The ARMS: A Survey Supporting Indicator Development and Economic Policy Analysis

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*This paper draws material from documentation and publications developed by ERS staff for different versions of the ARMS survey. Web links to source material are cited in the text and references. The authors are respectively Agricultural Economist and Branch Chief at the Economic Research Service, USDA, Washington DC.
Executive Summary

The annual Agricultural Resource Management Survey (ARMS) is USDA's primary source of information on the financial condition, production practices, resource use, and economic well-being of America's farm households. ARMS is the only U.S. national survey that provides observations of field-level, crop-specific, farm practices, the economics of the farm businesses operating the field (or dairy herd, green house, nursery, poultry house, etc.), and the characteristics of the American farm household (age, education, occupation, farm and off-farm work, types of employment, family living expenses, etc.)—all collected in a representative sample.

ARMS data are collected at the individual field or production unit level (Phase II), and for the whole farm (Phase III). Crop-specific field-level data include information on chemicals and seeds, equipment, previous crops, land characteristics, irrigation, and pest, nutrient, and crop residue management practices. These data can support the development of environmental indicators and calibrate economic models used in agri-environmental policy analyses.

This paper describes the ARMS survey instrument, scope of commodity coverage, specific information collected at the field and farm-level, uses of ARMS for indicator development, and some recent innovations made to the survey (e.g., linking the CEAP and ARMS, organic oversample, and geo-coding field level observations). Overall, the ARMS survey is a valuable and versatile source of national data to support economic research on farmers' technology adoption decisions and to relate those decisions to economic performance, structural attributes of farms and farm families, and environmental and natural resource impacts.
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USDA's Agricultural Resource Management Survey (ARMS) is an integrated data collection system that enables the development of field, farm business and household accounts for the same unit of observation (ERS, USDA, ARMS briefing room). ARMS data provide a direct linkage between commodity production practices (including conservation) and the financial status of the farm and its operator's household. The data also provide insights on several facets of the agricultural sector, including its contribution to the national economy, the organization and performance of farms, the income and well-being of farm households, and the economics of production practices used across commodity enterprises. Information collected in the survey can be used to examine the effects of economic or policy events on fields, farms and farm households.

The objectives of this paper are to (1) describe the scope and sampling structure of the ARMS survey, (2) illustrate some uses of this survey for agri-environmental indicator development, and (3) explain how the core survey was recently expanded to introduce innovations with the potential to create new research uses of the survey data.

I. Scope and Sampling Structure of the ARMS Survey

The ARMS survey is conducted in three phases over the course of the survey year, which runs from June through April.

- **Phase I** is conducted during the summer of the reference year:
  Farmers selected for inclusion in the survey sample are screened to verify their operating status and to determine whether they are producing commodities targeted for data collection.

- **Phase II** is conducted in the fall and winter of the reference year:
  Randomly selected operating farms from Phase I are interviewed to collect information on their production practices, chemical use, and field-level costs of production. Phase II mirrors the former Cropping Practices Survey. Phase II data are collected at the individual field or production unit level for firms growing selected commodities.

- **Phase III** is conducted in the spring of the year following the reference year:
  A nationally representative sample of farmers is interviewed to obtain information on their farm-level costs and returns during the reference year. Farmers that reported production practices for specific commodities in Phase II are also contacted during Phase III to obtain information on their farm-level costs and returns, including data needed to estimate the costs of production associated with their production practices. Phase III data are collected at the whole farm level. Phase III replaces the former Farm Costs and Returns Survey.

The interrelationships between the three phases of the survey and the scope of each phase are described in the following figure.
The ARMS survey is technically described as a multi-phase, multi-frame, stratified, probability-weighted sampling design. The primary sample is derived from a National Agricultural Statistics Service (NASS) list frame. The NASS list consists of farm operations that exhibit certain characteristics. The lists are constructed and maintained from many different sources, including the Census of Agriculture and other NASS surveys. Because some information is already known about these farms, the list can be sorted according to farm types and size classes. The second sampling frame for ARMS is the NASS area frame. This is used only to capture farms not on the list frame, and consists of randomly selected agricultural land segments that represent all land in farms. Each year, NASS conducts a spring survey selected from the area frame to estimate crop acreage and land use. This survey identifies all land uses within each segment and can be used to stratify target crops for follow-on surveys. A sample for ARMS is then selected from the spring survey results. Only those farms not on the list frame (nonoverlap) are retained for sampling.

Because of the complexity of the sample design, each observation has a different weight, or expansion factor, to reflect its probability of selection and, therefore, the part of the population that it represents. Appropriate sample weights (expansion factors) are used to prepare population estimates from the survey results. A jackknife re-sampling process is used with 15 replicate weights (expanded to 30 replicates in 2009) from NASS for each sample to estimate the relative standard error (RSE) for each data item.

Furthermore, data from the Phase II of ARMS is divided into three data files: 1) fertilizers, 2) pesticides, and 3) all other data designated as the main file (e.g., field characteristics, management practices, and production input data other than fertilizers and pesticides). Sample weights associated with each of the three data files depend on the number of usable responses for the respective parts of the Phase II questionnaire. The usability of these tables for the construction of chemical or fertilizer use estimates is determined independently from the completion of the remainder of the questionnaire. Typically, there are slightly different response rates for these three parts of the questionnaire, and hence, weights differ.
between the main file and the two sub-files (pesticide and fertilizer). Cross-tabbing of variables across the three data files can result in different population estimates for the same variable. In general, such population estimate differences across tables are minimal.

Commodity-specific information is collected on a rotating basis in both the field-level (Phase II) and whole-farm (Phase III) portions of the ARMS. Production practice data for major crop and livestock activities (corn, soybeans, wheat, cotton, dairy, and hogs) are gathered more often than that for other commodities (other feed grains, other small grains, sugarbeets, rice, peanuts, tobacco, and poultry). Livestock data (cow-calf, hogs, and dairy) have been collected approximately every 5 years, on a staggered rotation. Livestock data is only collected in the Phase III whole-farm ARMS.

The States included in the Phase II survey vary each year, depending on the crops surveyed and with the added goal of helping minimize respondent burden. Field-level data collected in ARMS Phase II surveys do not represent the total U.S. acreage of each crop surveyed, but generally represent over 90 percent of acreage and production of the target commodity. The sampling used in ARMS Phase II was not intended to support State estimates, but sufficient data are obtained in many States to report these estimates. However, the ability to partition data for individual States is very limited.

II. Use of ARMS Data for Agri-Environmental Indicator Development and Economic Analysis

ARMS data on the economic activities of individual farm households aid policy analysis on how farmers cope with risk, adjust to policy shocks, and make decisions on labor allocation and technology adoption. The data also enable researchers to carry out disaggregated analyses ranging from a group-wise estimates of financial well-being based on farm and/or household characteristics (e.g., the ERS farm typology) to behavioral hypothesis testing with unit-level data.

The Crop Production Practices data set is based on information collected through a series of annual field-level commodity surveys. Also known as Phase II of the Agricultural Resource Management Survey (ARMS), this series is USDA's primary source of information about the current status and trends in crop production practices for several large-acreage field crops (ERS, USDA, Customized summaries from ARMS). This survey also obtains data on U.S. farmers' agricultural resource use, as well as data to assess potential environmental impacts associated with crop production practices. Crop Production Practices data also supplement ERS's Commodity Costs and Returns data. Data collected through Phase II of the ARMS survey are described in the figure below.
Phase II data include information on the field itself (such as the soil management practices, previous crops, highly erodible designation, and yield), size of the field, and the operator's tenure, including rental arrangements. Seed type, sowing rate, and cost are collected, as well as information on the tillage equipment used on the field. Amounts of fertilizer, nutrients, and methods of application for the crop are recorded, including information on how the nutrient management decisions are made. Pesticide-management variables include the amount and number of applications of each pesticide ingredient, and the management information used to make that determination. Additional information includes irrigation water applications and timing, water-management practices, responses to fuel and fertilizer price changes, and the use of crop insurance.

Customized annual ARMS data summaries are available on the ERS webpage for several field crops and production practice topics for production years beginning in 1996 (years available differ by commodity). Data for the following crops and topic areas are available (or forthcoming):

**Field Crops**

- Rice (2000, 2006)
- Sorghum (2003)
- Barley (2003)
- Oats (2005)
- Apples (2007)
Topics

- Irrigation technology and water use
- Nutrient use and management
- Crop residue management and previous crop
- Pest management
- Pesticide use
- Seed use
- Tillage systems
- Manure management
- Precision Agriculture

The ARMS database provides a foundation for benchmarking the status of production practice adoption and resource use in U.S. agriculture. ARMS data are also used as a source of information to develop agri-environmental indicators and to develop parameters for models used in agri-environmental policy analysis (MacDonald et al., 2009). Examples of research applications of ARMS data are posted on the ARMS website and other briefing rooms (see, for example, published papers at ARMS Bibliography.)

III. Recent Innovations in the ARMS Survey

The core ARMS survey has recently been extended to accommodate changing policy issues and research needs. Examples of extensions include conducting an organic sample, and the integration of economic and environmental surveys.

a. Organic Sample: Organic farming has become one of the fastest growing segments of U.S. agriculture (ERS, USDA, Organic Agriculture Briefing Room). The U.S. organic farm sector has a broad mix of farm sizes and production specialties, and includes many farms that manage both conventional and organic crop and livestock operations as they transition into organic production. Noteworthy facts about organic agriculture include:

- Every State in the U.S. had some organic agriculture by 2005.

- The organic farm sector is diverse, with both small-scale operations marketing directly to consumers, and large-scale operations targeting national and international markets.

- The organic fruit and vegetable sector has the highest level of adoption, but many organic production specialties, including dairy and poultry, have expanded.

While growing rapidly, organic farms still represent a small percentage of farms. ERS and NASS expanded USDA's major producer survey, the Agricultural Resource Management Survey in 2005 to include organic farmers. Dairy and soybeans were the first two organic farm sectors included in this survey.
The 2005 ARMS included a sub-sample of organic dairies and collected detailed information about the production practices and costs on dairy farms in 24 States representing over 90 percent of national milk production (McBride and Greene, 2009). Estimates of milk costs and returns are available from the survey for 2005, by State. As part of the survey, a subsample of organic dairy operations was developed from lists provided by major organic milk processors and certifiers.

USDA's 2006 ARMS collected information about the production practices and costs of soybean growers in 19 States (representing over 97 percent of U.S. planted soybean acres) (McBride and Greene, 2009; Miller, Greene and Livingston, 2009). As part of the survey, a subsample of organic soybean producers was developed from lists provided by major organic certifiers. A set of estimates is now available from the survey that presents costs and returns for 2006 by region and size of operation for all soybean producers and for conventional and organic producers for regions and size groups with sufficient observations to ensure statistical reliability.

Finally, in 2007, USDA included a crop-specific survey of apple producers in the annual Agricultural Resource Management Survey. The survey collected detailed information about U.S. apple production in 7 States (Washington, Pennsylvania, Oregon, North Carolina, New York, Michigan and California) representing over 90 percent of national apple production. Organic apple production accounted for approximately 4 percent of total apple production in the United States in 2007, and a subsample targeting organic apple operations was included in the survey. Data from this survey were used to compare organic and conventional apple operations in the use of selected production practices and participation in Federal programs in 2007 (Organic Apple Production Synopsis). USDA continues to include targeted a targeted over-sample of organic producers for one of two surveyed commodities. The 2009 ARMS surveyed organic wheat producers, with 2010 to feature organic corn and dairy.

b. CEAP/ARMS: Integration of Economic/Environmental Surveys: The Conservation Effects Assessment Project (CEAP) was initiated in 2003 to monitor and evaluate the environmental effectiveness and economic costs of USDA's conservation programs. The project was spearheaded by the Natural Resources Conservation Service (NRCS) and the Agricultural Research Service (ARS). One objective of CEAP was to develop and model conservation benefits and quantify the impact of conservation practices at the watershed scale using farmer surveys about conservation practices and program participation. This survey information can be linked to National Resources Inventory (NRI) data points, providing a mechanism to measure the effects of conservation behavior on the physical environment.

CEAP also made possible linkages between changes in farming behavior and participation in conservation programs. But farmers may adopt conservation practices for reasons other than the conservation program itself. For example, in 2001, 60 percent of corn farmers were using crop residue management, even though they did not need to in order to meet conservation compliance requirements. But a profit motive may not be the only driver behind the decision to use good farming practices. Different farm households may prefer different farming practices due to concerns over succession, the desire to limit the time and energy spent farming, or the need for income stability. These factors can also affect decisions about conservation practices and program participation.

In addition to detailed environmental information from the NRI, and survey information about the conservation activities practiced by farms, information about other factors influencing the program
participation decision (i.e. farm economic performance and enterprise mix, household size and composition, operator age or farming experience, participation in government programs, and reliance on farming as a source of income) is needed for a composite picture of how conservation programs influence farming behavior, which may in turn affect environmental quality.

To address this issue, USDA introduced a companion project in 2004: the Conservation Effects Assessment Project--Agricultural Resource Management Survey (CEAP-ARMS). The CEAP-ARMS questionnaire linked the ARMS farm household, resource, and economic data directly to CEAP production practice and program participation data, and corresponding field-specific NRI data. Some broad policy questions that have been addressed with this integrated survey include: (1) to what extent do land and conservation program participant/non-participant characteristics vary; and (2) can information on observed land and program participant/non-participant heterogeneity be used to design better targeted agri-environmental policies?

By linking data at the NRI, field, and farm level, CEAP-ARMS can enhance USDA's ability to evaluate the impacts of conservation programs on farm operator behavior by isolating the impacts of program incentives from those due to other farm programs and other factors (such as, farm household and financial constraints, technology changes, and farm size). In tandem, CEAP-ARMS can enhance USDA's ability to predict the impacts of farm operator behavior and improve its ability to design and implement programs to achieve resource and conservation policy goals more cost-effectively (Lambert, Schaible, Johansson and Vasavada, 2007).

IV. Conclusions

ARMS is critical to the research and analysis mission of USDA’s ERS and is a key input to developing agricultural statistics across USDA and other government agencies. It provides the information base for sector estimates of value added, income for farms by type of commodity specialization, costs of producing major crop and livestock commodities, indices of prices paid by farmers for production inputs, and an annual report on the status of family farms. ARMS also supports USDA estimates of household income and wealth, and contributes to a variety of applied farm production, management, technology adoption, resource use, and household well-being research applications.

Recent innovations to the ARMS survey have extended the usefulness of the data by examining specific sectors (e.g. organic), integrating economic and environmental surveys to provide a more holistic view of agricultural production decision making, and enabling use of site-specific information and spatial characteristics of the sample point in agri-environmental policy analysis.
REFERENCES


