NON-SAMPLING ERRORS ASSOCIATED WITH COLLECTION OF AGRICULTURAL ECONOMIC DATA

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INTRODUCTION

The Statistical Reporting Service (SRS) of the U.S. Department of Agriculture (USDA) conducts an annual Farm Costs and Returns Survey (FCRS). This survey is a multiple frame survey to obtain data on farm expenditures, production practices and income sources using a combination of detailed and global questionnaires. Survey data are used extensively for analysis of farm production expenses, cost of production and the financial situation of the farm sector. For this survey information to be used effectively for decision making, data users need to be aware of the impacts of both sampling and non-sampling errors on data reliability.

Sampling errors are calculated and published for selected items. Non-sampling errors are only mentioned since methods are not available to estimate their magnitude. Still, data users should be aware of the kinds of errors, procedures used to minimize the errors and some of the ways to evaluate possible impacts.

Non-sampling errors are divided into seven categories for discussion. The categories are:

1. Non-response
2. Outliers
3. Identification of Sample Units
4. The Universe of Data
5. Dynamics of Changes
6. The Influence of Human Nature
7. Recording and Handling of Data

NON-RESPONSE

The problem of non-response is associated with nearly every survey. In the case of probability surveys, adjustments must be made to properly expand quantitative data. Procedures to compensate for non-response include editing required data into the questionnaire, adjusting expansion factors for missing questionnaires, making imputations based on presence or absence of observable characteristics, using an adjacent report, or using hot deck procedures to impute data. In the case of the FCRS, non-respondent's data are assumed to have the same characteristics as the respondents in the same sample strata and expansion factors are adjusted accordingly. Adjustment procedures should be consistent with the characteristics of the data being collected. For farm economic data, the diversity and magnitude of farm to farm differences make it extremely difficult to adjust or impute on an individual report basis.

Non-response on surveys is more than refusing to provide information. It can result from inability to locate or contact the respondent or, in some cases, because the information is not accessible or compiled at the time of the survey. Response to the FCRS is voluntary. Therefore, the respondent must believe that providing the information will be beneficial in some way. Reasons for refusals include such factors as belief that the data will be used against the farmer (negative value), privacy concerns (none of the government's business), misunderstanding of how data are collected and used, too many repeated survey contacts, or the respondent does not have time to provide the information.

One of the major ways used to improve the response on the FCRS is to publicize the survey by getting the farm press and trade organizations to support cooperation on the survey by explaining the need for the data and how they are used. Interviewers receive specialized training to explain the survey and the data uses to respondents. In some cases, the statistician in charge of a field office will follow up to obtain an individual's cooperation. Assurance of the confidentiality of individual reports is essential for good cooperation. With recurring surveys, special reporting arrangements may be needed, especially with larger farm operators. Advance notices of the survey and scheduling appointments contribute to better response along with sending the survey results back to respondents.

Evaluating the impact of non-response on the survey results is essential to detect possible biases and to identify problem areas to be targeted for additional emphasis on the next survey. Although direct quantative methods are not available to analyze the impact of non-response, non-quantative or indirect analysis of the data can yield an insight to possible biases. Usually, the first approach is tabulating response rates by subgroups within the sample. Criteria often used are sample strata, size or type of operations, and geographic distributions. Distribution analysis of reported data may be helpful, especially if other survey data or benchmark data such as Census reports are available. In some cases if a different method of estimation can be used, comparing the results may provide an indication of possible bias. More subjective procedures include obtaining comments and documenting the data collectors' observations of reasons given for refusing data and the observable characteristics of the units for which no data are obtained. To maintain response rates at a maximum, constant and unrelenting efforts are required to identify reasons for non-response and then to redirect emphasis and resources to improve cooperation on the surveys. Statistical agencies are researching both statistical and non-statistical methods to address the problem of missing data. These procedures are helpful in reducing the impact of non-response but cannot be a substitute for reported data.

OUTLIERS

Outliers are valid reports but the data are so extreme that they have a major influence on survey results. In many cases there is a severe distortion of the data at the regional level or by type or size of farm. Usually the outliers are larger operations with atypical characteristics that are assigned to an incorrect sample strata with a large expansion factor.

Reports which may be considered outliers are often recognized during the initial questionnaire review. At this point the reports are identified but continue to be processed as valid reports. After the initial summarization of the survey data, special tabulations are made to further identify possible outliers. These tabulations usually focus on data distributions and the impact of individual sample units on estimates. The process used to detect and adjust for outliers should incorporate both statistical processes and subject matter expertise.

For analysis of the outliers in the FCRS, individual

report contributions to the survey total are tabulated. Any report which represents one-half of one percent of the U.S. total expenditures or five percent of a regional total is identified as a possible outlier. Then, a formal board of survey statisticians and subject matter experts is assembled to decide on adjustment procedures to be used. Based on both statistical considerations and the knowledge of the universe, individual reports are post stratified into a stratum that has similar characteristics. Eight reports contributed nearly 5 percent of the U.S. total on the 1984 FCRS. After adjustment, they accounted for less than one-half of one percent of the total. This process introduces bias but provides more stable results since only a few reports can introduce major year to year fluctuations.

This review and adjustment of the data shows the need to have large or atypical operations identified before samples are drawn to assure they will have proper weight in the survey totals. The analysis discussed above deals with reports that have an unusually large contribution. It is also essential to review the opposite side to be sure that reports with unusually low expenditures are properly handled and do not have an undue impact on survey results. This is especially important with farms sampled from strata where large income or expenditures are expected and only minimal data are reported. Some statistical procedures have been developed to identify outliers and adjust data and more research is expected in the future.

IDENTIFICATION OF SAMPLE UNITS

The FCRS has a multiple frame survey design combining list and area frames. To avoid duplication and overexpansion of data, the identification of sampling units common to both sampling frames must be possible. Overlap occurs when a unit is in the universe of both sample frames. The area frame includes all farms but it is an inefficient sampling frame for farm economic data because a small proportion of the farms account for most of the production and expenditures. When a list frame is used with the area frame, the sample design is much more efficient. However to assure the data are properly expanded and summarized, any operation identified in the area sample must be reviewed to determine if that farm is on the list universe . Making this match is more difficult than most people realize.

The list frame is never completely up-to-date. In fact, the information is often at least one or two years old which means name and addresss changes have occurred, farms have changed size or changed the type of commodities produced, and the type of proprietorship may be altered. In addition to these factors, respondents do not consistently use only one name for an operation. They may report a farm name on one survey but the senior partner's name on the next survey.

Identifying the type of proprietorship is essential for determining overlap status and assuring data is not duplicated. For partnership operations, more than one partner can usually report the information requested. Generally, a change in proprietorship, such as adding or dropping a partner, requires some data adjustment because the probability of selection is altered. For corporate operations, a change in managers or stockholders does not necessarily alter the probability of the operation being selected.

Interviewer and editing manuals include decision flowcharts to show how various situations should be handled. However, unless a person understands the sampling design and theory, some of the actions may seem incorrect. The importance of following the manual is stressed at training schools and if the data collectors in the field have any questions, they are instructed to call the statistician in charge of the survey.

To minimize the errors related to identification of sample units requires that the list frame be as current as possible with complete names, addresses and control information. The identification and farm screening section of the questionnaire must obtain sufficient data to identify the operation to be interviewed and how to handle changes in name or operation. Then in the frame and sample designs, the sample unit should be defined in a manner that corresponds to the operating arrangements in the field that respondents readily understand. This requirement can be met by advance field testing of questionnaires and procedures.

THE UNIVERSE OF DATA

Selecting the data to be collected on a survey such as FCRS is an involved process. The subject matter expert can identify the data wanted. The questions for the survey statistician are "Does this information exist?" and "How can it be collected on a survey?". It is helpful to consider data in three categories: (1) quantitative data which can be measured or are of record (e.g., rent paid), (2) qualitative data where presence or absence can be verified and some quantitative evaluation can usually be made (e.g., value of your farm) and (3) subjective or judgmental data which cannot be verified but only represents the respondent's evaluation at the time of data collection (e.g., for your locality, what is the average value of tillable land?).

Designing the questionnaire requires a knowledge of the universe and the quantitative information that exists in the universe as well as "a feel" for the qualitative and judgmental data that can be supplied by respondents. The questionnaire must be designed to have a flow consistent with the way respondents generally organize their information. Quantitative data can use direct questions but the qualitative and judgmental questions need more defining and may require "lead-in questions" or probing on the part of the interviewer. It is important that questions use terminology that is familiar and accepted by the respondents. To minimize these non-sampling errors resulting from ineffective design, questionnaires are reviewed and field tested on a small sample of respondents. In order to assure that the correct information is obtained, the interviewers are trained on the data to be obtained as well as interviewing and probing techniques.

Training alone is insufficient; quality control checks and procedures are needed. These include close supervision and observation of the data collectors, documenting interviewers comments and feedback, recontacting respondents, and checking questionnaires for notes or indications that the respondent had trouble in answering or changed an answer after probing. Using split samples is an effective method to evaluate the bias introduced through the questionnaire and the data collection procedures. Another effective means is to build in questions so that selected items can be compared with information from other sources -Census, administrative records or other surveys.

DYNAMICS OF CHANGES

Make a change and you have an opportunity for introducing bias or errors into a system. This area is where some of the largest non-sampling errors for the FCRS have been detected but data users have little information to evaluate possible impacts. Changes that impact survey results are sample design, questionnaire design, training emphasis, edit procedures, ADP systems and software, training manuals and materials, and personnel.

A constant awareness of possible impacts and pretesting of changes is essential if survey results are to be kept on a comparable basis from year to year. For major surveys such as the FCRS, continuity of key personnel is essential. Formal as well as on-the-job training is also essential to assure that the personnel have the specialized skills and experience to assure smooth transitions when personnel changes occur.

Before survey data are published, the results are analyzed for unusual changes. The data are compared with previous surveys, reviewed at each summary level, and consistency between data items checked. Possible problem areas are identified for further study and corrective action on the next survey.

For repetitive surveys, all changes should be fully documented for future reference. When data users find results which seem inconsistent, one of the first questions should be "Were the questions and procedures the same as on the earlier survey or were changes incorporated into the survey?" Copies of the questionnaires are very useful when interpreting published survey results if data are interrelated or aggregated for published totals.

THE INFLUENCE OF HUMAN NATURE

People's attitudes and biases can have both positive and negative impacts on survey results. Some good intentions on the part of the data collector may result in biased responses. For example, the desire to be helpful and minimize an interview time often leads to suggesting answers, not giving respondent adequate time to fully comprehend a question or inadequate probing by the interviewer. Negative attitudes of supervisors also influence the attitudes of data collectors.

Controlling these kinds of biases in a survey is not a statistical problem but a survey management concern. Data collectors must be carefully selected for the job to be done, trained in data collection procedures and know the purpose of survey and how the data are used. Training sessions should have open discussions of individual's biases and how not following instructions can impact survey results.

Good survey management procedures include monitoring the work of all data collectors both experienced and inexperienced, rotation of assignments, comparison of performance on different types of surveys or geographic areas, review of refusal rates, and review of preferences or refusals to work on certain surveys. The quality check program should also provide feedback from respondents on how the enumerator conducted the interview.

RECORDING AND HANDLING OF DATA

This group of non-sampling errors is generally associated with questionnaire design and processing of the data. The errors tend to relate more to specific items within the survey. Some of the more frequent problems related to the questionnaire are consistency and clarity in definitions, unclear bounding rules for extended recall questions, consistency of codes and sequencing from survey to survey (confusing to data collector), type of marks put into blank cells, clear identification of reporting units and consistency in use of include-exclude qualifiers. Control of these non-sampling errors depends largely on the experience and expertise of the survey statisticians. Established design standards, pretesting of the questionnaire, and a feedback system from the data collectors are all essential.

There is always a chance of an error when data are being handled manually or data are being keyed. The machine operator can misread the data, a wrong entry key can be hit or interruptions can result in missed or duplicated data. The importance of documenting exceptions was reinforced on the FCRS when the area segment expansion factors were being automated. To accomodate the earlier program a few factors had been divided by 10 or 100. New people assigned to the project were not aware of the exceptions. Although questions were raised during data review, the check of expansion factors in the program indicated they were correct. When the error was finally identified, two previous years survey data had to be resummarized. Generally, errors occurring during keying and processing of data are infrequent. The errors that do occur are usually detected by edit checks built into the systems.

However, edit checks designed to detect errors can bias data by limiting the amount of change. Usually, data checks are set such that when a value exceeds certain limits the data are flagged for review by statisticians. The data remains in the system unless corrections are entered. In some cases, the data could have a major influence on survey results. When this happens, action must be taken before the data will be accepted by the summary program. In cases where the edit checks are too restrictive, large volumes of error printouts are generated and review time is limited. When this happens the tendency is to hastily review the error printout and change the data to pass the edit limits.

Procedures to minimize the impact from data handling errors are testing of all edit and summary systems; full involvement of data processing staff in all phases of the survey, especially in the questionnaire design and preparation of summary specifications; manual and automated review of questionnaires; detailed review of output; and postanalysis of the survey.

SUMMARY

Control of non-sampling errors requires the constant vigilance of all people working on a survey. Pretesting of survey instruments and procedures with quality control measures is essential. The most important links in the survey are the repondent and the data collector. Data collectors must obtain the cooperation of the respondents and then accurately record the information. Therefore, the interviewers' training and understanding of the survey is of paramount importance.