

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

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

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

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

Gross value of production:
 Wheat
 Wheat straw and grazing
 Total, gross value of production

Cash expenses:

Seed
 Fertilizer
 Chemicals
 Custom operations
 Fuel, lube, and electricity
 Repairs
 Hired labor
 Purchased water and baling
 Total, variable cash expenses

General farm overhead
 Taxes and insurance

Interest

Total, fixed cash expenses

Total, cash expenses

Gross value of production, less cash expenses

Economic (full-ownership) costs:

Variable cash expenses
 General farm overhead
 Taxes and insurance
 Capital replacement
 Operating capital
 Other nonland capital
 Land
 Unpaid labor
 Total, economic (full-ownership) costs

Residual returns to management and risk

Yield (*Bushels per planted acre*)

Farm-operator account, excluding Government programs

Gross value of production:
 Wheat
 Wheat straw and grazing
 Total, gross value of production

Variable cash expenses:

Seed
 Fertilizer
 Chemicals
 Custom operations
 Fuel, lube, and electricity
 Repairs
 Hired labor
 Purchased water and baling
 Total, variable cash expenses

General farm overhead
 Real estate and property taxes
 Insurance
 Interest
 Land rent
 Total, fixed cash expenses

Noncash expenses:

Capital replacement
 Hired labor benefits

Total costs:

Variable cash expenses
 Fixed cash expenses
 Noncash expenses

Total costs

Residual returns to equity, unpaid labor,
 management, and risk

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:

$$H_0: \mu_1 = \mu_2$$

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

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

Item	95-percent confidence interval					
	Cash costs			Economic costs		
	Lower	Mean	Upper	Lower	Mean	Upper
<i>Dollars per planted acre</i>						
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:

$$\sigma_y = \frac{\alpha_1^2 \sigma_{11} + \alpha_1 \alpha_2 \sigma_{12} + \dots + \alpha_1 \alpha_k \sigma_{1k} + \alpha_2 \alpha_1 \sigma_{21} + \alpha_2^2 \sigma_{22} + \dots + \alpha_2 \alpha_k \sigma_{2k} + \dots + \alpha_k \alpha_1 \sigma_{k1} + \alpha_k \alpha_2 \sigma_{k2} + \dots + \alpha_k^2 \sigma_{kk} + \sigma_\varepsilon}{\sigma_y}$$

where σ_{ii} and σ_{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:

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

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 $1 - R^2$. 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).