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# Agricultural Chemical Usage - Field Crop Methodology and Quality Measures

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## Agricultural Resource Management Survey Methodology Chemical Usage Statistics

**Scope and Purpose:** The National Agricultural Statistics Service (NASS) collects data about fertilizer and chemical use and pest management practices for selected field crops. This field crop data has been collected annually since the 1991 crop year. The selected field crops are chosen on a rotational basis. The States involved are selected based on NASS acres planted estimates and evaluated each year to ensure maximum coverage. NASS aims to cover at a minimum 80 percent of acres planted in the United States. The data are collected as Phase II of the Agricultural Resource Management Survey (ARMS II). The ARMS is a cooperative agreement between USDA's Economic Research Service (ERS) and NASS.

The ARMS is conducted in three phases. The initial screening phase identifies in-business, in-scope operations, multiple operating arrangements, and operations having commodities of interest for Phase II and III. The second phase (ARMS II) collects data on agricultural production practices, chemical and other resource use, and variable costs of production for each crop for which a cost of production survey is conducted. ERS is responsible for estimating cost of production for major commodities and determines the commodity rotation. The ARMS Phase III data focuses on farm finances.

**Survey Timeline:** Data collection may begin on October 1 and continue through mid December to ensure completion of the crop year. NASS Field Offices (FOs) along with NASS Headquarters (HQ) spend the next several months reviewing reported data for reasonableness and conduct producer follow-ups, as necessary. The estimates are released to the NASS Quick Stats 2.0 system during the third week in May.

**Sample Size, Sampling Frames, and Methods:** The ARMS II is selected as a follow-on survey to the ARMS Phase I (ARMS I) Screening Survey. The ARMS I sample is selected from the NASS list frame using Sequential Interval Poisson Sampling to minimize overlap between the current year's ARMS I sample, last year's ARMS I sample, and other NASS surveys. Each eligible operation in the list frame is given a positive probability of selection. A given operation's probability of selection is calculated based on farm value of sales (FVS) strata membership and acreage levels of the ARMS II commodities. After the screening phase, operations which report positive acreage for ARMS II target commodities are subsampled for the ARMS II. Multiple operating arrangements are further subsampled so that only one suboperation is included in the ARMS II sample. The sampling weights are adjusted upwards to account for this subsampling.

There are usually two surveys within the ARMS II: a Production Practices Report Survey (PPR) and a Production Practices and Costs Report Survey (PPCR). The PPCR survey is only conducted during ARMS II, and there was no PPR survey in 2011. The 2011 PPCR commodities were barley and sorghum. The ARMS II barley and sorghum samples were 2,200 and 1,000, respectively. The ARMS II sample size varies depending on the commodities.

**Data Collection and Editing:** 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 ARMS II questionnaires must display an active OMB number that gives NASS the authority to conduct the survey, a statement of the survey purpose and the use of the collected data, a response burden statement that estimates the time required to complete the form, a confidentiality statement that the respondent's information will be protected from disclosure, and a statement that response to the survey is voluntary and not required by law.

Using these questionnaires, chemical data are collected only by personal visit from an enumerator. Postcards are mailed to producers prior to field contact stating the importance of cooperation and that contact will be made in the coming weeks. Once contact is made by the field enumerator, an appointment is made to collect data. Data is collected for one field randomly chosen from all the operation's fields planted to the ARMS II field crop. The field enumerator returns the questionnaires to the NASS FO for editing and data entry. Questionnaire responses are captured and edited for consistency using automated systems, and a report of questionnaires with errors is generated. NASS field office statisticians will correct the errors on the report or comment to their validity if the data are deemed to be correct. Records with errors can pass to summary only with field statistician comments and HQ acceptance.

**Analysis Tools:** Fertilizer and chemical use data are processed through an interactive data analysis tool which displays data for all reports by product or commodity. This application tool provides various scatter plots, graphs, tables, charts, and listing tools that allow the analyst to compare an individual record to other similar records within their state or at a national level. Outliers and unusual data relationships are investigated by field office and headquarters statisticians to determine validity. Suspect data found to be in error are corrected.

**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 comprehensive interviewer training, validation and verification of processing systems, detailed computer edits, and the analysis tool. Re-contact with respondents is conducted on an as needed basis.

**Nonresponse Adjustment:** Response to the ARMS II is voluntary. 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 to make accurate estimates of total chemical usage. For ARMS II, item level nonresponse is accounted for by imputing data where there are missing values. Imputed rates of application for chemicals are calculated through an automated imputation system that calculates an unweighted mean for an imputation group based on commodity, state, and product. When a group lacks other responses, groups are collapsed by state to preserve as much of the homogeneity as possible.

**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 values for the population. The input to the calibration algorithm is the weights generated from the sampling procedures. Sampling weights are calculated based on numerous factors so that the sample allocations are representative of the entire population of farms at the state level for the target field crop(s) in that state. Due to survey nonresponse, weights are adjusted through a calibration algorithm. Calibration adjusts the sampling weights so the expanded data will match planted acreage totals from the January Crop Production report [<http://usda01.library.cornell.edu/usda/current/CropProdSu/CropProdSu-01-12-2012.pdf>]. This ensures that the chemical data collected will accurately represent the chemical usage for all target field crops for the entire target population.

**Estimators:** The ARMS II utilizes direct expansions for all survey indications. Direct expansions are calculated by summing the reported or imputed chemical data values by the calibrated weights. Variance estimates are computed for all expansions.

**Outliers:** NASS conducts a review of outliers found in the chemical use data by reviewing application rates for all records for the same product and commodity combinations. The FO and HQ statisticians work together to ensure the data are as accurate as possible. The FO statisticians review outliers within their states, and the HQ statistician examines outliers across all states for the published categories. A determination is made as to whether an adjustment to the application data is required. Most outliers trace back to unique situations that do not exist in the target population as much as the survey weight would indicate.

**Estimation:** HQ statisticians execute a summary that generates state level and national level indications. Field Offices are responsible for performing a detailed review of their survey results and providing comments that justify their survey results. HQ statisticians conduct a final review of survey results from all states. Any irregularities revealed by the summary must be investigated and, if necessary, resolved. After final review, national level summary results are adopted as official national estimates except in cases where strong justification supports deviating from survey totals.

There are three main types of data that NASS estimates for these surveys - fertilizer application, pesticide application, and Integrated Pesticide Management (IPM) data. For the application data, NASS collects information about the commercial fertilizers and pesticides applied during the crop year. For fertilizer, these applications are collected as either actual pounds or percent analysis of Nitrogen (N), Phosphate (P), Potash (K), and Sulfur (S). For pesticides, these applications are collected at the product level, generally per application. These product level data are converted to pounds of active ingredient, summarized, and published. If there are not a sufficient number of reports, the data is suppressed from publication, along with any needed complementary suppression.

For both fertilizer and pesticide application data, NASS estimates Area Applied (percent acres treated), Number of Applications, Rate per Application (pounds of active ingredient per acre), Rate per Crop Year (number of applications multiplied by rate per application), and Total Amount Applied.

The standard deviation for each active ingredient is calculated to determine data distribution for each crop. Chemical distribution rates are given by active ingredient for the Percent of Acres Treated, Number of Applications, Rate per Application, and Rate per Crop Year. Rate Distribution tables include the median, the 10<sup>th</sup> and 90<sup>th</sup> percentiles, the mean, and the coefficient of variation (CV) for an active ingredient when a sufficient number of farm operators report applying it on the specified crop.

The IPM data are generally a series of yes/no questions pertaining to specific pest management practices. IPM data are collected for the randomly chosen field. From these data, NASS releases the percent of operations using the practice as well as the percent of acreage. The percent of acreage assumes that the operation treats all fields of a particular commodity in the same way.

## Quality Metrics for Agricultural Chemical Usage

**Purpose and Definitions:** Under the guidance of the Statistical Policy Office of the Office of Management and Budget (OMB), 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 non-sampling 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 that are used to be representative of the entire population.

**Response rates** measure the proportion of the sample that is represented by the responding units in the survey.

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

### Barley Chemical Distribution, Sample Size, and Response Rates – Program States: 2011

State	Sample size	Response rate
	2011	2011
Arizona .....	88	62.5
California .....	109	67.0
Colorado .....	138	39.9
Idaho .....	200	75.0
Minnesota .....	149	64.4
Montana .....	200	71.0
North Dakota .....	201	55.7
Oregon .....	103	71.8
Pennsylvania .....	150	71.3
Virginia .....	140	67.1
Washington .....	199	63.8
Wisconsin .....	124	69.4
Wyoming .....	150	63.3
Program States .....	1,951	64.9

### Sorghum Chemical Distribution, Sample Size, and Response Rates – Program States: 2011

State	Sample size	Response rate
	2011	2011
Colorado .....	149	42.3
Kansas .....	200	60.5
Nebraska .....	152	53.3
Oklahoma .....	148	59.5
South Dakota .....	149	49.0
Texas .....	200	61.0
Program States .....	998	54.9

### Barley Agricultural Chemical Distribution Table – Program States: 2011

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
<b>Herbicides</b>				
2,4-D, 2-EHE .....	10	7	3	7
2,4-D, dimethylamine salt .....	10	3	5	6
Bromoxynil heptanoate .....	6	(Z)	4	4
Bromoxynil octanoate .....	4	(Z)	3	3
Clopyralid .....	7	0	2	2
Dicamba, dimethylamine salt .....	13	5	9	12
Fluroxypyr 1-MHE .....	5	(Z)	1	1
Glyphosate isopropylamine salt .....	3	7	3	9
MCPA, 2-ethylhexyl ester .....	3	(Z)	3	3
MCPA, dimethylamine salt .....	25	(Z)	8	8
Metsulfuron-methyl .....	19	0	14	14
Pinoxaden .....	3	(Z)	1	1
Pyrasulfotole .....	8	0	2	2
Thifensulfuron .....	5	(Z)	3	3
Tribenuron-methyl .....	5	2	4	5
<b>Insecticides</b>				
Lambda-cyhalothrin .....	10	0	5	5
<b>Fungicides</b>				
Propiconazole .....	7	(Z)	5	5
Pyraclostrobin .....	11	2	4	5

(Z) Less than half of the unit shown.

### Sorghum Agricultural Chemical Distribution Table – Program States: 2011

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
<b>Herbicides</b>				
2,4-D, 2-EHE .....	7	9	8	6
2,4-D, dimethylamine salt .....	9	5	4	7
Atrazine .....	2	6	9	13
Dicamba, dimethylamine salt .....	9	6	6	7
Dimethenamid-P .....	12	5	3	3
Glyphosate isopropylamine salt .....	4	6	2	7
Glyphosate potassium salt .....	12	8	2	9
Mesotrione .....	9	4	3	3
S-Metolachlor .....	4	4	5	7

## Information Contacts

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