.45	2.00**	0.02	0.34	1.31
No-till	*Percent of farms*	1.31	2.03**	2.34**	2.40**	0.45
Custom operations:						
Any custom	*Percent of farms*	3.74***	0.72	3.18***	5.49***	1.72*
Land preparation/ cultivation	*Percent of farms*	1.96**	3.88***	4.29***	5.13***	2.95***
Planting	*Percent of farms*	0.62	0.15	1.97**	2.49**	0.54
Fertilizer/chemical application	*Percent of farms*	2.05**	0.02	0.58	2.29**	2.75***
Harvesting/hauling	*Percent of farms*	1.49	0.53	2.27***	1.97*	0.95
Fuel use:						
Diesel	*Gallons/acre*	2.62***	2.61***	7.32***	4.43***	0.09
Gasoline	*Gallons/acre*	0.79	0.67	0.41	0.17	0.01
LP gas	*Gallons/acre*	0	0	0	0	0.95
Natural gas	*1,000 cubic feet/acre*	0	0	0	0	0
Electricity	*Kilowatt hours/acre*	0	0	0	0	0.81
Labor use:						
Unpaid labor	*Hours/acre*	1.73*	2.38**	1.41	2.12**	0.81
Paid labor	*Hours/acre*	1.30	1.30	0.59	3.22***	3.42***

See footnotes at the end of this table.

Continued—

Appendix table 2—Estimated t-statistics on input use of wheat production operations among regions, 1994--Continued

Item	Unit	Southeast & Central and Southern Plains	Southeast & Pacific	Northern Plains & Central and Southern Plains	Northern Plains & Pacific	Central and Southern Plains & Pacific
Wheat yield:						
Actual yield	*Bushels/acre*	5.99***	1.92*	0.47	5.27***	5.14***
Expected yield	*Bushels/acre*	7.55***	3.40***	0.83	5.42***	5.45***
Seed:						
Seed rate-one time	*Bushels/acre*	19.73***	5.88***	3.53***	1.16	2.39**
Acres reseeded	*Percent of acres*	4.97***	2.84***	4.01***	0.24	3.95***
Home-grown seed	*Percent of seed*	4.98***	0.54	0.45	2.98***	3.89***
Fertilizer use:						
Any fertilizer	*Percent of farms*	5.05***	1.03	1.56	1.26	2.45**
Nitrogen	*Percent of farms*	2.56**	0.42	1.57	1.02	2.24**
Phosphorus	*Percent of farms*	0.91	0.83	4.73***	4.26***	0.01
Potassium	*Percent of farms*	7.30***	5.59***	4.30***	2.42**	1.42
Manure	*Percent of farms*	5.84***	4.33***	3.59***	2.66***	1.78*
Fertilizer application rate:						
Nitrogen	*Pounds/acre*	3.34***	0.15	0.28	2.21**	2.52**
Phosphorus	*Pounds/acre*	2.30**	2.52**	1.41	1.71*	0.81
Potassium	*Pounds/acre*	5.81***	5.68***	1.76*	0.85	1.49
Manure	T*ons/acre*	5.43***	2.24**	2.28**	0.69	1.59
Chemical use:						
Any chemicals	*Percent of farms*	1.07	8.33	3.95***	0.84	10.71***
Herbicides	*Percent of farms*	0.54	8.15	4.23***	0.75	11.14***
Insecticides/fungicides	*Percent of farms*	0.57	0.31	3.91***	3.49***	0.46
Herbicides	*Acre treatments*	1.88*	5.42***	8.55***	0.30	7.68***
Insecticides/fungicides	*Acre treatments*	1.01	2.04**	3.03***	0.27	3.42***
Tillage systems:						
Conventional with moldboard plow	*Percent of farms*	1.05	1.83*	0.09	2.20**	2.69***
Conventional without moldboard plow	*Percent of farms*	2.04**	0.51	2.55**	1.21	1.67*
Mulch tillage	*Percent of farms*	1.38	0.72	1.99**	1.67*	0.34
No-till	*Percent of farms*	0.75	0.81	0.76	0.96	0.43
Custom operations:						
Any custom	*Percent of farms*	0.92	1.53	1.25	2.63***	2.79***
Land preparation/ cultivation	*Percent of farms*	2.54**	4.41***	1.33	1.76*	3.10***
Planting	*Percent of farms*	0.08	0.15	1.12	1.58	0.63
Fertilizer/chemical application	*Percent of farms*	2.53**	0.47	0.80	2.99***	2.80***
Harvesting/hauling	*Percent of farms*	1.43	0.97	1.85*	1.52	0.28
Fuel use:						
Diesel	*Gallons/acre*	2.92***	3.25***	3.17***	3.31***	2.24**
Gasoline	*Gallons/acre*	0.72	1.12	0.48	0.90	0.71
LP gas	*Gallons/acre*	1.19	1.69*	0.63	0.24	0.55
Natural gas	*1,000 cubic feet/acre*	0	0	0	0	0
Electricity	*Kilowatt hours/acre*	2.41**	1.07	2.03***	1.07	1.06
Labor use:						
Unpaid labor	*Hours/acre*	2.69***	2.77***	3.18***	3.14***	1.62
Paid labor	*Hours/acre*	2.47**	2.48**	1.04	4.67***	4.10*

* = Significant at the 10-percent level.
** = Significant at the 5-percent level.
*** = Significant at the 1-percent level.

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Appendix table 3—Coefficient of variation: Wheat production costs per planted acre, by region, 1994

Item	North Central	Southeast	Nothern Plains	Central and Southern Plains	Pacific	All FCRS farms
			Percent			
Cash expenses:						
Seed	7.68	3.18	8.43	2.78	6.06	3.55
Fertilizer	12.81	8.08	11.09	5.39	10.53	6.71
Chemicals	66.26	14.95	15.46	12.37	12.52	8.13
Custom operations	22.12	12.44	35.72	8.83	25.35	8.05
Fuel, lube, and electricity	9.62	4.91	9.78	8.98	45.87	13.52
Repairs	5.48	4.87	6.59	3.32	5.10	3.35
Hired labor	18.71	18.15	24.10	16.36	12.81	13.01
Purchased water and baling	16.87	11.71	24.27	25.75	26.96	19.67
Total, variable cash expenses	7.60	4.28	7.87	3.19	14.24	5.45
General farm overhead	14.63	10.14	15.27	7.39	13.83	7.13
Taxes and insurance	5.55	7.73	10.19	3.59	14.52	5.82
Interest	24.79	16.57	22.68	14.46	16.07	10.92
Total, fixed cash expenses	8.77	7.52	4.78	6.15	6.03	3.48
Total, cash expenses	4.69	3.50	5.41	2.78	10.89	4.25
Economic (full-ownership) costs:						
Variable cash expenses	7.60	4.28	7.87	3.19	14.24	5.45
General farm overhead	14.63	10.14	15.27	7.39	13.83	7.13
Taxes and insurance	5.55	7.73	10.19	3.59	14.52	5.82
Capital replacement	3.49	2.88	5.68	4.82	4.53	3.12
Operating capital	7.60	4.28	7.87	3.19	14.24	5.45
Other nonland capital	3.91	3.52	5.07	4.28	3.67	2.33
Land	8.01	16.21	6.42	6.30	5.28	4.11
Unpaid labor	5.22	11.05	16.49	5.39	15.19	6.64
Total, economic (full-ownership) costs	3.98	3.39	7.01	2.48	7.27	4.00
Yield	3.69	6.23	2.88	3.55	10.08	3.23

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Appendix table 4—Coefficient of variation: Wheat production costs per planted acre, by variable cost group, 1994

Item	Low-cost producers	Mid-cost producers	High-cost producers	All FCRS farms
		Percent		
Cash expenses:				
Seed	7.07	3.42	4.25	3.55
Fertilizer	14.21	6.26	9.87	6.71
Chemicals	11.11	7.76	13.98	8.13
Custom operations	43.15	10.72	15.24	8.05
Fuel, lube, and electricity	14.71	9.72	30.39	13.52
Repairs	6.65	3.06	5.60	3.35
Hired labor	33.92	15.57	16.82	13.01
Purchased water and baling	34.23	27.18	38.94	19.67
Total, variable cash expenses	6.79	2.53	11.20	5.45
General farm overhead	23.08	5.37	13.45	7.13
Taxes and insurance	13.89	3.43	13.84	5.82
Interest	22.69	11.05	13.38	10.92
Total, fixed cash expenses	6.48	4.72	8.04	3.48
Total, cash expenses	6.16	2.20	9.98	4.25
Economic (full-ownership) costs:				
Variable cash expenses	6.79	2.53	11.20	5.45
General farm overhead	23.08	5.37	13.45	7.13
Taxes and insurance	13.89	3.43	13.84	5.82
Capital replacement	5.84	3.61	6.40	3.12
Operating capital	6.79	2.53	11.20	5.45
Other nonland capital	4.41	3.36	4.98	2.33
Land	13.21	3.51	11.30	4.11
Unpaid labor	21.33	5.52	8.39	6.64
Total, economic costs	9.99	2.03	8.55	4.00
Yield	8.33	2.17	17.09	2.23

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Appendix table 5—Coefficient of variation: Wheat production costs per planted acre, by enterprise size, 1994

Item	Wheat acres planted				All FCRS farms
	Fewer than 50 acres	50-199 acres	200-399 acres	400 or more acres	
			Percent		
Cash expenses:					
Seed	6.94	6.30	5.41	4.57	3.55
Fertilizer	7.48	13.01	8.13	8.71	6.71
Chemicals	18.61	15.28	12.48	10.41	8.13
Custom operations	20.16	16.43	14.78	10.18	8.05
Fuel, lube, and electricity	8.67	6.16	16.73	19.78	13.52
Repairs	6.01	4.04	4.02	4.79	3.35
Hired labor	30.38	15.72	21.92	17.75	13.01
Purchased water and baling	28.06	15.82	56.60	47.66	19.67
Total, variable cash expenses	5.02	6.05	5.83	7.88	5.45
General farm overhead	26.73	10.99	9.82	9.09	7.13
Taxes and insurance	11.72	6.86	6.97	8.26	5.82
Interest	20.74	21.66	17.57	13.85	10.92
Total, fixed cash expenses	10.15	9.10	8.35	4.38	3.48
Total, cash expenses	5.21	4.77	5.43	6.08	4.25
Economic (full-ownership) costs:					
Variable cash expenses	5.02	6.05	5.83	7.88	5.45
General farm overhead	26.73	10.99	9.82	9.09	7.13
Taxes and insurance	11.72	6.86	6.97	8.26	5.82
Capital replacement	3.61	3.46	4.07	4.42	3.12
Operating capital	5.02	6.05	5.83	7.88	5.45
Other nonland capital	5.10	3.90	3.97	3.19	2.33
Land	7.34	7.29	5.25	5.60	4.11
Unpaid labor	16.41	8.89	7.07	8.69	6.64
Total, economic (full-ownership) costs	3.79	3.71	3.84	5.66	4.00
Yield	6.93	6.28	5.50	4.60	3.23

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.

Appendix table 6—Input use of wheat production operations, by enterprise size, 1994

Item	Unit	Wheat acres planted			
		Fewer than 50 wheat acres	50-199 wheat acres	200-399 wheat acres	400 or more wheat acres
Wheat yield:					
Actual yield	*Bushels/acre*	46.63	37.03	35.54	31.17
Expected yield	*Bushels/acre*	49.33	43.30	40.61	37.87
Seed:					
Rate-one time	*Bushels/acre*	1.83	1.60	1.44	1.34
Acres reseeded	*Percent of acres*	0.96	1.06	1.04	3.10
Home-grown seed	*Percent of seed*	17	33	50	51
Fertilizer use:					
Any fertilizer	*Percent of farms*	93	88	92	95
Nitrogen	*Percent of farms*	92	88	92	95
Phosphorus	*Percent of farms*	71	62	63	67
Potassium	*Percent of farms*	57	38	25	13
Manure	*Percent of farms*	7	*	*	*
Fertilizer application rates:					
Nitrogen	*Pounds/acre*	66.57	56.47	62.86	54.63
Phosphorus	*Pounds/acre*	40.12	26.25	25.19	18.69
Potassium	*Pounds/acre*	35.87	20.68	12.17	2.95
Manure	*Tons/acre*	0.39	0.10	0.01	0.02
Chemical use:					
Any chemicals	*Percent of farms*	31	47	64	74
Herbicides	*Percent of farms*	30	45	58	73
Insecticides/fungicides	*Percent of farms*	*	*	10	10
Herbicides	*Acre treatments*	0.34	0.46	0.65	0.90
Insecticides/fungicides	*Acre treatments*	0	0.02	0.08	0.05
Tillage system:					
Conventional with moldboard plow	*Percent of farms*	13	6	5	5
Conventional without moldboard plow	*Percent of farms*	66	54	73	74
Mulch tillage	*Percent of farms*	12	25	14	20
No-till	*Percent of farms*	9	15	9	*
Custom operations:					
Any custom operations	*Percent of farms*	58	59	59	75
Land prearation/ cultivation	*Percent of farms*	6	8	13	36
Planting	*Percent of farms*	2	6	*	7
Fertilizer/chemical application	*Percent of farms*	47	46	46	59
Harvesting/hauling	*Percent of farms*	20	26	18	30
Fuel use:					
Diesel	*Gallons/acre*	4.57	4.04	5.20	5.02
Gasoline	*Gallons/acre*	3.43	2.77	3.73	2.20
LP gas	*Gallons/acre*	0.04	0.28	0	0.14
Natural gas	*1,000 cubic feet/acre*	0.04	0.11	0.13	0.30
Electricity	*Kilowatt hours/acre*	0.08	0.05	0.31	0.14
Labor use:					
Unpaid labor	*Hours/acre*	2.28	1.72	1.45	1.12
Paid labor	*Hours/acre*	0.57	0.32	0.26	0.41

* = 0.1 to less than 5 percent. Totals may not add to 100 percent due to omission of a category or rounding error.

Source: U.S. Department of Agriculture's 1994 Farm Costs and Returns Survey.