



# Farm Production Expenditures Methodology and Quality Measures

ISSN: 2166-966X

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Released July 25, 2025, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA).

## Tenure, Ownership, and Transition of Agricultural Land Survey Methodology for Farm Production Expenditures

**Scope and Purpose:** Estimates of farm production expenditures are based on data collected in the Tenure, Ownership, and Transition of Agricultural Land Survey (TOTAL). The TOTAL survey provides a snapshot of the financial health of the farm sector and farm household finances. TOTAL is the only source of information available for objective evaluation of many critical policy issues related to agriculture and the rural economy. The survey is conducted in all states, with Alaska and Hawaii being included in 2024, but excluded in prior years. TOTAL is cosponsored by the USDA's Economic Research Service (ERS).

The TOTAL survey was conducted in two phases. The initial phase (ARMS I) screened a large sample of farms and ranches to determine which farms qualified for subsequent phases of ARMS/TOTAL. Subsamples of qualifying farms are selected for the other phase. The next phase (TOTAL) collected whole farm finance and operator characteristics information for a calendar year. In addition, costs of production and expenditure data were collected in one interview during TOTAL.

Farm production expenditures are estimated for five regions, accounting for all states, with Alaska and Hawaii being included in 2024, but excluded in prior years. In addition to the five regions, expenditures of fifteen states with the greatest agricultural cash receipts and the other states within the corresponding regions are published. Farm production expenditures are also estimated for eight economic sales classes and two farm type categories.

**Survey Timeline:** Data collection and analysis for the ARMS I are conducted from May through July. The TOTAL survey data collection begins in December and concludes in May with further analysis and review continuing until the results are published in late July.

**Sampling:** The target population for the TOTAL survey is all agricultural establishments with more than \$1,000 in agricultural sales (or potential sales). NASS uses a dual frame approach, consisting of list frame and area frame components, to provide complete coverage of this target population.

NASS maintains a list of farm and ranch operators, known as the list frame. NASS is constantly seeking new operations from outside list sources confirmed to be qualifying farms before being added to the list. A profile, known as control data, of each operation is maintained, which indicates what the farm has historically produced and a general indication of size. This information allows NASS to define list-frame sampling populations that are specific to each survey and employ advanced and more efficient sample designs.

The TOTAL survey list sample is selected based on a calculated Farm Value of Sales (FVS). All farms on the list frame with an estimated FVS of \$1,000 or more are eligible. The value of sales control data need not be exact as it is used to stratify similar list operations into homogeneous groups.

NASS utilizes the Sequential Interval Poisson (SIP) sampling method to select the ARMS I sample. In a SIP sample design, each operation is assigned a Permanent Random Number (PRN) between 0 and 1 from a uniform distribution. A sample can be defined as all operations falling within a specified range of PRNs. This provides a mechanism to control overlap across multiple surveys. In this case, SIP is used to minimize overlap between the previous year's ARMS sample and the current year Agricultural Survey sample, which is a large-scale quarterly acreage and grain stocks survey program.

Calculating a probability of selection for each operation in the TOTAL population is a complicated task. For the CRR samples, target samples sizes are set by FVS strata. The probability of selection for each operation starts with the same probability for each record within a stratum and then for each individual record gets adjusted several times based on farm type and whether the record had one of the current target crops on control data.

The area frame contains all land in the United States (except Alaska and Hawaii) and is therefore complete for the TOTAL survey program. The land is stratified according to intensity of agriculture using satellite imagery. Land in each stratum is divided into segments of roughly one square mile. Segments are optimally allocated and sampled to effectively measure crops and livestock. Annually, NASS conducts the June Area Survey and conducts face-to-face interviews of every individual who operates or owns land within a sampled area segment. All farms and ranches found operating in these segments are checked to see if they are included in the list-frame TOTAL survey population. Farms and ranches that are not on the list frame are sampled for the TOTAL survey so that the target population is completely represented.

The United States list-frame sample size for the TOTAL survey is approximately 43,000. The area-frame sample size is approximately 2,000. Each list-frame and area-frame sampling unit is assigned a sampling weight which is used to create the survey estimates.

**Data Collection:** For consistency across modes, the paper version is considered the master questionnaire and Computer Assisted Web Interview (CAWI) and Computer Assisted Personal Interview (CAPI) instruments are built to model the paper instrument. ERS plays a significant role in the development of questionnaires. Questionnaire content and format are evaluated annually by NASS and ERS through a specifications process, where requests for changes are evaluated and approved or disapproved. Input may vary from question wording or formatting to a program change involving the deletion or modification of current questions or addition of new ones. If significant changes to either the content or format are proposed, a NASS survey methodologist will pre-test the changes for usability. Prior to the start of data collection, all modes of instruments are reviewed and the CAWI instrument is thoroughly tested.

All federal data collections require approval by the Office of Management and Budget (OMB). NASS must document the public need for the data, show the design applies sound statistical practice, ensure the data do not already exist elsewhere, and show that the public is not excessively burdened. The TOTAL questionnaires must display an active OMB number that gives NASS the authority to conduct the survey, as well as a statement of the purpose of the survey and the use of the data being collected. The questionnaires must include a response burden statement that gives an estimate of the time required to complete the form, a confidentiality statement that the respondents' information will be protected from disclosure, and a statement saying that response to the survey is required by law. For the TOTAL survey, respondents must be informed that their data will be shared with the cosponsor.

All survey instruments collect information to verify the sampled unit, determine any changes in the name or address, identify any partners to detect possible duplication, verify the farm still qualifies for the target population, and identify any additional operations operated by the sampled operator.

Sampled farms and ranches receive a presurvey postcard explaining the survey purpose and timeline and guaranteeing that they will be contacted for survey purposes only. Mail, web, telephone and face-to-face interview modes of data collection are utilized for the TOTAL survey. A second questionnaire is mailed in early February to sampled farms and ranches who have not yet returned a completed questionnaire.

**Survey Edit:** As survey data are collected and captured, they are edited for consistency and reasonableness using automated systems. Reported data are typically first edited as a "batch" of data when first captured. The edit logic ensures administrative coding follows the methodological rules associated with the survey design. Relationships between data items on the current survey are verified and, in certain situations, items are compared to data from earlier surveys to make sure certain relationships are logical. The edit determines the status of each record to be either "dirty" or "clean". Dirty records must be either updated or certified by an analyst to be accurate. Corrected data are reedited interactively. Only clean records are eligible for analysis tools and summary.

**Analysis Tool:** Edited economic and cost of production data are processed through an interactive analysis tool that displays data for all reports by questionnaire item. The tool provides various scatter plots, tables, charts, and special tabulations that allow the analyst to compare an individual record to other similar records within their state. These tools make outliers and unusual data relationships evident and Regional Field Offices and Headquarters staff review them to determine if they are correct. Suspect data found to be in error are corrected, while data found to be correct are kept.

**Nonsampling Errors:** Nonsampling errors are present in any survey process. These errors include reporting, recording, editing, and imputation errors. Steps are taken to minimize the impact of these errors, such as questionnaire testing, comprehensive interviewer training, validation and verification of processing systems, detailed computer edits, and the analysis tool.

**Nonresponse Adjustment:** Some producers refuse to participate in the survey, others cannot be located during the data collection period, and some submit incomplete reports. These nonrespondents must be accounted for if accurate estimates of total farm expenditures are to be made. For this survey, item level nonresponse is accounted for by imputing data where there are missing values using a multivariate approach. Prior to the implementation of the multivariate approach, NASS used an un-weighted conditional means imputation system that placed records into homogenous groups and imputed based on reported data from those groups. From 2014 to 2018 NASS used a technique called Iterative Sequential Regression (ISR), a multivariate method where parameter estimates and imputations are obtained using a Markov chain Monte Carlo sampling method. A multivariate approach, implemented in 2019, uses a regression-based hot deck imputation methodology called Predictive Mean Matching (PMM), which creates and uses a multivariate model of the fully and partially observed records to create a donor pool of records with reported values to generate imputed values. PMM allows for the relationships within the data to be preserved and the imputed values to better represent the variability of the data. Records with imputed data are re-edited to ensure the returned value is acceptable.

**Calibration:** Calibration is a weighting technique used in survey sampling to adjust the survey weights for sampled elements so that the weighted sum of a set of benchmark variables equals a pre-determined set of known population values. The input to the calibration algorithm used for TOTAL is the weights generated from the sampling procedures. Sampling weights are calculated based on numerous factors so that the sample allocation can be representative of the entire population of farms at the state level for the fifteen leading cash receipts states and at the regional level for all other states. Due to survey nonresponse and the possibility of disproportionate responses across different farm types and economic sales classes, weights are adjusted through a calibration algorithm. Calibration adjusts the sampling weights so that the expanded data will match several known commodity, livestock, and farm number published totals. This ensures that the expense data collected will accurately represent the expense breakdowns for all farm types and farm sizes as well as cover the expenses for the entire target population.

**Estimators:** The TOTAL survey utilizes calibrated direct expansions for all survey indications. For both the list and area frame respondents, calibrated direct expansions are calculated by summing the reported or imputed economic and expenditure values weighted by the calibration weights. Variance estimates are computed for all expansions. The dual frame calibrated direct expansion and variance are the sum of the estimates from the list frame and the portion of the area frame that contains operations not included on our list frame population for the TOTAL survey.

**Outliers:** NASS conducts a formal review of outliers found in the expanded data. Outliers may be caused by aging control data resulting in misstratification, data errors, or the nonresponse and calibration adjustments to the sampling weight. A preliminary calibration and summary are run and any individual record accounting for 0.5 percent of the national expansion for total expenses or 2.5 percent of a regional expansion for total expenses is tagged as an outlier. After verifying the data have not been misrecorded or mishandled, background information on these outliers is compiled and presented to a National Outlier Board. This Board is a team of NASS and ERS analysts that meets to discuss the national outliers and form a consensus on a course of action. Most outliers trace back to unique situations that do not exist in the target population as often as a large calibrated sample weight indicates. The Board looks at other reports of the same type and sales class as the reported data on the outlier. The Board examines the weights of the comparable reports and most often overrides the outlier's weight with the median weight of the comparable reports. After the extreme outliers have been addressed, the Board reviews the national totals by expense category following the same methodology and, when necessary, overrides the outlier's weight with the median weight of the comparable reports. Finally, Headquarters staff examines outliers found at the state level for the published expense categories. A determination is made as to

whether a weight adjustment is justified. Adjustments are not made to all outliers, but they are reviewed closely for accuracy. Once all adjustments are made, the calibration program is executed again to create the final set of weights for summary purposes.

**Estimation:** When all samples are accounted for, all responses fully edited, and the analysis material is reviewed, Headquarters staff executes a summary that generates state-level totals for the fifteen leading cash receipt states and regional totals for the remaining states. Since all states conduct identical surveys, the samples can be pooled and national survey results computed. The summary results provide point estimates and their standard errors for each estimated data series. It also provides information used to assess the performance of the current survey and evaluate the quality of the survey estimates, such as expansions by farm types and economic sales classes, response rates, and the effectiveness of calibration.

The TOTAL survey supports the annual estimates of total farm expenditures and the total expenses related to the following categories: Livestock, Feed, Farm Services, Rent, Agricultural Chemicals, Fertilizer, Interest, Taxes, Labor, Fuels, Farm Supplies and Repairs, Farm Improvements and Construction, Tractors and Self-Propelled Farm Machinery, Other Farm Machinery, Seeds, Trucks and Autos, and Miscellaneous Capital Expenses.

Regional Field Offices are responsible for performing a detailed review and providing comments that justify survey results. Any irregularities revealed by the summary must be investigated and, if necessary, resolved. Regional Field Offices see their states' survey results only and do not have access to other states' results.

For the national estimates, NASS assembles another joint panel of NASS and ERS analysts to serve as the Agricultural Statistics Board, which reviews the national-level survey results and establishes the national estimates. Since larger sample sizes yield more precise results, NASS employs the "top-down" approach by determining the national estimates first and then reconciling the region and state estimates to the national number for all estimates. The Board has the advantage of being able to examine results across states, review the state comments and justifications, and utilize external administrative data available only at the U.S. level to corroborate survey results. The same estimators used in the state summaries are utilized by the national summary. Upon Board consensus, national-level summary indications are adopted as official national estimates except in cases where strong justification supports deviating from survey totals. In a separate process, a team of Field Office and Headquarters staff must reexamine the region and state results and adjust state estimates to sum to the national estimate. This process occurs both when indications are adopted as official estimates and when estimates deviate from survey totals.

Estimates are open to revision on a predetermined schedule only if new information becomes available. In general, revisions to the expenditure estimates may be considered one year later if there were revisions made to any of the calibration targets or other information became available that significantly impacts the previous year estimates. External information (administrative data) is also utilized in this process. In order to be considered, these data must be deemed to be reliable and come from unbiased sources. Census of Agriculture farm production expenditure estimates are available every five years and are used to assess the accuracy of the TOTAL survey results.

## Quality Metrics for Farm Production Expenditures

**Purpose and Definitions:** Under the guidance of the Statistical Policy Office of the Office of Management and Budget (OMB), the United States Department of Agriculture’s National Agricultural Statistics Service (NASS) provides data users with quality metrics for its published data series. The metrics tables below describe the performance data for the survey contributing to the publication. The accuracy of data products may be evaluated through sampling and nonsampling error. The measurement of error due to sampling in the current period is evaluated by the coefficient of variation for each estimated item. Non-sampling error is evaluated by response rates and the percent of the estimate from respondents.

**Sample size** is the number of observations selected from the population to represent a characteristic of the population. Operations that did not have the item of interest or were out of business at the time of data collection have been excluded.

**Response rate** is the proportion of the sample that completed the survey. This calculation follows Guideline 3.2.2 of the Office of Management and Budget Standards and Guidelines for Statistical Surveys (Sept 2006).

**Coefficient of variation** provides a measure of the size for the standard error relative to the point estimate. It is used to measure the precision of the results of a survey estimator.

**Weighted item ratio** is a ratio of reported survey data expanded by the original sampling weight compared to final nonresponse adjusted summary totals.

### Farm Production Expenditures Sample Size and Response Rates – United States: 2023 and 2024

State and region	Sample size		Response rate	
	2023	2024	2023	2024
	(number)	(number)	(percent)	(percent)
<b>Atlantic</b> .....	4,259	5,593	41.6	43.5
North Carolina .....	1,640	1,370	49.7	49.9
Other States .....	2,619	4,223	36.5	41.4
<b>South</b> .....	6,926	7,680	38.0	44.1
Arkansas .....	1,553	1,418	49.6	45.9
Florida .....	1,944	1,665	27.5	38.0
Georgia .....	1,789	1,394	34.8	41.0
Other States .....	1,640	3,203	43.0	47.7
<b>Midwest</b> .....	12,240	11,013	39.3	49.1
Illinois .....	1,781	1,367	33.1	48.0
Indiana .....	1,528	1,333	45.6	45.2
Iowa .....	2,003	1,443	37.2	54.1
Minnesota .....	1,891	1,353	44.6	59.9
Missouri .....	1,643	1,429	30.6	42.6
Wisconsin .....	1,829	1,399	43.1	52.6
Other States .....	1,565	2,689	41.0	45.2
<b>Plains</b> .....	8,023	9,338	37.8	40.6
Kansas .....	1,782	1,427	35.9	43.2
Nebraska .....	1,770	1,450	35.3	34.6
Texas .....	2,768	2,210	42.5	46.2
Other States .....	1,703	4,251	34.8	38.9
<b>West</b> .....	5,588	6,658	43.2	48.4
California .....	2,205	2,106	50.1	55.0
Washington .....	1,818	1,685	38.1	49.6
Other States .....	1,565	2,867	39.4	42.9
United States .....	37,036	40,282	39.6	45.3

# **Quality Metrics for Farm Production Expenditures – Region, Selected States, Farm Type, and Economic Class: 2023 and 2024**

Total	Coefficient of variation		Weighted item ratio	
	2023	2024	2023	2024
	(percent)	(percent)	(percent)	(percent)
Total farm production expenditures .....	2.2	2.3	39.8	43.2
Livestock, poultry, and related expenses .....	6.2	9.7	54.4	54.6
Feed .....	4.1	4.3	43.2	43.9
Farm services .....	3.0	3.0	38.5	40.6
Rent .....	2.5	4.0	33.4	40.1
Agricultural chemicals .....	2.5	3.0	35.6	39.6
Fertilizer, lime, and soil conditioners .....	2.4	4.5	35.2	38.3
Interest .....	3.6	6.9	37.6	39.5
Taxes (real estate and property) .....	1.8	2.2	40.7	40.2
Labor .....	6.7	8.2	30.7	47.5
Fuels .....	2.6	2.8	38.5	40.1
Farm supplies and repairs .....	3.5	2.9	37.2	41.9
Farm improvements and construction .....	5.3	7.3	42.7	41.2
Tractors and self-propelled farm machinery .....	4.1	7.0	41.8	40.6
Other farm machinery .....	5.4	7.3	39.7	42.0
Seeds and plants .....	4.4	3.5	33.9	39.1
Trucks and autos .....	4.9	5.0	47.8	45.9
Miscellaneous capital expenses .....	6.4	6.2	53.0	57.8
Regional - total farm production expenditure				
<b>Atlantic</b> .....	7.3	6.5	36.9	35.0
North Carolina .....	3.2	5.6	39.5	34.5
Other States .....	9.4	8.3	36.1	35.2
<b>South</b> .....	5.9	4.5	53.4	39.9
Arkansas .....	2.3	5.1	50.8	53.7
Florida .....	11.7	11.0	18.5	25.4
Georgia .....	7.5	5.3	106.2	30.6
Other States .....	13.2	8.7	41.1	45.0
<b>Midwest</b> .....	2.1	4.3	36.1	47.8
Illinois .....	4.8	3.1	32.2	47.9
Indiana .....	2.8	3.8	46.3	36.7
Iowa .....	4.0	16.2	31.8	45.5
Minnesota .....	4.0	2.9	39.8	45.6
Missouri .....	5.2	4.9	30.3	36.8
Wisconsin .....	3.0	3.2	42.6	66.0
Other States .....	9.2	9.4	36.2	54.4
<b>Plains</b> .....	4.0	5.2	46.3	40.4
Kansas .....	11.6	13.6	75.1	55.5
Nebraska .....	9.2	13.5	39.8	39.6
Texas .....	3.9	7.4	40.9	39.2
Other States .....	7.3	4.7	35.0	31.4
<b>West</b> .....	6.6	4.4	33.5	45.7
California .....	10.4	4.4	32.3	46.9
Washington .....	13.0	12.4	42.5	44.1
Other States .....	10.1	8.5	31.8	44.8
Farm type - total farm production expenditure				
Crop .....	3.2	2.6	34.8	41.3
Livestock .....	3.2	3.6	45.3	45.2
Economic class - total farm production expenditure				
Less than \$10,000 .....	5.0	4.2	47.3	39.3
\$10,000-\$49,999 .....	5.1	5.5	64.2	60.1
\$50,000-\$99,999 .....	6.9	6.0	44.3	39.5
\$100,000-\$249,999 .....	5.4	15.6	52.2	50.3
\$250,000-\$499,999 .....	5.4	6.6	41.4	45.1
\$500,000-\$999,999 .....	4.6	9.8	37.8	42.3
\$1,000,000-\$4,999,999 .....	2.7	2.9	34.7	34.4
\$5,000,000 and over .....	6.2	6.9	39.4	51.5

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- Cornell’s Mann Library website houses NASS’s and other agency’s archived reports at <https://usda.library.cornell.edu>. All email subscriptions containing reports will be sent from <https://usda.library.cornell.edu>. To receive the reports via e-mail, you will have to go to the website and subscribe to the reports. If you need instructions to set up an account or subscribe, they are located at: <https://usda.library.cornell.edu/help>. You should whitelist [notifications@usda-esmis.library.cornell.edu](mailto:notifications@usda-esmis.library.cornell.edu) in your email client to avoid the emails going into spam/junk folders.

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