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Estimating the USDA, Economic Research Service Commodity Costs and Returns and the Milk Cost of Production Estimates Data Series

Jeffrey Gillespie, Amy Boline, Kate Vaiknoras, Samantha Padilla, and Monte Vandeveer

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Abstract

USDA, Economic Research Service (ERS) publishes annual costs and returns estimates for 12 major agricultural commodities (field crops, livestock, and milk) as part of the agency's Commodity Costs and Returns data series and Milk Cost of Production Estimates data series. Since 1975, commodity costs and returns estimates have been made for these commodities because legislation has mandated their estimation, the estimates help inform policy development, and/or the commodities account for a sizeable share of U.S. agricultural production. The estimates are published biannually at national and regional levels for all commodities and at the State level for milk. Methods used to produce cost and returns estimates are consistent with recommendations made by the American Agricultural Economics Association Task Force on Commodity Costs and Returns in 2000. Special commodity versions of USDA's Agricultural Resource Management Survey and other USDA, National Agricultural Statistics Service data are the primary sources of information for developing cost and returns estimates. Commodity costs and returns data are used for policy and production decisions by a variety of stakeholders including policymakers, consultants, agricultural producers and agribusinesses, university extension personnel, and researchers. This report provides information on the methods and data sources used by USDA to develop its Commodity Costs and Returns estimates.

Keywords: commodity costs, ARMS, crops, livestock, milk

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About the Authors

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Estimating the USDA, Economic Research Service Commodity Costs and Returns and the Milk Cost of Production Estimates Data Series

Introduction

USDA, Economic Research Service (ERS) has published annual production costs and returns (CAR) estimates for major U.S. field crop and livestock commodities since 1975. The primary motivation to begin publishing these estimates was the Agriculture and Consumer Protection Act of 1973 (the 1973 Farm Bill), which directed USDA to establish national, weighted average cost of production estimates for wheat, feed grain,[1] cotton, and dairy commodities, and update the estimates annually. The legislation specified that the estimates should include all typical variable costs, including interest, as well as returns on fixed costs and management. Other commodities have also been included in USDA's Commodity Costs and Returns estimates data series. These commodities include cow-calf, hogs, peanuts, rice, and soybeans. In earlier years, estimates for sugar beets (1981–2007) and tobacco (1996–2004) were included as well.

This report describes the methods used by USDA to estimate annual CAR estimates for 12 commodities: barley, corn, cotton, cow-calf, hogs, milk, oats, peanuts, rice, sorghum, soybeans, and wheat. This report also briefly covers the Agricultural Resource Management Survey (ARMS), how USDA develops CAR estimates from ARMS, and how the estimates are updated biannually. Although this report covers the methods used in creating USDA's Commodity Costs and Returns data series, readers are also referred to other sources, such as the American Agricultural Economics Association Task Force on Commodity Costs and Returns (AAEA-TFCCR) Estimation Handbook (2000), for greater detail. This report is based on and expands on the documentation provided on the USDA, ERS Commodity Costs and Returns data series website, so some of the wording in this report is repetitive of what is provided on the website with elaboration for further detail. Though forecasts for the cost of production (COP) of field crops are included as part of the USDA Commodity Costs and Returns data series, methods used to produce these forecasts are not discussed in this report.

Overview of the Commodity Costs and Returns Data Product

To meet the legislative directive of the Agriculture and Consumer Protection Act and stakeholder needs, U.S. agricultural commodity CAR estimates are reported at both national and regional levels twice per year. Milk estimates are also reported by State. The first release annually of USDA's Commodity Costs and Returns and Milk Cost of Production estimates normally occurs on the first weekday in May and the second release on the first weekday in October. Data are reported for the most recently completed crop year and the most recently completed year of livestock production, as well as for earlier years. Data for the previous year

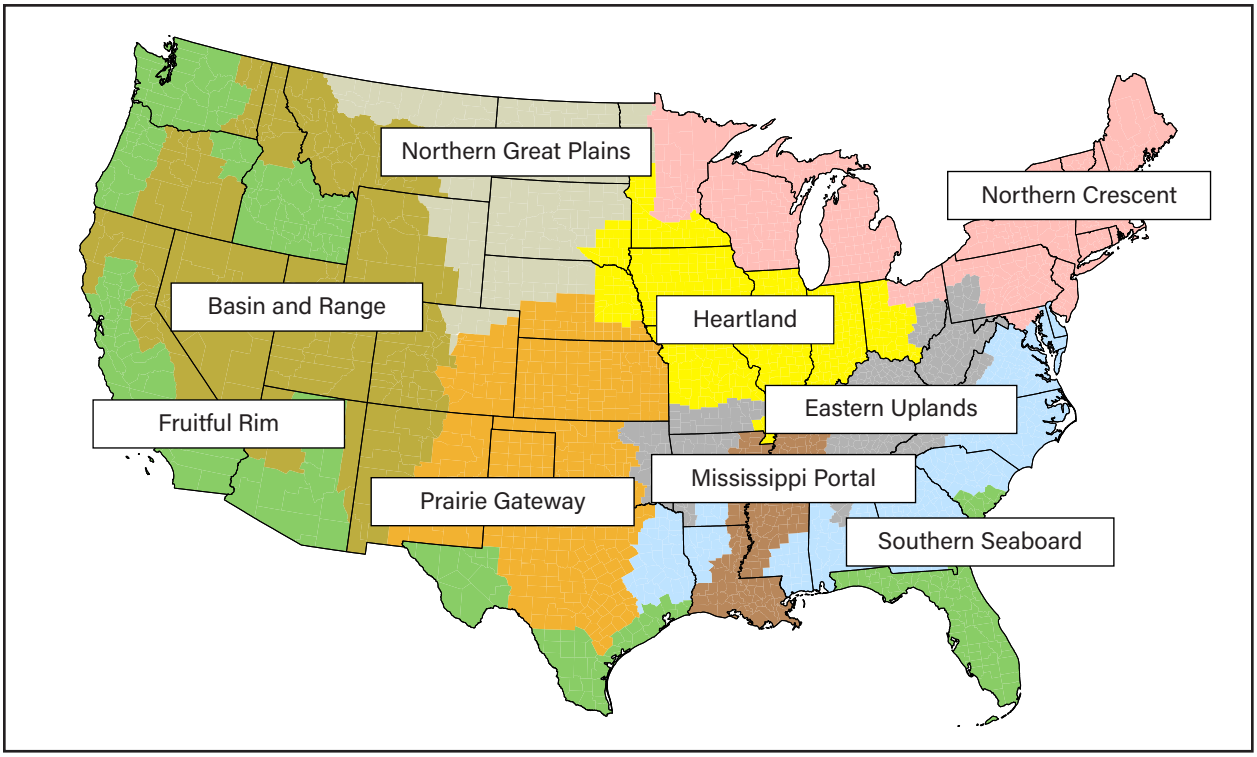
[1] The feed grains included in commodity CAR estimates are barley, corn, oats, and sorghum.

are considered preliminary in the May update each year. Estimates for the previous year may be final at the October release, though additional adjustments to prior years may be made in subsequent releases if revised data used for updates are made available.

Since the first USDA Commodity Cost and Returns estimates were published in 1975, two distinct methodologies have been used for estimating the data. These methodologies are referred to as "historical" and "recent." Historical methods were used to estimate commodity CAR and present them as a time series of estimates starting from the first year a particular commodity estimate was made, typically the late 1970s or early 1980s (depending on the commodity), until the late 1990s or early 2000s. Recent methods, on the other hand, have been used by USDA to estimate and present commodity CAR as a time series of estimates using the format and revised methods as endorsed by the AAEA-TFCCR handbook (2000). The first recent estimates were published in 1995 (peanuts and sorghum), and other commodities were converted over the following decade as new ARMS commodity surveys were conducted. In 2005, oats was the last commodity to be converted. This report focuses on the recent methods used to estimate CAR.

Most recent regional estimates are reported by USDA, ERS Farm Resource Region, while earlier historical regional boundaries followed U.S. State lines where States were grouped according to similar production practices and resource characteristics. USDA, ERS Farm Resource Region boundaries (figure 1) provide a consistent delineation across commodities and classify farms into similar resource and farm-type regions along county lines (Heimlich, 2000). Alternative regional boundaries are used for peanuts and rice. For peanuts, the Southern Seaboard is currently divided into two regions—one that includes North Carolina, South Carolina, and Virginia, and the other that includes Alabama and Georgia. Rice regions currently include the Arkansas Non-Delta, California, Gulf Coast, and Mississippi River Delta regions (figure 2).

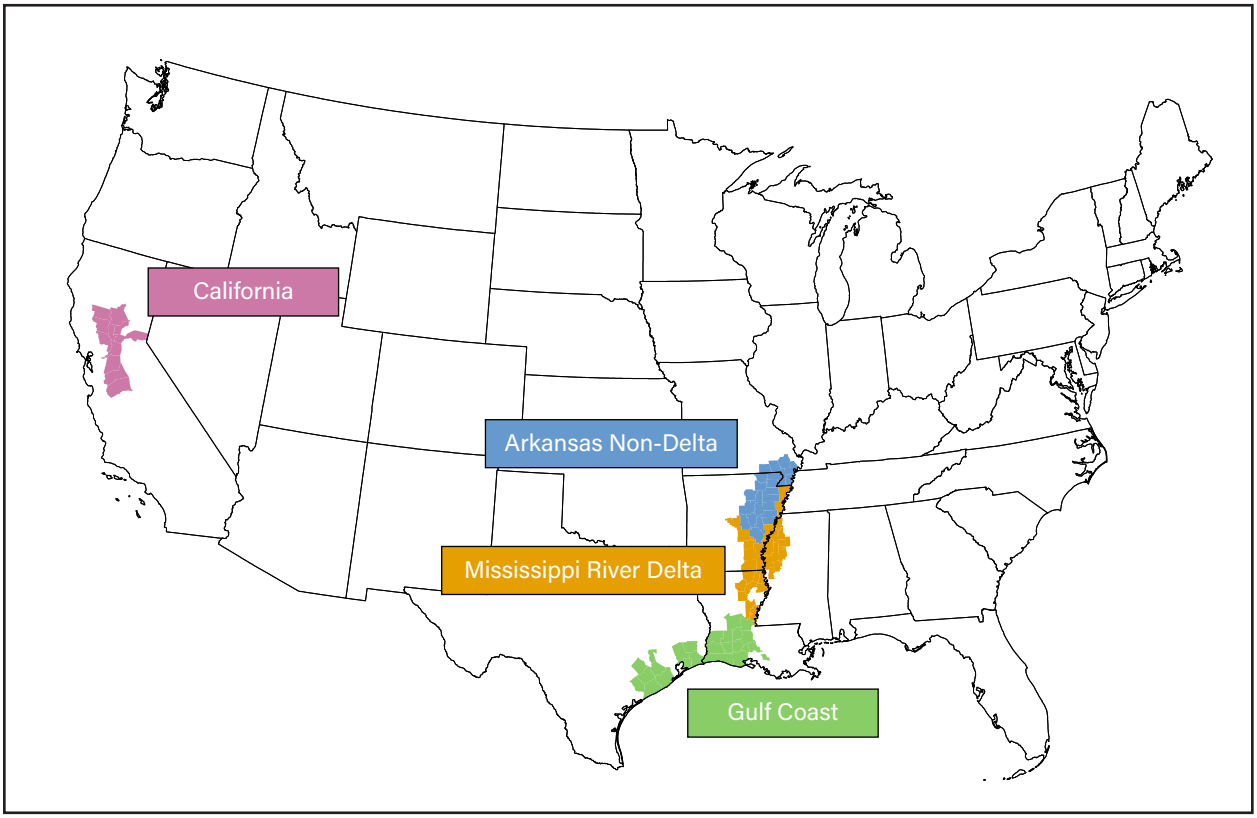
Figure 1
USDA, Economic Research Service Farm Resource Regions



Note: Alaska and Hawaii are not sampled in the Agricultural Resource Management Survey for any of the commodities included in the Commodity Costs and Returns data series.

Source: USDA, Economic Research Service.

Figure 2
Rice production regions, as reported in USDA Commodity Costs and Returns data



Note: Alaska and Hawaii are not shown because they are not sampled in the Agricultural Resource Management Survey for the rice versions of the survey.

Source: USDA, Economic Research Service.

USDA, ERS Commodity Costs and Returns estimates are developed from ARMS, so the estimates are based on actual costs incurred by producers in the past year. As such, the estimates differ from projected accounts, often referred to as enterprise budgets that are reported by many land grant universities for the current year to assist in farm planning. The CAR of all participants who incur costs in producing the commodity at the farm level—not just those of the farm operator but also those of landlords, contractors, and contractees—are included in the USDA Commodity Costs and Returns estimates. For this reason, the estimates are often referred to as sector accounts, representing the costs and returns of all resources used in producing the commodity.

Though the ARMS is conducted every year, special commodity-specific versions of ARMS that are used to develop the commodity CAR estimates are conducted on a rotating basis about every 4 to 10 years, depending upon the commodity. When new ARMS commodity data are made available, this information is used to develop the estimates for the survey year, which are then updated in subsequent years using annual price, acreage, and production data provided by USDA, National Agricultural Statistics Service (NASS). These updates continue until the next ARMS commodity survey for that specific commodity, from which new survey year estimates are made. For example, the most recent ARMS corn survey was conducted in 2021, so 2021 survey year estimates for corn production were developed from this data, with subsequent year estimates reflecting new USDA, NASS price, acreage, and production estimates. This methodology essentially binds the technology underlying the accounts to the survey year technology. For example, the distribution

of technologies included in the 2016 dairy ARMS (pasture-based systems, parlor systems, organic systems, robotic systems, etc.) were represented in USDA's 2016 Milk Costs and Returns estimates and were held constant in the years thereafter with input price adjustments. When the new 2021 dairy ARMS survey-year estimates became available, the underlying distribution of these technologies changed, impacting the milk CAR estimates from 2021 until the next dairy ARMS. Survey-year estimates should be regarded as the most reliable because the estimates reflect both prices and technologies used during the survey year. The reliability of estimates in nonsurvey years likely varies by commodity according to the degree of technical and structural change that has occurred since the last survey.

The theoretical basis and accounting methods used for recent USDA Commodity Costs and Returns estimates conform with standards recommended by the AAEA-TFCCR handbook (2000). These estimates include only costs incurred in the production of each commodity. For crops, this excludes crop marketing and storage costs. Returns above operating and total costs are estimated by valuing production at the end of the production period, using a harvest period price. However, producers often delay crop sales and store commodities with the expectation that the price in later months will exceed the harvest-period price plus the costs incurred with carrying the crop inventory. Thus, the return estimates above operating and total costs likely understate the actual returns received by producers. Marketing costs are included in the livestock accounts where production is not typically stored for a significant period before being marketed.

All Government program payments and crop insurance income and expenses are excluded from commodity CAR estimates.[2] For example, estimated returns for crop commodities exclude marketing loan benefits, which have been substantial for some commodities during years of low crop prices, and estimated returns for dairy exclude payments through the Dairy Margin Coverage program, which have also been substantial in recent years. While Government payments may provide revenue to farmers in some years, they are not direct returns from commodity production. The major Government farm programs change about every 5 years with new farm bills, and these changes seldom coincide with ARMS commodity survey years. Furthermore, Government payments often reflect market conditions (i.e., lower market prices imply higher program payments), so payment rates usually change every year. Thus, program payments reported in the survey year may have little relation to payments in other years, complicating the estimation of program payments in nonsurvey years. ARMS does not allocate Government payments by commodity, further complicating an estimation of payments specific to a commodity. Users wishing to analyze the impacts of a new or revised Government program on commodity costs and returns may estimate the impacts using partial budgeting by determining expected additional revenues, reduced revenues, additional costs, and/or reduced costs associated with the program.

The Agricultural Resource Management Survey (ARMS)

ARMS is conducted in three distinct phases. ARMS Phase 1 is conducted during the summer of the crop or livestock production year to develop a list of farms that are producing the commodity during that year. ARMS Phase 2 follows and is conducted for crop commodities during the fall of the production year to collect detailed information about input use, field operations, and production costs of a specific chosen field on the surveyed farm. Unique ARMS Phase 2 questionnaire versions are used for each of the crop commodities surveyed in a particular year.

[2] USDA, ERS Farm Income and Wealth Statistics data indicate that Federal Government total direct Government payments to U.S. farms between 2018 and 2022 ranged from $13.7 billion in 2018 to $45.6 billion in 2020.

During the winter and spring of the following year, ARMS Phase 3 collects farm-level information using several distinct versions: the Costs and Returns Report (CRR) version, crop-specific versions, and livestock versions (though there may not be any crop or livestock versions in a particular year, depending on the crop and livestock survey rotations). The CRR version collects whole-farm economic data on a cross-section of U.S. farms that may be producing a wide range of commodities. Crop-specific versions collect whole-farm economic and additional crop-specific information for the same farms that were surveyed in Phase 2. All crop commodities include a Phase 3 version in addition to the Phase 2 version. Livestock versions collect whole-farm economic and commodity-specific information about production practices and input use for cow-calf, dairy, and hog farms.

ARMS data collection may be conducted using mail surveys, inperson enumeration, computer-assisted enumeration, or other modes, with the chosen mode depending primarily on the complexity of the specific questionnaire.[3] Questionnaires are developed jointly by USDA, NASS and USDA, ERS. Survey enumerators are trained for data collection by both agencies and are employed by the National Association of State Departments of Agriculture. Questionnaires, interviewer manuals, and respondent booklets may be found on the USDA, ERS ARMS Farm Financial and Crop Production Practices website.

Target populations for crop commodities for ARMS include all farms producing one or more acres of the commodity. To qualify for the ARMS hog survey, operations must have had a minimum of 25 head in inventory at some point during the survey year. A minimum of 10 cows milked at some point during the year is required for dairy operations, while cow-calf operations must have at least 20 beef cows at some point during the year to qualify. U.S. States selected for the survey must collectively represent at least 90 percent of U.S. production of the commodity. Each farm sampled in ARMS represents a known number of farms with similar attributes. Thus, weighting the data for each farm by the number of farms each farm represents provides a basis for calculating target population estimates. National, regional, and State (dairy) commodity CAR estimates are published by USDA when there are sufficient observations and there is no risk of disclosure of the economic or production characteristics of any particular farm.

Types of Costs and Estimating Approaches

Recent cost estimates in the USDA, ERS Commodity Costs and Returns data are categorized as either operating costs or allocated overhead costs. Operating costs are generally variable costs and include costs of seed, fertilizer, feed, chemicals, custom operations, veterinary and medical expenses, repairs, interest on operating capital, and others. Allocated overhead costs is a category of expenses recommended by the AAEA-TFCCR handbook (2000) that includes costs of hired labor, opportunity cost of unpaid labor, capital recovery of machinery and equipment, opportunity cost of land, general farm overhead, and taxes and insurance. In historic estimates, costs were categorized as either variable or economic costs.

Four basic approaches are used to estimate commodity costs in survey years: direct costing, valuing input quantities, indirect costing, and allocating whole-farm expenses. The choice among approaches used to estimate a particular cost item is driven primarily by the ability of respondents to report commodity-specific costs for the item. For example, most farmers can report the cost of seed purchased for a field but cannot report the fuel cost for a field because fuel is typically used to produce several commodities across many fields on the same farm. Table 1 provides the lists of costs that are determined using each of the four different approaches to estimate commodity costs.

[3] In recent years, primarily in response to complications associated with personal enumeration during the Coronavirus (COVID-19) pandemic, computer-assisted web interview and computer-assisted personal interview instruments have been used for some surveys. In some cases, the respondent has had a choice of response mode.

Table 1
Approaches used to estimate costs reported in the USDA Commodity Costs and Returns data

Direct costing	Valuing input quantities	Indirect costing	Allocating whole-farm expenses
Crop commodities			
Purchased seed	Homegrown seed	Fuel, lube, and electricity	General farm overhead
Fertilizer	Manure	Repairs	Taxes and insurance
Chemicals	Unpaid labor	Capital recovery	
Custom operations	Hired labor		
Ginning (cotton)	Land		
Purchased water	Operating interest		
Commercial drying (rice, peanuts)			
Livestock and milk commodities			
Purchased feed	Homegrown feed	Capital recovery	General farm overhead
Feeder animals	Grazed feed		Taxes and insurance
Vet and medicine	Unpaid labor		
Bedding and litter	Land		
Marketing	Operating interest		
Custom services			
Fuel, lube, and electricity			
Repairs			
Hired labor			

Source: USDA, Economic Research Service.

Direct costing involves summarizing ARMS responses to questions about amounts paid for an input item. For items such as crop fertilizer and chemicals, cost is determined by asking the respondent how much was spent on the surveyed field for the inputs used to produce the crop. For other items, such as livestock custom services and repairs, cost is determined by asking the respondent how much of the total farm expenditures for the input were used for the production of the commodity. Direct costing is the preferred cost estimation procedure because direct costing does not require any assumptions about prices or quantities. However, direct costing works well only when the respondent has commodity-specific records or can recall the amount spent for the commodity.

Valuing input quantities combines survey data on the physical quantities used in the production process with secondary data on input prices. This approach is used when farm-produced or farm-owned inputs and opportunity costs are the best means of determining the input values. For example, homegrown seed and homegrown feed costs are estimated by valuing the quantities used of each item by crop prices.

Indirect costing uses a combination of survey information on production practices, technical information on machine performance, and engineering formulas determined from machinery tests. This method is used for estimating costs associated with using farm machinery and equipment because these items typically help produce multiple farm commodities and, thus, are not easily allocated to a single commodity. Survey information on machine type, size, and hours used is combined with secondary information on fuel use rates, repair rates, replacement costs, and years of expected life to drive engineering formulas that compute annual machinery operating and ownership costs. Much of the secondary information is publicly available through the American Society of Agricultural and Biological Engineers (ASABE). These costs are computed for inputs such as machinery, irrigation equipment, livestock housing, and feed storage. For example, ASABE publishes machinery performance data in its Agricultural Machinery Management Data (2011).

Allocating whole-farm expenses takes survey responses to whole-farm expense items and allocates the responses to a commodity according to an allocation scheme. This method is used for estimating items whose cost cannot be directly attributed to a single commodity but where all commodities must contribute to the cost. The allocation scheme used in USDA's Commodity Costs and Returns is an estimate of the share of the total farm operating margin, or farm value of production minus operating costs accounted for by the commodity. For example, if a commodity accounts for 30 percent of the total farm operating margin, the commodity is charged 30 percent of the farm's overhead, taxes, and insurance costs.

Surveys often include item nonresponses or responses that are out-of-range of reasonable expectations. Out-of-range responses and item nonresponse may result from respondents preferring not to respond to a particular question, not fully understanding the question, providing the incorrect units for the volume or weight of an input, or various other reasons. Given the extent of the data required to estimate CAR for various commodities and the differing nature of the estimated costs for each one, USDA's Commodity Costs and Returns team does not use only one method for estimating all missing or out-of-range data. Generally, in such cases, an analyst examines other data in the survey that could provide accurate information on the cost. For example, if a dairy respondent does not report the cost of purchased feed, the analyst will first examine responses to a question that requests respondents to list purchased feeds and their associated costs. A total purchased feed cost can usually be derived from that information. If no other information is available for estimating the cost, the analyst will generally impute the value using a mean value of responses from similar farms. The granularity to which the imputed value can be estimated (national, State, regional, production system, farm size, etc.) generally depends on the number of observations available by category. Regarding some of the specific costs in this report, some alternative methods used to estimate missing or out-of-range data are discussed.

Estimating Field Crop Commodity Costs and Returns for Survey Years

Estimating field crop production CAR involves the use of responses from both Phases 2 and 3 of ARMS. Most of the data for estimating crop CAR comes from Phase 2. Phase 3 data are utilized for (1) allocating whole-farm expenses costs and (2) estimating crop drying and cotton ginning costs because both actions may have occurred after the Phase 2 survey has been conducted, and commodities from multiple fields will likely be dried or ginned together. Phase 3 data may also be used as alternative information in cases where Phase 2 data are missing or require validation. All crop commodity CAR data are reported by USDA on a per-acre basis. For all crops except for peanuts and rice, regions for which estimates are reported are the USDA, ERS Farm Resource Regions.

Gross Value of Production: Crop Commodities

Generally, the survey year gross value of crop production is estimated by valuing survey-crop yields using State average, survey year, harvest month crop prices. The harvest month crop price is the price that is reported in the most common harvest month for a particular U.S. State, found in USDA, NASS Agricultural Prices reports. For field crops, the gross value of production includes the primary product (e.g., soybeans, grain, peanuts) and sometimes a secondary product such as straw or grazing. Table 2 summarizes the equations for each component of the gross value of production for crops. For the primary product, the gross value of production, GVP_{pp}, is estimated as the product of the quantity of the primary product harvested, Q_{harv}, (e.g., bushels of corn harvested) as reported by ARMS respondents and the State harvest month commodity price, P_{pp} (e.g., price per bushel of corn).

Table 2
Summary of gross value of production for crop commodities

Value of production	Equation	Components
Primary product GVP_{pp}	$GVP_{pp} = Q_{harv} * P_{pp}$	Q_{harv} = quantity of the primary product harvested P_{pp} = primary product harvest month price
Secondary product GVP_{sp}	$GVP_{sp} = f(Q_{harv}) * P_{sp}$	$f(Q_{harv})$ = relationship to quantity of the primary product harvested P_{sp} = secondary product harvest month price
Total gross value of production GVP_{tot}	$GVP_{tot} = GVP_{pp} + GVP_{sp}$	GVP_{pp} = primary product value GVP_{sp} = secondary product value

Source: USDA, Economic Research Service.

Secondary products may include straw, which is generally harvested following the harvest of the primary product, and grazing, where for some crops, livestock may graze the crop during growth or the stubble after harvest of the primary product. Commodities for which straw is included as a secondary product are barley, oats, and wheat. The gross value of production of straw is estimated using the price and the quantity of straw harvested, both reported in ARMS Phase 2. Commodities for which grazing is included as a secondary product are barley, oats, sorghum, and wheat. The gross value of production from grazing is determined directly from an ARMS Phase 2 question asking for the amount received from other people for livestock grazing on the field. The gross values of production of corn and sorghum silage are estimated in a manner similar to primary products because both silage and grain would not be harvested on the same field. Because USDA, NASS does not publish silage prices, the USDA, NASS price of other hay is used. The crop commodity CAR data are expressed on a per-acre basis, so the gross value of production estimates is divided by acres planted.

USDA, ERS Commodity Costs and Returns data users sometimes ask why nationally reported yields and prices in the data series do not equal those reported by USDA, NASS in its Crop Production reports and Agricultural Prices reports. Yields reported in the commodity CAR data are derived from ARMS commodity surveys, which are targeted to the States that produce at least 90 percent of the production of the commodity; yields reported by USDA, NASS in its Crop Production reports are from separate national surveys. Prices may differ from those reported in USDA, NASS Agricultural Prices reports because prices used in the commodity CAR data are USDA, NASS State-level prices for the State's most common harvest month. For most commodities, harvest months differ by State.

Operating Costs: Crop Commodities

Operating costs for crop commodities are detailed in table 3.

Table 3
Summary of operating costs for crop commodities

Cost	Equation	Estimation method	Components
Purchased seed $COST_{pseed}$	$COST_{pseed} = SR * ACRES * RESEED * P_{seed}$	Direct costing using ARMS Phase 2	SR = seeding rate $ACRES$ = planted acres in the field $RESEED$ = number of times the field was seeded P_{seed} = per-unit cost of seed
Homegrown seed $COST_{hseed}$	$COST_{hseed} = Q_{hseed} * P_{seed, t-1}$	Valuing input quantities using State-level seed prices from previous year	Q_{hseed} = total quantity of homegrown seed $P_{seed, t-1}$ = price of the commodity from the previous year in the State where the farm is located
Total seed cost $COST_{seed}$	$COST_{seed} = COST_{pseed} + COST_{hseed}$		$COST_{seed}$ = sum of purchased and homegrown seed costs
Commercial fertilizer $COST_{cfert}$	$COST_{cfert}$	Direct costing using ARMS Phase 2	
Soil conditioners $COST_{scond}$	$COST_{scond} = (Q_{lime} * P_{lime}) + (ACRES * P_{gyp})$	Valuing input quantities using ARMS Phase 2	Q_{lime} = tons of lime applied, reported in ARMS Phase 2 P_{lime} = price of lime per ton. $ACRES$ = planted acres in the field P_{gyp} = price of gypsum per acre
Manure and compost $COST_{mancomp}$	$COST_{mancomp}$	Valuing input quantities using ARMS Phase 2	
Total fertilizer $COST_{fert}$	$COST_{fert} = COST_{cfert} + COST_{scond} + COST_{mancomp}$		$COST_{fert}$ = sum of soil conditioners, commercial fertilizer, manure, and compost costs
Chemical costs $COST_{chem}$	$COST_{chem}$	Direct costing using ARMS Phase 2	$COST_{chem}$ = sum of chemical pesticides and biological pest controls
Custom services $COST_{custc}$	$COST_{custc}$	Direct costing using ARMS Phase 2 and ARMS Phase 3	$COST_{custc}$ = sum of costs of all reported custom service operations
Commercial drying (for rice and peanuts) $COST_{custd}$	$COST_{custd}$	Direct costing using ARMS Phase 3	$COST_{custd}$ = cost of commercial drying
Irrigation fuel $COST_{fuelirr}$	$COST_{fuelirr}$	Direct costing using ARMS Phase 2	$COST_{fuelirr}$ = cost of fuel used for irrigation

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Cost	Equation	Estimation method	Components
Drying fuel $COST_{fueldry}$	$COST_{fueldry}$	Indirect costing and published fuel usage data except for peanuts, which uses direct costing. All use ARMS Phase 3	$COST_{fueldry}$ = cost of fuel used for drying the crop
Equipment fuel $COST_{fueleq}$	$COST_{fueleq}$	Indirect costing using ARMS Phase 2 and American Society of Agricultural and Biological Engineers Agricultural Machinery Management data	$COST_{fueleq}$ = cost of fuel for trucks, tractors, and other self-propelled equipment
Total fuel cost $COST_{fuelc}$	$COST_{fuelc} = COST_{fuelirr} + COST_{fueldry} + COST_{fueleq}$		$COST_{fuelc}$ = sum of fuel used for irrigation, drying, and equipment
Repair costs $COST_{repac}$	$COST_{repac}$	Indirect costing using ARMS Phase 2 and 3 and American Society of Agricultural and Biological Engineers Agricultural Machinery Management data	$COST_{repac}$ = sum of estimated repair costs associated with machines used for crop field operations, irrigation, and drying
Ginning costs (cotton) $COST_{gin}$	$COST_{gin}$	Direct costing using ARMS Phase 3	$COST_{gin}$ = cost associated with ginning cotton
Water costs (corn, cotton, rice, sorghum, and soybeans) $COST_{piw}$	$COST_{piw}$	Direct costing using ARMS Phase 2	
Other costs (barley, peanuts, oats, and wheat) $COST_{othc}$	$COST_{othc} = COST_{piw} + COST_{bal}$	Direct costing using ARMS Phase 2	$COST_{piw}$ = irrigation water $COST_{bal}$ = baler twine or wire used to bale straw
Interest on operating inputs $COST_{iopc}$	$COST_{iopc} = (COST_{opinc} * (1 + STI)^{0.5}) - COST_{opinc}$		$COST_{opinc}$ = total operating input costs STI = short-term interest rate

ARMS = Agricultural Resource Management Survey.

Source: USDA, Economic Research Service.

Seed costs, $COST_{seed}$, for crops are determined via direct costing for purchased seed, $COST_{pseed}$, and valuing input quantities for homegrown seed, $COST_{hseed}$. The ARMS Phase 2 asks respondents to report their per-acre seeding rate, the number of acres that were reseeded (if any) and the number of times they were reseeded, the total number of acres in the field, and their per-unit cost of seed. These values allow for the calculation of purchased seed costs (table 3). The cost of homegrown seed, $COST_{hseed}$, is estimated by valuing input quantities. It is assumed that homegrown seed comes from the previous year's harvest, so $COST_{hseed}$ is based on the USDA, NASS-reported price of the commodity from the previous year in the State where the farm is located, $P_{seed, t-1}$. Total seed cost is calculated as: $COST_{seed} = COST_{pseed} + COST_{hseed}$.

Fertilizer cost, $COST_{fert}$, is the cost of all commercial fertilizers, soil conditioners (lime and gypsum), manure, and compost. The cost of commercial fertilizer, $COST_{cfert}$, is estimated via direct costing from ARMS Phase 2 using the following question: "What was the total cost of all nutrient or fertilizer products applied to the selected field?" Responses to this question do not allow for splitting fertilizer costs by type of fertilizer. In cases where respondents do not respond to the direct costing question, valuing input quantities is used. ARMS Phase 2 includes a table in which respondents report information about each fertilizer application made to the field. The information includes quantities or percentages of total reported quantities of nitrogen, phosphate, potash, and sulfur, and the number of acres to which the fertilizer was applied. Using data from this table, total quantities of nitrogen, phosphate, potash, and sulfur applied to the field are calculated. These quantities are multiplied by nutrient prices to yield the total costs of these nutrients.[4] The summed values of these costs are used for respondents who do not report total commercial fertilizer costs directly.

The cost of soil conditioners, $COST_{scond}$, is determined by valuing input quantities. In ARMS Phase 2, respondents are asked to report whether they ever apply lime to the selected field. If they respond affirmatively, the respondents are asked how many tons were applied the last time lime was applied and how many years elapsed between lime applications. This information is used to allocate the cost of lime across years. The annualized quantity of lime (Q_{lime}) used is then multiplied by the price of lime (P_{lime}). For some farms, gypsum is applied. In cases where this information is indicated in ARMS Phase 2, it is assumed that 1 ton per acre of gypsum is applied. To obtain the total cost of gypsum, the number of acres in the field is multiplied by the price of gypsum (P_{gyp}). The total cost of soil conditioners, $COST_{scond}$, is the sum of lime and gypsum costs (table 3).

The costs of manure and compost, $COST_{mancomp}$, are determined by valuing input quantities. In ARMS Phase 2, respondents report the number of crop acres on which manure or compost was applied and the quantity applied. The animal species or other source of manure or compost is reported, as well as the application method. Quantities of nitrogen, potassium, and phosphorus are estimated based on the source of manure or compost using standards such as those found in Manure Production and Characteristics, by the American Society of Agricultural and Biological Engineers (ASABE, 2019). The quantity of nitrogen is also adjusted by application type, such as broadcast or sprayed with incorporation or injected/knifed in. Total quantities of nitrogen, potassium, and phosphorus are multiplied by their respective prices to yield $COST_{mancomp}$. The total fertilizer cost is the sum of the costs of commercial fertilizer, soil conditioners, and manure/compost (table 3).

Chemical costs, $COST_{chem}$ which include the costs of both chemical pesticides and biological pest controls, are estimated via direct costing using the sum of responses to the following ARMS Phase 2 questions: (1) "What was the total cost of all chemical, biocontrol, or pesticide products applied to the selected field?," and (2) "What were the total materials and application costs for all biological pest controls for the selected field?" Materials included are defoliants, herbicides, insecticides, fungicides, surfactants, wetting agents, growth regulators, and materials applied before planting and during the previous fallow period. In cases where a respondent does not provide this information, data from a detailed pesticides application table in ARMS Phase 2 are used to determine the cost of chemicals applied. In this table, respondents report each chemical application, including the product applied, the amount applied, the number of acres the product was applied to, and the unit cost of the product. The total cost per application is calculated using this information. Each application cost is then summed to obtain the total chemical cost for the field.

Custom services costs for crops, $COST_{custc}$, include paid services for which the producer reported outsourcing. $COST_{custc}$ is determined via direct costing using a table in ARMS Phase 2, which asks: "Which of the following services were performed for the (year, commodity) crop on the selected field?" Respondents indicate

[4] USDA publishes fertilizer prices in the USDA, Agricultural Marketing Service Market News reports for various States and the USDA, ERS Fertilizer Use and Price data.

which of seven specific services were performed using custom services, including custom land preparation, shaping, and/or leveling; custom cultivating; custom planting and/or reseeding; custom harvesting; custom hauling to storage or point of first sale; custom harvesting and hauling from field to storage or point of first sale; and custom raking, baling, and hauling the straw from the selected field. For each service, the respondent is asked: "Including operator, landlord, and contractor costs, how much was spent for (this service) on the selected field for the (year, commodity) crop?" The custom services cost category also includes expenses for the custom application of nutrients, fertilizers, manure, compost, chemicals, biocontrols, and pesticides. Finally, the category includes custom soil and plant tissue tests, scouting, technical, and consulting services. The costs of all fertilizers and chemicals themselves are not included, only the application costs. ARMS Phase 3 is used to determine custom service costs associated with drying, $COST_{custd}$, using direct costing. For respondents who indicated the crop was custom dried, they are asked, "How much was spent for custom drying of the (year, commodity) crop?" $COST_{custc}$ is the sum of the costs of all reported custom service operations. For rice and peanuts, custom drying costs are reported separately.

Fuel, lube, and electricity costs for crops, $COST_{fuelc}$, is the sum of the costs of fuel used for irrigation equipment **(**$COST_{fuelirr}$**)**; on-farm drying **(**$COST_{fueldry}$**)**; and trucks, tractors, and self-propelled machinery such as combines and cotton pickers ($COST_{fueleq}$). For ARMS Phase 2 respondents indicating they irrigated the field during the crop year, $COST_{fuelirr}$ is determined using direct costing by asking: "What was the cost of the fuel or electricity used to irrigate the selected field?" In cases where a respondent does not respond to the direct costing irrigation fuel question, $COST_{fuelirr}$ is estimated using indirect costing based on the reported motor type of irrigation system, hours of pumping, and price parameters, all from ARMS Phase 2.

$COST_{fueldry}$ for all crops except peanuts are estimated using indirect costing based on a series of questions in ARMS Phase 3 that request information on the quantity of the commodity dried by the operation, fuel type used to dry the commodity, and moisture percentage of the commodity at harvest. Additional information needed to estimate $COST_{fueldry}$ includes assumed commodity moisture percentage after drying and assumed parameters for the amount of fuel used to dry one unit of the commodity 1 percentage point of moisture. Assumed moisture percentage after drying is determined using publications from university extension services recommending crop moisture percentage at sale. Parameters specifying the amount of fuel used to dry the commodity have been sourced from various publications, such as Nichols (1985), Hellevang and Morey (1986), and Paulsen and Odekirk (2000), as well as standard conversion factors for British thermal units (Btu) to units of fuel for diesel, gasoline, propane, natural gas, and electricity. New publications are reviewed periodically to evaluate the accuracy of current parameters. For peanuts, which are typically dried in trailers or wagons, ARMS Phase 3 includes questions that allow for direct costing of fuel for drying: "What was the total cost of each fuel used to dry the peanuts?" followed by cells to be completed for each fuel type (including diesel, gasoline, liquefied petroleum gas, natural gas, electricity, and other). $COST_{fueldry}$ for peanuts is the sum of the reported costs for each fuel type.

$COST_{fueleq}$ is determined based on the usage of the equipment via indirect costing. ARMS Phase 2 includes a table where respondents provide information on each field operation (land forming, tillage, planting, fertilizer and pesticide operations, harvesting, hauling, etc.), including equipment type and size used. ASABE Agricultural Machinery Management Data include fuel usage assumptions for various sizes of agricultural machinery. For each field operation, the quantity of fuel used is calculated based on machine or implement type and width, power source (tractor or self-propelled), and other factors as needed (based on ASABE coefficients). For example, current fuel consumption for a tractor is assumed at 0.06 gallons per horsepower per hour for gasoline (or 0.044 gallons for diesel) engines, as shown in ASABE Agricultural Machinery Management Data (2006). This quantity of fuel is then multiplied by the fuel price to determine the cost of fuel used in that field operation for trucks, tractors, and other self-propelled equipment. Fuel costs for each field operation are then summed to yield a total fuel cost for trucks, tractors, and other self-propelled equipment.

Repair costs for machinery and equipment for crops ($COST_{repac}$) are determined using indirect costing. As discussed with $COST_{fuelc}$, ARMS Phase 2 requests information on each field operation, including the equipment used and the size of the equipment. ASABE Agricultural Machinery Management Data include parameters for repair costs associated with a range of agricultural machinery types. The AAEA-TFCCR handbook (2000), chapter 5, provides details on the formulas used to determine repair costs, assuming the use of the ASABE Agricultural Machinery Management Data. The procedures outlined by the AAEA-TFCCR are applied to machinery used on each responding farm to determine repair costs for each field operation. $COST_{repac}$ is determined as the sum of the estimated repair costs associated with each machine used in the crop field operations. Also included are estimated repair costs for machinery used in irrigation and drying.

Ginning cost ($COST_{gin}$) is the cost associated with ginning cotton, so ginning is included only for USDA's Cotton Costs and Returns estimates. $COST_{gin}$ is estimated via direct costing. In the ARMS Phase 3 cotton survey, respondents are asked whether they paid for ginning costs via cash, cottonseed, or both. If cash was used, they are asked, "What was the total cash payment this operation paid for the ginning of its (year) cotton crop?" If cottonseed, they are asked, "What was the total credit this operation received for the cottonseed exchanged during the ginning of its (year) cotton crop?" If both cash and cottonseed are used to pay for ginning, respondents are instructed to answer both the cash and cottonseed expense questions. In addition, respondents are asked, "If not already included in the cost of ginning, report the total amount this operation paid for compress, bag, and tie charges for the (year) cotton crop." $COST_{gin}$ is the sum of the costs from this series of cotton ginning questions.

Purchased irrigation water cost ($COST_{piw}$) is estimated via direct costing. In ARMS Phase 2, respondents are asked, "What was the total cost for the water purchased for the selected field during the (year) growing season?" Respondents are instructed to include operator, landlord, and contractor costs, as well as ditch maintenance costs for the field. $COST_{piw}$ is itemized separately for corn, cotton, rice, sorghum, and soybeans. For barley, peanuts, oats, and wheat, $COST_{piw}$ is included in an aggregated cost category called other variable expenses, $COST_{othc}$, which also includes costs associated with baler twine or wire used to bale straw (barley, oats, and wheat) or hay (peanuts), $COST_{bal}$. $COST_{bal}$ is estimated via direct costing. In ARMS Phase 2, respondents are asked, "What was the total cost of baler twine/wire used to bale the (commodity, straw/hay) from this field?" For barley, peanuts, oats, and wheat, $COST_{othc} = COST_{piw} + COST_{bal}$.

Interest on operating inputs for crops, $COST_{iopc}$, is the opportunity cost associated with capital that is invested in operating inputs. First, the sum of all operating input costs is estimated: $COST_{opinc} = COST_{seed} + COST_{fert} + COST_{chem} + COST_{custc} + COST_{fuelc} + COST_{repac} + COST_{gin} + COST_{piw} + COST_{othc}$, where $COST_{gin}$ is for cotton only; $COST_{piw}$ is for corn, cotton, rice, sorghum, and soybeans only; and $COST_{othc}$ is for barley, oats, peanuts, and wheat only. As recommended by the AAEA-TFCCR handbook (2000), pages 2–25, interest on operating costs for each farm is estimated as: $COST_{iopc} = COST_{opinc} * (1 + STI)^{0.5} - COST_{opinc}$, where STI is the short-term interest rate, or the 6-month Treasury Bill rate from the Economic Report of the President. The coefficient 0.5 indicates that interest is calculated assuming the amount is outstanding for half (6 months) of the year.

Total operating cost for crops, $COST_{operc}$ is estimated as the sum of all operating costs:
$COST_{operc} = COST_{seed} + COST_{fert} + COST_{chem} + COST_{custc} + COST_{fuelc} + COST_{repac} + COST_{gin} + COST_{piw} + COST_{othc} + COST_{iopc}$

Allocated Overhead Costs: Crop Commodities

Table 4 summarizes the equations and estimation methods for each allocated overhead cost component for crops, as well as the source of information used to calculate each cost.

Table 4
Summary of allocated overhead costs for crop commodities

Cost	Equation	Estimation method	Components
Paid labor $COST_{pdlc}$ and unpaid labor $COST_{uplc}$	$COST_{pdlc}$ and $COST_{uplc}$	Valuing input quantities using ARMS Phases 2 and 3	Labor hours for drying; machine operations; and scouting, irrigating, and other labor costs; wage rates
Capital recovery of machinery and equipment $COST_{recc}$	$COST_{recc} = COST_{mrecc} + COST_{irec} + COST_{drec}$	Indirect costing using ARMS Phases 2 and 3	$COST_{mrecc}$ = sum of capital recovery costs for machinery $COST_{irec}$ = capital recovery costs for irrigation equipment $COST_{drec}$ = capital recovery costs for drying equipment
Land $COST_{landc}$	$COST_{landc} = COST_{rent} + COST_{own}$	Direct costing using ARMS Phase 2 and valuing input quantities using ARMS Phase 3	$COST_{rent}$ = actual rental cost for rented land $COST_{own}$ = opportunity cost of owned land
Taxes and insurance $COST_{txin}$	$COST_{txin} = \%GM_{comm} * COST_{ftxin}$	Allocating whole-farm expenses using ARMS Phase 3	$\%GM_{comm}$ = portion of the farm's gross margin allocated to production of the commodity $COST_{ftxin}$ = whole-farm taxes and insurance costs
Farm overhead $COST_{over}$	$COST_{over} = \%GM_{comm} * COST_{fover}$	Allocating whole farm expenses using ARMS Phase 3	$\%GM_{comm}$: See above. $COST_{fover}$ = whole-farm overhead costs

ARMS = Agricultural Resource Management Survey.

Source: USDA, Economic Research Service.

Labor costs are divided into two classifications in the commodity costs and returns estimates: unpaid labor, $COST_{uplc}$, and paid labor costs, $COST_{pdlc}$. For crops, labor costs for both items are determined by valuing input quantities and come from three major labor use categories: (1) drying, (2) machine operations, and (3) scouting, irrigating, and other work. This report focuses on how labor costs are estimated for each of these labor use categories and then allocated between $COST_{uplc}$ and $COST_{pdlc}$, first concentrating on hours of labor used and then wages assumed.

Labor hours associated with crop drying are determined from ARMS Phase 3. Respondents are asked, "How many hours of each type of labor were used to dry the (year, commodity) crop?" Responses are reported separately for: (1) paid and unpaid producers, family members, and other unpaid workers; (2) full-time hired workers; and (3) part-time or seasonal hired workers. Hours required to dry the crop are determined by dividing the hours for each labor category by the total units dried and then aggregated to a per-planted acre basis.

Labor hours associated with field machinery operations are determined from the field operations table in ARMS Phase 2. Labor hours required for each field operation are determined based on performance rates for machinery using ASABE standards, which allow for estimation of the time required for a machine of a particular size to cover 1 acre. An additional 10 percent of the labor hours required for each field operation

are assumed for machinery setup and miscellaneous operations to determine the total labor hours required. For each field operation, the ARMS Phase 2 field operations table asks respondents to indicate the type of labor used (operator, partner, unpaid worker, paid part-time or seasonal worker, and paid full-time worker), so machinery labor hours can be allocated to the correct labor classification.

Labor hours associated with additional field work are queried in a separate table in ARMS Phase 2. The respondent is asked, "How many hours did (type of worker) spend on the selected field," with instructions to report separately for: (1) scouting for weeds, insects, and diseases; (2) irrigating; and (3) performing other work by hand. Labor hours for each are reported separately by type of worker, including: (1) operator, (2) partner(s), (3) unpaid workers, (4) paid part-time or seasonal workers, and (5) paid full-time workers. All labor hours (drying; field operations; and scouting, irrigation, and other work) are increased by 20 percent to account for overhead labor associated with all operations for the enterprise.

Wage rates assumed for hired labor ages 16 years and older are regional hired labor wage rates from USDA, NASS Farm Labor reports. Unpaid labor for workers under 16 years of age is valued at each State's minimum wage rate. Unpaid operator and other unpaid worker labor wages are determined based on a regression model estimated using ARMS Phase 3 Costs and Returns Report version data. In this version, respondents (not the same respondents as for the crop surveys) are asked to provide the operator's total salary and wages from off-farm sources and the number of hours the operator worked off-farm. For each year, these effective wage rates are regressed on region, operator age, and educational variables to determine the impact of these variables on the wage rate. Regional, age, and educational variables are also available from the ARMS Phase 3 commodity versions, so unique wage rates can be estimated for all farms in the sample using results from the regression equation.

The ratio of benefits to wages for paid labor is determined from ARMS Phase 3, where respondents are asked to report the total benefits paid to hired labor. Benefits include the employer's share of health insurance, pension or retirement plans, workers' compensation, other benefits, and the total cash wages paid to hired farm and ranch labor. The ratio of cash benefits to total cash wages paid is estimated and multiplied by the paid labor expenses to obtain an estimate of the benefits to paid labor for production of the commodity. The total cost of paid labor, $\boldsymbol{COST_{pdlc}}$ is the sum of paid part-time and full-time labor expenses plus benefits. The total cost of unpaid labor, $\boldsymbol{COST_{uplc}}$ is the sum of unpaid operator, unpaid partner, and unpaid worker labor expenses.

Capital recovery of machinery and equipment costs for crops ($\boldsymbol{COST_{recc}}$) are estimated using indirect costing for trucks, tractors, implements, and irrigation equipment. The basis for the capital recovery cost calculation for trucks, tractors, and implements, $\boldsymbol{COST_{mrecc}}$, is the field operations table in ARMS Phase 2, which includes all machinery used on the field, as discussed for $\boldsymbol{COST_{fueleq}}$, $\boldsymbol{COST_{repac}}$, and labor costs. ASABE machinery standards specify the time required for the equipment to cover an acre. The ARMS Phase 2 surveys (starting in 2023) include questions concerning machinery prices. Respondent-reported prices are used unless respondents did not report such prices; in these cases, other sources are used for machinery prices. For surveys prior to 2023, it was necessary to use sources external to ARMS for all machinery prices. Using this information, $\boldsymbol{COST_{mrecc}}$ is the sum of capital recovery costs for all machinery, determined using the approach recommended in chapter 6 of the AAEA-TFCCR handbook (2000). The long-term interest rate used in the calculation is the 10-year average total rate of return on farm assets, as reported in the USDA, ERS Farm Income and Wealth Statistics data.

A series of questions in ARMS Phase 2 collect information on irrigation equipment. This information allows for the development of capital recovery costs for the irrigation equipment, $\boldsymbol{COST_{irec}}$. Capital recovery costs are estimated for all the machinery components—pumps, gearheads, motors, and systems—using the approach recommended in chapter 6 of the AAEA-TFCCR handbook (2000). Finally, ARMS Phase 3 collects

information on machinery used in crop drying. Capital recovery costs for drying, $COST_{drec}$, are estimated using the same approach. The total capital recovery cost for crops is
$COST_{recc} = COST_{mrecc} + COST_{irec} + COST_{drec}$.

Land cost for crops, $COST_{landc}$, is the sum of the actual rental cost per acre for rented land, $COST_{rent}$, and the opportunity cost of owned land, $COST_{own}$. For ARMS Phase 2 respondents indicating they rented the land in the surveyed field, they are asked (1) "What was the cash rent paid per acre for this (year, commodity) field?" and (2) "What was the total cost of all inputs provided by any landlord on the (year, commodity) crop on the selected field?" Any landlord costs for inputs to produce the commodity are deducted from the rental rate because those input costs are accounted for elsewhere. For owned land used to produce the commodity, $COST_{own}$ is estimated as the expected rental value-to-land value rate for the farm. The farm's land value is obtained via ARMS Phase 3. The ARMS CRR Phase 3 version is used to estimate the mean ratio of rental value to land value on farms that produce the commodity of interest by State. For each farm, the land value reported in the ARMS Phase 3 commodity version is multiplied by the estimated State ratio of rental value to land value to obtain the rental rate for owned land or the assumed land cost.

Taxes and insurance costs, $COST_{txin}$, are determined by allocating whole-farm expenses. Two questions in ARMS Phase 3 are the primary sources for $COST_{txin}$ information. The first asks respondents to report the property taxes paid on livestock, machinery, and other farm production items (but not on real estate). Real estate taxes are assumed to be included in land rental rates, so these taxes are assumed to be included in $COST_{land}$. The second question asks respondents to report costs of insurance for the farm business, including all casualty insurance, hail insurance, and any other crop or livestock insurance, and motor vehicle liability and blanket insurance policies. Expenses for Federal crop insurance are then deducted from the insurance cost. The remaining taxes and insurance costs are assumed to apply to the entire farm. The survey crop's share of this expense is that crop's share of total gross margin. Thus, $COST_{txin}$ is the product of the total of taxes and insurance costs, $COST_{ftxin}$ multiplied by the portion of the farm's gross margin allocated to production of the commodity $\%GM_{comm}$.

The farm's $\%GM_{comm}$ is estimated as follows using data from ARMS Phase 3:
$\%GM_{comm} = GM_{comm} \div GM_{farm}$ where $\%GM_{comm}$ is the portion of the farm gross margin from the production of the commodity, GM_{comm} is the gross margin associated with the production of the commodity, and GM_{farm} is the farm gross margin. Specifically, GM_{comm} is the gross value of production associated with the commodity, less the following costs associated with the commodity, as reported in ARMS Phase 3: seed; fertilizer; biocontrols and agricultural chemicals; purchased feed; bedding and litter; veterinary and medical; fuels, oils, and lubricants; electricity; purchased water for irrigation; repairs; cash wages for labor; payroll taxes and benefits for hired labor; contract labor; and custom work. GM_{farm} is the gross value of production of the farm, less the following whole-farm costs as reported in ARMS Phase 3: seed; fertilizer; biocontrols and agricultural chemicals; livestock purchases and leasing of livestock; purchased feed; bedding and litter; veterinary and medical; fuels, oils, and lubricants; electricity for irrigation, drying, and livestock facilities; purchased irrigation water; repairs; cash wages for labor; payroll taxes and benefits for hired labor; contract labor; and custom work.

General farm overhead expenses, $COST_{over}$, include a portion of several expenses reported in ARMS Phase 3: electricity not accounted for by irrigation, drying, and specialized livestock facilities; other utilities such as telephone service, water for other than irrigation, and internet access; farm supplies, marketing containers, hand tools, and farm shop power equipment; maintenance and repair of farm buildings other

than specialized livestock production facilities and irrigation equipment and pumps; vehicle registration and licensing fees; professional farm management services; and general business expenses. The sum of these expenses is multiplied by $\%GM_{comm}$ to obtain the general farm overhead expense for the crop commodity, $COST_{over}$.

Total allocated overhead expenses for crops, $COST_{allocc}$, are estimated as:
$COST_{allocc} = COST_{pdlc} + COST_{uplc} + COST_{recc} + COST_{landc} + COST_{txin} + COST_{over}$.

Total costs for crops, $COST_{totc}$, are estimated as: $COST_{totc} = COST_{operc} + COST_{allocc}$. The crop commodity CAR data are expressed on a per-acre basis, so all cost estimates are divided by acres planted.

Estimating Field Crop Costs and Returns for Nonsurvey Years

For years between ARMS commodity surveys, commodity CAR data are estimated using new input and product prices, holding technology constant at the survey year level. For crops, nonsurvey year values for crop acreage, production, and yields are also incorporated as follows:

Estimating Nonsurvey Year Gross Value of Production: Crops

Measures of gross value of production are updated for nonsurvey years using production, yield, and commodity price data published by USDA, NASS in its Crop Production and Agricultural Prices reports. To update the value of production associated with primary products (grain, cotton lint, peanuts, soybeans), a yield index YI is first estimated for each State as:
$YI_{pp,state} = (PROD_{pp,uy} \div PLACRES_{pp,uy}) \div (PROD_{pp,sy} \div PLACRES_{pp,sy})$,

where $PROD$ is the State crop production, $PLACRES$ is the State crop acres planted,[5] pp refers to the primary product, and uy and sy denote the update year and survey year, respectively. For corn and sorghum, where a portion of the crop is harvested for silage rather than for grain, USDA, NASS provides data on acres of silage harvested. The State area harvested for silage is subtracted from the State $PLACRES$ for both survey and update years. Each farm's quantity of the primary product produced in the update year, $QPROD_{pp,uy}$, is then estimated as:
$QPROD_{pp,uy} = YI_{pp,State} * QPROD_{pp,sy}$.

The farm's gross value of production for the primary product during the update year is then:
$GVP_{pp,uy} = QPROD_{pp,uy} * P_{pp,uy}$,

where $P_{pp,uy}$ is the State price of the primary product in the update year, obtained from USDA, NASS Agricultural Prices.[6]

For some crops, secondary products, such as straw, silage, or hay, may be produced or the stubble may be grazed. For barley, oats, and wheat, no State-level production statistics are available for the secondary products of straw, silage, and grazing through USDA, NASS. In these cases, the survey year gross value of

[5] In the case of oats, relatively high proportions of planted acres are used for cover crops, so instead of planted acres, harvested acres are used for *PLACRES*.

[6] If a State-level harvest month price is not available from USDA, NASS, a harvest month price from a neighboring State may be used instead. Alternatively, an average annual price for the State may be used.

production for secondary products is updated for nonsurvey years by multiplying by State-level price ratios (*PR*) of the USDA, NASS price received for other (*not alfalfa*) hay (*oh*), $PR_{oh} = P_{oh,uy} \div P_{oh,sy}$. For peanut hay, the other hay price ratio is also used for the adjustment, and the hay yield is adjusted proportionately to the peanut yield.

For corn and sorghum, State-level production statistics are available for silage production. For these cases, $YI_{si,State} = (PROD_{si,uy} \div HV\,ACRES_{si,uy}) \div (PROD_{si,sy} \div HV\,ACRES_{si,sy})$, where *HV ACRES* refers to acres harvested and *si* refers to silage. Each farm's quantity of silage produced in the update year is then estimated as: $QPROD_{si,uy} = YI_{si,State} * QPROD_{si,sy}$. Because USDA, NASS does not publish silage prices, the other hay price from USDA, NASS is used as follows to estimate the State price of silage during the update year: $P_{si,uy} = (P_{oh,uy} * YIELD_{oh,uy}) \div ((QPROD_{si,uy} * FMPLACRES_{si,sy}) \div FMHVACRES_{si,sy})$, where *P*, *YIELD*, and *QPROD* are State-level price, yield, and production quantities, respectively, and *FMPLACRES* and *FMHVACRES* are farm-level planted and harvested acres during the survey year. The farm's gross value of production for silage during the update year is: $GVP_{si,uy} = QPROD_{si,uy} * P_{si,uy}$.

For cotton, the secondary product is cottonseed. Cottonseed production is assumed to be proportionate to cotton lint production, so changes in cotton production relative to the survey year will also change cottonseed production proportionately. Cottonseed prices are available through USDA, NASS, so update-year prices are used to value update-year cottonseed production.

Estimating Nonsurvey Year Costs: Crops

Crop costs are updated by multiplying the base survey year cost estimate by price or price index ratios, $PR_i = P_{i,uy} \div P_{i,sy}$, where $P_{i,uy}$ is the update year price or price index for input *i* and $P_{i,sy}$ is the survey year price or price index for input i (table 5). The *PR* is multiplied by the relevant cost category to obtain the update year costs.

Table 5
Data used to determine price ratios for estimating nonsurvey year estimates for field crops

Cost category	Price or price index used	Notes
Seeds	Seeds and plants totals—index for price paid	
Fertilizer	Fertilizer totals, including lime and soil conditioners—index for price paid	Average of first 6 months of each year
Chemicals	Chemical totals—index for price paid	Average of first 6 months of each year
Custom services	Ag services—index for price paid	
Fuel, lube, and electricity	Fuels—index for price paid	
Repairs	Supplies and repairs—index for price paid	
Ginning (cotton)	Ag services—index for price paid	
Purchased irrigation water (corn, cotton, rice, sorghum, soybeans)	Ag services—index for price paid	
Other operating expenses (barley, oats, peanuts, wheat)	Ag services—index for price paid	
Interest on operating inputs	6-month Treasury bill rate	Source: Economic Report of the President
Hired labor	Labor, wage rates—index for price paid	
Opportunity cost of unpaid labor	Labor, wage rates—index for price paid	
Capital recovery of machinery and equipment	Machinery totals—index for price paid	

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Cost category	Price or price index used	Notes
Opportunity cost of land	Rent, cash, cropland—expense, measured in U.S. dollars/acre	Varies by State
Taxes and insurance	Taxes—index for price paid	
General farm overhead	Supplies and repairs—index for price paid	

Note: All data are annual averages obtained through USDA, National Agricultural Statistics Service Agricultural Prices reports unless otherwise noted. All input price indices currently use a base year of 2011. For fertilizer and chemicals, averages of the first 6 months of price indices are used because these expenses are typically incurred during the first 6 months of the calendar year.

Source: USDA, Economic Research Service.

Estimating Livestock and Dairy Costs and Returns for the Survey Year

Cost and return categories associated with livestock and milk commodities naturally differ from those categories for crops. For example, for livestock and milk, feed and veterinary expenses are included, but seed and fertilizer expenses are not. In addition, ARMS differs between crop commodities and livestock and milk commodities in that, for crops, both Phase 2 and Phase 3 survey data are used. However, for livestock and milk, only a Phase 3 survey instrument is used. Also note that for hogs, multiple CAR estimates are developed for the following: hogs, all (includes all hog farms); farrow-to-finish only; farrow-to-feeder only; feeder-to-finish only; farrow-to-weanling only; and weanling-to-feeder only. This section details the components used to calculate the gross value of production, operating costs, and allocated overhead costs for cow-calf, hog, and milk production. Unlike crop CAR (which are expressed on per-acre bases), cow-calf, hog, and milk estimates are expressed on per-cow (beef cows and heifers that have calved), per hundredweight of gain, and per hundredweight of milk sold bases, respectively.

Gross Value of Production: Livestock and Milk

For cow-calf, $GVP_{cc} = GVP_{calves} + GVP_{stockers} + GVP_{ocatt}$, where definitions for each of these components are provided in table 6.

Table 6
Definitions of components of cow-calf gross value of production

GVP_{cc}	Gross value of production for cow-calf
GVP_{calves}	Sum of: Steer, bull, and heifer calf sales Value of steer, bull, and heifer calves removed under production contract
$GVP_{stockers}$	Sum of: Stocker and yearling steer and heifer sales Value of stocker and yearling steers and heifers removed under production contract
GVP_{ocatt}	Sum of: Sales of cull bulls and cows Value of cull bulls and cows removed under production contract Sales of breeding cow-calf pairs, cows and replacement heifers, and bulls Value of breeding cow-calf pairs, cows and replacement heifers, and bulls removed under production contract

Source: USDA, Economic Research Service.

For hogs, $GVP_{hogs} = GVP_{mkthog} + GVP_{feedpig} + GVP_{nurpig} + GVP_{cull} + GVP_{brstk} + INVCH + OTHINC$ where definitions for each of these components are provided in table 7.

Table 7
Definitions of components of hogs gross value of production

GVP_{hogs}	Gross value of production for hogs
GVP_{mkthog}	Sum of: Market hog sales Value of market hogs removed under production contract
$GVP_{feedpig}$	Sum of: Feeder pig sales Value of feeder pigs removed under production contract
GVP_{nurpig}	Sum of: Nursery pig sales Value of nursery pigs removed under production contract
GVP_{cull}	Sum of: Sales of cull sows, cull gilts originally intended for breeding, and cull boars Value of cull sows, cull gilts originally intended for breeding, and cull boars removed under production contract
GVP_{brstk}	Sum of: Sales of bred and open gilts for breeding, sows for breeding, and boars for breeding Value of bred and open gilts for breeding, sows for breeding, and boars for breeding removed under contract
$INVCH$	Value of the December 31 hog inventory minus the January hog inventory for the production year
$OTHINC$	Value of hog manure produced

Source: USDA, Economic Research Service.

For milk, $GVP_{dairy} = GVP_{milk} + GVP_{catt} + OTHINC$, where the definitions for each of these components are defined in table 8.

Table 8
Definitions of components of milk gross value of production

GVP_{dairy}	Gross value of production for dairy
GVP_{milk}	Value of milk sold
GVP_{catt}	Sales of cull cows and bulls; milk cows; replacement heifers; breeding bulls; and heifer, bull, and steer calves
$OTHINC$	Sum of: Value of dairy manure produced Income received from renting space to other dairy operations

Source: USDA, Economic Research Service.

Revenues from sales of animals in each class (cull, feeder, etc.) sold on the open market or via marketing contract are reported in sales and contract removals tables of the ARMS Phase 3 survey. For animals removed under a production contract, the tables report only the number of animals in each class and average weights. These animals are valued using market prices obtained via USDA, NASS Agricultural Prices for animal types

that have available published prices, such as market hogs. For production contract removals of other animal types (such as nursery pigs), ARMS Phase 3 independent producer survey average prices are used. Total milk sales are reported in ARMS Phase 3; this is the basis for determining the value of milk production. Manure is valued using ASABE coefficients for quantity per animal produced (by species) and for the composition of nitrogen, phosphorus, and potassium, such as those found in ASABE (2019).[7] These quantities are adjusted for storage and application method losses and are valued using nitrogen, phosphorus, and potassium prices. Livestock and milk commodity CAR data are expressed on a per-cow (cow-calf), per hundredweight gain (hogs), or per hundredweight sold (milk) basis, so the appropriate divisor is used for all gross value of production estimates for each respective commodity.

Operating Costs: Livestock and Milk

Operating costs for livestock and milk commodities are shown in table 9. As with crops, costs are categorized as either operating costs or allocated overhead costs and include the full cost associated with producing a commodity—those of the operators or partners, landlord, and contractor. Obtaining contractor costs is particularly important for hog production because most U.S. hogs are produced under production contracts. ARMS asks for the costs incurred by all three of these categories of producers. All are summed to yield a total cost for each input associated with producing the commodity. For cow-calf production, all expenses exclude those incurred for feedlot cattle.

Table 9
Summary of operating costs for livestock and milk commodities

Cost	Equation	Estimation method	Components
Purchased feed $COST_{pfeed}$	$COST_{pfeed}$	Direct costing	
Homegrown feed $COST_{hfeed}$	$COST_{hfeed} = \sum_{i=1}^{n} (Q_{hfeed,i} * P_{feed,i})$	Valuing input quantities using national-level feed prices	n = total number of feeds fed $Q_{hfeed,i}$ = total quantity of homegrown feedstuff, i $P_{feed,i}$ = price of feedstuff i
Grazed feed (cow-calf and dairy only) $COST_{gfeed}$	$COST_{gfeed} = COST_{grent} + \sum_{i=1}^{n} (ACRES_{own,i} * RENTV_{own,i})$	Direct costing for rented acres, valuing input quantities for owned acres	n = total number of different pasture types used $COST_{grent}$ = reported rent paid for grazing $ACRES_{own,i}$ = total owned acres of pasture type i used for grazing $RENTV_{own,i}$ = rental value of owned acres of pasture type i used for grazing
Total feed cost $COST_{feed}$	$COST_{feed} = COST_{pfeed} + COST_{hfeed} + COST_{gfeed}$		Sum of purchased, homegrown, and grazed feeds. Hog costs do not include grazed feed.

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[7] The commodity CAR team reviews new data sources as the sources become available. For example, a recently released database that reports on nutrient components of manure is ManureDB, as provided by Bohl Bormann et al. (2023).

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Cost	Equation	Estimation method	Components
Cattle for backgrounding (cow-calf only) $COST_{bkgr}$	$COST_{bkgr} = COST_{pbkgr} + (Q_{cbkgr} * P_{bkgr})$	Direct costing for purchased backgrounding cattle, valuing input quantities for contract backgrounding cattle	$COST_{pbkgr}$ = cost of purchased backgrounding cattle Q_{cbkgr} = quantity of backgrounding cattle placed under contract on operation P_{bkgr} = price of backgrounding cattle
Nursery pigs (Hogs only) $COST_{npig}$	$COST_{npig} = COST_{pnpig} + (Q_{cnpig} * P_{npig})$	Direct costing for purchased nursery pigs, valuing input quantities for contract nursery pigs	$COST_{pnpig}$ = cost of purchased nursery pigs Q_{pnpig} = quantity of nursery pigs placed under contract on operation P_{npig} = price of nursery pigs
Feeder pigs (hogs only) $COST_{fpig}$	$COST_{fpig} = COST_{pfpig} + (Q_{cfpig} * P_{fpig})$	Direct costing for purchased feeder pigs, valuing input quantities for contract feeder pigs	$COST_{pfpig}$ = cost of purchased feeder pigs Q_{cfpig} = quantity of feeder pigs placed under contract on operation P_{fpig} = price of feeder pigs
Veterinary and medicine $COST_{vet}$	$COST_{vet}$	Direct costing	Medical supplies, veterinary and custom services for livestock; agricultural chemicals and biocontrols
Bedding and litter $COST_{blit}$	$COST_{blit}$	Direct costing	
Marketing $COST_{mark}$	$COST_{mark}$	Direct costing	
Custom services $COST_{custl}$	$COST_{custl}$	Direct costing	
Fuel, lube, and electricity $COST_{fuell}$	$COST_{fuell}$	Direct costing	
Repair costs $COST_{repal}$	$COST_{repal} = COST_{repeq} + COST_{repfa}$	Direct costing	$COST_{repeq}$ = cost of repairs and maintenance for machinery and equipment $COST_{repfa}$ = cost of repairs and maintenance for livestock facilities
Other costs (dairy only) $COST_{othl}$	$COST_{othl}$	Direct costing	$COST_{othl}$ = cost associated with organic certification
Interest on operating inputs $COST_{iopl}$	$COST_{iopl} = (COST_{opinl} * (1 + STI)^{0.5}) - COST_{opinl}$		$COST_{opinl}$ = total operating input costs STI = the short-term interest rate, or the 6-month Treasury bill rate

Note: All livestock and milk estimates use Agricultural Resource Management Survey Phase 3 data.

Source: USDA, Economic Research Service.

Total feed cost, $COST_{feed}$, constitutes the highest operating cost for surveyed livestock commodities. Costs for three feed categories are estimated for cow-calf and milk: purchased feed, homegrown harvested feed, and grazed feed. Only purchased feed and homegrown harvested feed are estimated for hogs. **Purchased feed** costs, $COST_{pfeed}$, are determined using direct costing from ARMS Phase 3 questions that ask the respondent how much was spent for purchased feed for the enterprise. For hog operations, it is especially important for the contractor's feed cost to be included because feed is provided by the contractor under many hog production contracts. Most livestock and dairy ARMS Phase 3 questionnaires also ask respondents to list in a table the types, quantities, and amounts spent for purchased feeds that were fed, though in some years, this table has been omitted. This process allows for a further cross-check on feed expense, particularly for responses where the direct costing value differs from expectations.

Homegrown feed expenses, $COST_{hfeed}$, are determined through valuing input quantities from a table completed in ARMS that requests information on each type of homegrown feed that was fed to animals on the operation during the year. For each listed feed, respondents are asked to report the total amount fed and the type of facility in which the feed was stored. For determining homegrown feed costs, feed quantities are valued at their market value rather than their cost of production. Prices for most homegrown feedstuffs are found in USDA, NASS Agricultural Prices data. For homegrown feeds with no price available from USDA, NASS, the analyst must find another price data source. In cases where a purchased feeds table is available in ARMS Phase 3, additional information on the value of homegrown feedstuffs for which no USDA, NASS price is available can be gleaned from the table if there are sufficient purchased observations for the feedstuff. Alternatively, prices may be found using other sources such as up-to-date extension publications.[8]

Grazed feed expense, $COST_{gfeed}$, for cow-calf and milk is determined via direct costing and valuing input quantities. For grazed land that is rented or leased, the rent paid for the land, taken directly from the survey, is used as the expense. For owned land, the amount of rent that could have been received for grazing the land is used as the expense by valuing input quantities. The rental rate assumed for owned land for cow-calf production is based on responses to a question asking respondents to provide the amount of rent the respondents could have received if the land were rented. The rental rate for owned land for dairy is based on averages from respondents who rented land. Different rental rates are assumed for different pasture types; for example, organic versus nonorganic, irrigated versus nonirrigated, and small grains pasture. In the case of cow-calf, some public land may be grazed, and the rent paid for that land is included in $COST_{gfeed}$. If other domestic animals also graze either private or public lands, the cost is allocated to the commodity based on the percentage of the forage estimated by the respondent to have been consumed by the species. **The total feed cost**, $COST_{feed}$, is estimated as: $COST_{feed} = COST_{pfeed} + COST_{hfeed} + COST_{gfeed}$.

Operating costs for cow-calf and hogs may also include the purchase of animals for feeding. In the case of cow-calf, the cost of **cattle for backgrounding**, $COST_{bkgr}$, is the expense of purchasing weaned calves for the background/stocker segment to be sold at a heavier weight to a feedlot. $COST_{bkgr}$ is determined via direct costing based on the respondent's reporting of the total expense for the purchase of backgrounding (stocker) cattle plus the value of the backgrounding (stocker) cattle placed on the operation under a production contract. For hogs, the costs of **feeder pigs**,$COST_{fpig}$, and **nursery pigs**, $COST_{npig}$, are expenses associated with purchasing these animals for feeding. For independent operations, these expenses are determined via direct

[8] Some feeds that are most commonly produced on the farm and which do not have published USDA, NASS prices provide particular challenges for pricing. For example, most corn silage is produced on farm, and the ARMS responses (including silage prices) can be rather sparse. Lazarus et al. (2016) discussed this issue in a review of the USDA, ERS Commodity Costs and Returns data and recommended that the survey silage value be compared with the value of corn grain. This recommendation was used for the 2016 milk estimates, where the price of corn silage was estimated as eight times the price of corn for grain, as discussed by Gillespie (2023). This finding was consistent with Edwards and Hart (2018) and Massey and Horner (2022), who suggested that the value of 1 ton of corn silage would be approximately 8 to 10 times the price of a bushel of corn.

costing based on the respondent's reporting of total expenses for these animals. For contract operations, the values of the animals placed on the operation under a production contract are determined via valuing input quantities, assuming average prices reported for these animals by surveyed independent producers.

Veterinary and medicine costs, $COST_{vet}$, are determined via direct costing using ARMS Phase 3 questions requesting expenses for medical supplies and veterinary and custom services for the enterprise, as well as a question requesting expenses for agricultural chemicals and biocontrols for the enterprise. $COST_{vet}$ includes expenses for artificial insemination and breeding; breeding fees and semen; branding; castrating; custom feed processing, grinding, and mixing services; veterinary services or supplies for pregnancy testing and other health examinations, hormone injections, and miscellaneous livestock medical services and supplies; performance testing; and removal of dead animals. Chemical and biocontrol expenses include sprays, dips, dusts, dairy pesticides, udder antibacterial disinfectants, and other chemicals purchased for use on livestock, but exclude cleaning chemicals for equipment and buildings for livestock and dairy. For hogs, contractors often provide veterinary and medical services and supplies which also are included in the estimate.

Bedding and litter costs, $COST_{blit}$, are determined via direct costing from an ARMS Phase 3 question requesting expenses for bedding and litter for livestock. Hashemi et al. (2011) list a number of different bedding materials for dairy cows, and Carroll and Underwood (2023) list various bedding materials cow-calf producers may use for various reasons, such as to protect animals, particularly newborn calves, during cold weather. $COST_{blit}$ is included for cow-calf, hogs, and milk.

Marketing cost for livestock and milk, $COST_{mark}$, is determined via direct costing from an ARMS Phase 3 question requesting marketing and storage expenses incurred for the enterprise, which could include check-off, commissions, storage, inspection, transportation, or marketing expenses for contract sales. $COST_{mark}$ is included for cow-calf, hogs, and milk.

Custom services cost for livestock and milk, $COST_{custl}$, is determined via direct costing from an ARMS Phase 3 question requesting costs of custom services work as performed by machines and labor hired as a unit. For livestock and dairy products, this typically includes hauling livestock, milk, feed, or manure. However, it excludes custom livestock services that are included in the $COST_{vet}$ category, such as those associated with artificial insemination and breeding, branding, castrating, custom feed processing, and pregnancy testing.

Fuel, lube, and electricity costs for livestock and milk, $COST_{fuell}$, are determined via direct costing from two ARMS Phase 3 questions. The first question requests expenses of all fuels, oils, and lubricants for the enterprise. The second question asks about electricity expenses for the enterprise. These expenses include purchases of all fuels (e.g., diesel fuel, gasoline and gasohol, natural gas, and liquefied petroleum gas, coal, fuel oil, kerosene, and wood), oils, and lubricants for the enterprise, as well as electricity for specialized livestock facilities, such as dairies and swine buildings.

Repair costs for livestock and milk, $COST_{repal}$, are determined via direct costing from two ARMS Phase 3 questions. The first question requests expenses for repairs, parts, and accessories for motor vehicles, machinery, and farm equipment for the enterprise. The second question requests maintenance and repair expenses for specialized livestock production facilities such as dairies, feedlots, poultry houses, and swine buildings for the enterprise. $COST_{repal}$, is the sum of expenses for motor vehicles, machinery, farm equipment, and buildings for the enterprise.

Other expense, $COST_{othl}$, is included in the milk costs and returns and includes the cost of third-party organic certification. In the ARMS dairy version, respondents who indicated they produced certified organic milk were asked how much was spent for third-party organic certification, which includes user fees charged by organic certifiers.

Interest on operating inputs, $COST_{iopl}$, is the opportunity cost associated with the capital that is invested in operating inputs, such as feed, feeder animals, and fuel. The cost is determined by first summing all operating input costs as: $COST_{opinl} = COST_{feed} + COST_{bkgr}$ (cow-calf only) + $COST_{fpig}$ (hogs only) + $COST_{npig}$ (hogs only) + $COST_{vet} + COST_{custc} + COST_{blit} + COST_{mark} + COST_{fuell} + COST_{repal} + COST_{othl}$ (milk only).

Note that the "commodity only" terms indicate that the particular cost would apply only to that commodity and none of the others. As with crops and as recommended by the AAEA-TFCCR handbook (2000), chapter 2, pages 2–25, the following equation is used to estimate interest on operating costs for each farm: $COST_{iopl} = COST_{opinl} * (1 + STI)^{0.5} - COST_{opinl,}$ where STI is the short-term interest rate, or the 6-month Treasury bill rate from the Economic Report of the President, and the coefficient 0.5 indicates that interest is calculated assuming the amount is outstanding for half (6 months) of the year.

Total operating cost for livestock and milk, $COST_{operl}$, is the sum of all operating costs: $COST_{operl} = COST_{feed} + COST_{bkgr}$ (cow-calf only) + $COST_{fpig}$ (hogs only) + $COST_{npig}$ (hogs only) + $COST_{vet} + COST_{blit} + COST_{mark} + COST_{fuell} + COST_{repal} + COST_{othl}$ (milk only) + $COST_{iopl}$.

Allocated Overhead Costs: Livestock and Milk

Table 10 summarizes the equations and estimation methods for each allocated overhead cost component for livestock and milk, as well as the source of information used to calculate each cost.

Table 10
Summary of allocated overhead costs for livestock and milk commodities

Cost	Equation	Estimation method	Components
Paid labor $COST_{pdll}$	$COST_{pdll} = COST_{wage} + COST_{ben} + COST_{clab}$	Direct costing	$COST_{wage}$ = cash wages paid to hired farm labor $COST_{ben}$ = payroll taxes and benefits for hired farm labor $COST_{clab}$ = contract labor expenses
Unpaid labor $COST_{upll}$	$COST_{upll}$	Valuing input quantities	Based on questions about the number of unpaid hours worked
Capital recovery of machinery and equipment $COST_{recl}$	$COST_{recl} = COST_{brec} + COST_{mrecl} + COST_{arec}$	Indirect costing	$COST_{brec}$ = capital recovery cost for feed storage, buildings, and manure facilities $COST_{mrecl}$ = capital recovery cost for machinery and equipment $COST_{arec}$ = capital recovery cost for breeding animals
Land $COST_{landl}$	$COST_{landl}$	Valuing input quantities	See text for details of what is included for each commodity.

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Cost	Equation	Estimation method	Components
Taxes and insurance $COST_{txin}$	$COST_{txin} = \%GM_{comm} * COST_{ftxin}$	Allocating whole-farm expenses	$\%GM_{comm}$ = portion of the farm's gross margin allocated to production of the commodity $COST_{ftxin}$ = whole-farm taxes and insurance costs
Farm overhead $COST_{over}$	$COST_{over} = \%GM_{comm} * COST_{fover}$	Allocating whole-farm expenses	$COST_{fover}$ = whole-farm overhead costs $\%GM_{comm}$: see above

Note: All livestock and milk estimates use Agricultural Resource Management Survey Phase 3 data.

Source: USDA, Economic Research Service.

Hired labor costs, $COST_{pdll}$, for livestock and milk are determined via direct costing and include three components. For the first component, ARMS Phase 3 queries respondents to report on cash wages paid to hired farm and ranch labor for the enterprise. This query is followed with questions about how much of the total was paid to the principal operator, the principal operator's spouse, other members of the household, and others from outside the producer's household. Cash wages paid to hired farm and ranch labor for the enterprise, $COST_{wage}$, are the amount reported by the respondent, less the estimated portion of those wages that were paid to the principal operator. For the second component, ARMS Phase 3 queries respondents to report on payroll taxes (Social Security, unemployment, etc.) and benefits (life insurance, health insurance, pensions, Workers' Compensation, retirement, etc.) for hired labor, $COST_{ben}$, for the enterprise. For the third component, ARMS Phase 3 queries respondents on the expenses for contract labor for the enterprise, $COST_{clab}$. Hired labor expense for the enterprise is: $COST_{pdll} = COST_{wage} + COST_{ben} + COST_{clab}$.

The opportunity cost of unpaid labor, $COST_{upll}$, for livestock and milk is determined by valuing input quantities based on responses from ARMS Phase 3 questions on the number of hours worked per week and by quarter by the principal operator, and the number of unpaid hours worked per week and by quarter by other unpaid workers. The percentage of total hours worked by children under the age of 16 years is also queried. Responses to these questions provide a basis to estimate the total annual number of hours worked by the principal operator, unpaid workers aged 16 years and older, and unpaid workers under 16 years of age. As discussed for crops, wage rates assumed for hired labor for workers aged 16 years and older are regional hired labor wage rates from USDA, NASS Farm Labor reports. Unpaid labor for workers under the age of 16 years is valued at the State minimum wage rate. Unpaid operator and other unpaid worker labor wages are determined based on a regression estimated using the ARMS Phase 3 CCR, as discussed in the crops labor cost section. Off-farm wages are estimated based on region, age, and education. These wages provide an estimate of the opportunity cost of labor.[9] Total hours worked for each labor category are multiplied by the appropriate wage rate.

Capital recovery of machinery and equipment, $COST_{recl}$, includes expenses for feed storage facilities, livestock and dairy housing and facilities, machinery and equipment, and breeding animals. $COST_{recl}$ is estimated using indirect costing. For feed storage, ARMS Phase 3 queries respondents on the types and

[9] A relatively high opportunity cost of unpaid labor was noted by Lazarus et al. (2016) for small dairy farms using these methods, with possible explanations being a high cost of switching occupations, a stagnating local economy with insufficient job openings, a high value of independence and farm lifestyle, and off-farm employment by other family members that cover family living expenses. The question of whether hours worked by unpaid labor were over-reported was also raised.

amounts of feed fed to animals and the types of facilities the feed was stored in. For example, potential facility types for various dairy feeds include but are not limited to an airtight upright silo, a bin for grain, a closed building/shed, and others. For livestock housing, holding facilities, and milking facilities, ARMS Phase 3 queries respondents to report on the type of building, frame type, size, and, for milking parlors, the type (e.g., herringbone, parallel, side opening). For manure handling, ARMS Phase 3 queries respondents on the type and size of the manure storage systems associated with housing (e.g., pit, lagoon, slurry/tank, dry stack). Prices for new feed storage facilities, buildings, and manure facilities from various sources are determined based on size. Capital recovery costs of the feed storage, buildings, and manure facilities, $COST_{brec}$, are determined in accordance with formulas provided in chapter 6 of the AAEA-TFCCR handbook (2000) that include:

$$COST_{brec} = \frac{(PP - SV)}{\left[\frac{1 - \frac{1}{(1+r)^n}}{r}\right]} + SV\,(r),$$

where PP is the purchase price, SV is the salvage value, r is the rate of return on farm assets as reported by USDA, ERS Farm Income and Wealth Statistics, and n is the time period in years.

ARMS Phase 3 queries respondents on the number of pickup trucks, cars, and sport utility vehicles used for livestock or dairy production, the total miles of each driven, the percentage of those miles driven for farm use, and the percentage of the farm use miles used for livestock or milk production. ARMS Phase 3 requests information on various truck types used and the number of miles each was driven for livestock or milk production. ARMS Phase 3 requests information on various tractor types and machinery and equipment, the number used for livestock or milk production, and the percentage of total farm use for livestock or milk production. The capital recovery formula shown for $COST_{brec}$, adjusted for the percentage of use for the livestock or dairy enterprise, is used to determine the total capital recovery for vehicles, tractors, machinery, and equipment, $COST_{mrecl}$. Machinery prices are from an ARMS Phase 2 question (starting in 2023) requesting prices for new machinery and other sources as required. Working animal (e.g., horses, mules) capital recovery costs are calculated in a similar manner, though no adjustment is made for the percentage of use for the livestock or dairy enterprise.

Breeding animal (e.g., cows, bulls, boars) capital recovery cost, $COST_{arec}$, is determined as in the formula shown for $COST_{brec}$, with salvage value assumed equal to zero. Only purchased animals are included in the purchase cost because expenses associated with raising homegrown animals are reflected elsewhere in the commodity cost estimates. For beef cow-calf and dairy $COST_{arec}$, useful lives of 5 years for cows and 3 years for bulls are assumed. For hog $COST_{arec}$, useful lives of 4 years for sows and 3 years for boars are assumed. Total capital recovery costs for livestock and milk are $COST_{recl} = COST_{brec} + COST_{mrecl} + COST_{arec}$.

The **opportunity cost of land** for livestock and milk, $COST_{landl}$, is determined by valuing input quantities. $COST_{landl}$ is an estimate of the amount of foregone rent an operator incurs by farming owned land or, alternatively, the rent paid for rented or leased land. For cow-calf, $COST_{landl}$ is determined from an ARMS Phase 3 question that requests total acres of land used for beef cattle barns, sheds, feed storage, and holding facilities. For dairy, $COST_{landl}$ is determined from ARMS Phase 3 questions that request total acres of land used for corrals, building sites, and manure storage. Land for pasture and for growing crops to feed animals for cow-calf and milk is excluded from $COST_{landl}$ because land is included as $COST_{gfeed}$ and $COST_{hfeed}$ as part of operating costs. For hogs, $COST_{landl}$ is determined from an ARMS Phase 3 question that requests total acres of land used for hog production, including pastures, hog lots, building sites, and manure storage, but excluding

acres used to produce crops to feed to hogs and acres on which hog manure was applied. For hogs, $COST_{gfeed}$ is not included as part of operating costs; thus, pasture used for hogs is included in $COST_{landl}$. For livestock and milk, USDA, NASS State estimates of rental rates for pasture are multiplied by reported acres to estimate $COST_{landl}$.

Taxes and insurance costs, $COST_{txin}$, for livestock and milk are determined in a similar manner as described earlier for crops. As with crops, real estate taxes are not included in $COST_{txin}$ because these taxes are assumed to be included in land rental rates via $COST_{landl}$ and in $COST_{gfeed}$ for cow-calf and dairy grazing. Because $COST_{txin}$ is estimated by allocating whole-farm expenses, $\%GM_{comm}$ is estimated in a similar manner as described for crops and applied to taxes and insurance costs to yield $COST_{txin}$. **General farm overhead** costs, $COST_{over}$ for livestock and milk are also estimated in a similar manner as for crops by allocating whole-farm expenses according to $\%GM_{comm}$.

As with crops, **total allocated overhead** expenses for livestock and milk are estimated as: $COST_{allocl} = COST_{pdll} + COST_{upll} + COST_{recl} + COST_{landl} + COST_{txin} + COST_{over}$.

Total costs for livestock and milk, $COST_{tot}$, are estimated as:

$$COST_{totl} = COST_{operl} + COST_{allocl}.$$

Because USDA's livestock and milk Commodity Costs and Returns data are expressed on a per-cow (cow-calf), per hundredweight gain (hogs), or per hundredweight sold (milk) basis, the appropriate divisor is used for all cost estimates for each respective commodity.

Estimating Nonsurvey Year Costs and Returns for Livestock and Dairy

For years between livestock and dairy surveys, CAR data are estimated using new input and product prices. As with crops, these estimates are determined by using price or price index ratios $PR_i = P_{i,uy} \div P_{i,sy}$, where $P_{i,uy}$ is the update year price or price index for input or output i and $P_{i,sy}$ is the survey year price or price index for input or output i.

Estimating Nonsurvey Year Gross Value of Production: Livestock and Dairy

The gross value of production measures are updated for nonsurvey years using commodity prices published in USDA, NASS Agricultural Prices. Table 11 shows the prices used to calculate price ratios for each value of production category.

Table 11

Data used to determine price ratios for estimating nonsurvey year gross value of production estimates for livestock and milk

Gross value of production category	Price or price index used, national unless otherwise noted
Cow-calf	
Calves	Cattle, calves—price received measured in U.S. dollars/cwt
Stockers and yearlings	Cattle, steers, and heifers, ≥500 pounds—price received measured in U.S. dollars/cwt
Other cattle	Cattle, cows—price received, measured in U.S. dollars/cwt
Milk	
Milk sold	Price received—measured in U.S. dollars/cwt, State-level price
Cattle	Cattle, cows—price received, measured in U.S. dollars/cwt
Other income	Fertilizer totals, including lime and soil conditioners, index for price paid (2011 base currently used)
Hogs	
Market hogs	Hogs, barrows and gilts—price received, measured in U.S. dollars/cwt
Feeder pigs	Hogs, feeder pigs—price paid, measured in U.S. dollars/cwt
Nursery pigs	Hogs, feeder pigs—price paid, measured in U.S. dollars/cwt
Cull stock	Hogs, sows—price received, measured in U.S. dollars/cwt
Breeding stock	Hogs, sows—price received, measured in U.S. dollars/cwt
Inventory change	Prices for each of the animal categories listed above
Other income	Fertilizer totals, including lime and soil conditioners—index for price paid (2011 base currently used)

cwt = hundredweight.

Source: USDA, Economic Research Service.

Estimating Nonsurvey Year Costs: Livestock and Dairy

Costs associated with livestock and dairy production are updated for nonsurvey years by multiplying the base survey year cost estimate by price ratios of the prices and price indices shown in table 12. Unless otherwise noted, data are obtained via USDA, NASS Agricultural Prices reports at the national level, and annual price data are used.

Table 12

Data used to determine price ratios for estimating nonsurvey year cost estimates for livestock and milk

Cost category	Price or price index used	Notes
Purchased feed for cow-calf and hogs	Feed, complete feeds—index for price paid	
Purchased feed for milk	Feed grains—index for price paid	
Homegrown harvested feed for cow-calf	Hay (excluding alfalfa)—price received, measured in U.S. dollars/ton	
Homegrown harvested feed for hogs	Corn, grain—price received, measured in U.S. dollars/bushel price	
Homegrown harvested feed for milk	Feed, forage—index for price paid	
Grazed feed for cow-calf and milk	Rent, cash, pastureland—expense, measured in U.S. dollars/acre	State price used
Veterinary and medicine	Ag services—index for price paid	
Bedding and litter	Ag services—index for price paid	
Marketing	Ag services—index for price paid	
Custom services	Ag services—index for price paid	
Fuel, lube, and electricity	Fuels—index for price paid	
Repairs	Machinery totals—index for price paid, and building materials—index for price paid	Two indices are averaged
Interest on operating capital	6-month Treasury bill rate	Source: Economic Report of the President
Other, operating costs, dairy	Ag services—index for price paid	
Hired labor	Labor hired—wage rate, measured in U.S. dollars/hour	State wage used
Opportunity cost of unpaid labor	Manufacturing wage rate, U.S. dollars/hour	Source: Bureau of Labor Statistics, State wage
Capital recovery of machinery and equipment	Machinery totals—index for price paid, and building materials—index for price paid	Two indices are averaged
Opportunity cost of land	Rent, cash, pastureland—expense, measured in U.S. dollars/acre	State rental rates used
Taxes and insurance	Ag services—index for price paid	
General farm overhead	Supplies and repairs—index for price paid	

Note: All data are obtained through USDA, National Agricultural Statistics Service Agricultural Prices reports at the national level unless otherwise noted. All input price indices currently use a base year of 2011.

Source: USDA, Economic Research Service.

Conclusion

USDA's Commodity Costs and Returns (CAR) data and Milk Cost of Production Estimates data provide information on the major economic CAR associated with the production of 12 major U.S. agricultural commodities. The data are particularly useful for effective policy design by agricultural policymakers needing information on the costs associated with producing commodities. These estimates are also used by agricultural consultants assisting in producer decision making or market analysis, producers wishing to benchmark their CAR against national averages or considering alternative production enterprises, extension staff designing educational programs, and researchers needing cost information for economic modeling. USDA's Commodity Costs and Returns estimates may be considered as average estimates for the production of agricultural commodities at regional or national levels or, in the case of dairy, State levels. However, there are some limitations. Because production technology, input usage, and production efficiency can vary widely across farms, such as by farm size, soil type, or organic or conventional status, these estimates cannot be assumed to represent all farms or all production conditions.

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