CHAPTER 9.
Coverage Evaluation and Research

COVERAGE EVALUATION

Introduction

The Bureau of the Census carried out the first coverage evaluation of the census of agriculture in 1945, and first released the findings of the agriculture census coverage evaluation for the 1950 census. Since then, the Bureau routinely has measured the accuracy and completeness of farm counts and selected data item totals for each agricultural enumeration and has published information on the limitations of the data. The basic methodology employed in the evaluation has remained relatively unchanged, although techniques have been refined and sample designs modified and improved.

The principal objectives of the 1982 coverage evaluation program were:

- Provide measures of the coverage of the census farm counts and of selected data items, such as land in farms, value of agricultural product sales, and operator characteristics.
- Provide estimates of selected characteristics for undercounted farms.
- Inform census data users of any known deficiencies that might affect the interpretation or use of the data.

General Procedures

The 1982 coverage evaluation program consisted of two major studies, an area-segment survey designed to measure the number and characteristics of farms not on the census mail list, and a classification-error study intended to estimate the number and characteristics of farms on the mail list that were overcounted or misclassified as out of scope (nonfarm). For the area-segment sample, an area probability sample of segments was drawn from the 1978 Census of Agriculture Area Sample (CAAS) to use as a representative base for measuring the census universe. The classification-error study employed a stratified sample drawn from the 3.7 million names and addresses on the 1982 census mail list. The Bureau used more intensive enumeration and processing techniques with these samples than were feasible in the regular census.

Data for the area-segment survey were collected by canvassing each area segment, but telephone enumeration was used for the classification-error study. The farms enumerated in the samples were matched to the census mail list to establish the relationship between the sample cases and the census, and the results were processed, tabulated, analyzed, and published.

Sample Survey Designs and Methodologies

Area-segment survey—The area-segment survey was designed to collect information on the characteristics of farms in rural areas (areas with a population of less than 2,500) not on the the 1982 census mail list. The survey was based on a subsample of land-area segments (see below). The 1978 CAAS was originally developed to supplement the census mail-list data at the State level and above by providing estimates of the number and characteristics of farms not on the census mail list. Budget constraints prevented its duplication for the 1982 census, but the 1978 sample frame provided a source for the 1982 area-segment survey.

The CAAS sample frame consisted of all the enumeration districts (ED's) and block groups listed in the 1970 Census of Population and Housing in each State. The sample unit, the "area segment," was a defined geographic area of land that could vary in geographic size and in the total number of housing units and/or farms it contained, depending on the stratum to which it was assigned. The *average* number of farms per segment was 10, but the actual number varied from none in low-density farm areas to as high as 12 in high-density areas. A total of 6,400 area segments was selected for the CAAS.

For the 1982 area-segment sample, the 6,400 segments originally selected for the 1978 CAAS were stratified by geographic region (Northeast, Midwest, South, and West) and by number of farms identified in the CAAS as not on 1978 mail list (0, 1, 2 or 3, and 4 or more). The segments in each strata then were ordered by farm density and segment number. A size measure, based on 1978 CAAS weights, was assigned to each segment; and the sample of segments was selected from each stratum with probability proportional to this size measure.

The Bureau determined that a sample of 344 segments would provide an absolute standard error of 2.0 percent, at the regional level, for the estimated proportion of census farms not on the mail list. Strata sample sizes within each region were based on an approximate optimum allocation of the sample, with the single requirement that at least two segments be allocated to each stratum. Once the CAAS subsample was selected, the Bureau then identified 344 *adjacent* area segments for use in the 1982 area-segment sample. The adjacent segments were used to avoid any bias from the earlier census enumeration. The selection probability of a 1982 sample segment was equal to the selection probability of the adjacent CAAS segment.

Classification error study—Coverage evaluation of recent censuses indicated that approximately 3 to 5 percent of farms on the census mail lists were misclassified as nonfarms, with an additional 1 to 2 percent of the nonfarms incorrectly identified as farms or overcounted because of duplication of report forms.

Classification errors could result from misinterpretation of census definitions or instructions, incomplete or erroneous reporting by respondents, or errors in census processing. The classification-error study (CES) was designed to provide estimates of the number and characteristics of farms on the 1982 census mail list but (1) misclassified as nonfarms, or (2) overcounted.

The CES sample was selected from the final census mail list *prior* to the initial census mailout. Addresses in Alaska and Hawaii were excluded from the sample because of budget constraints, while farms with expected annual sales of $500,000 or more, institutional farms ("abnormals"), and some multiunits were excluded because they were subject to intensive mail and/or telephone followup as well as report form review to ensure the accuracy and completeness of reported data as part of the census procedures. The first stage was the selection of a systematic sample of the census mail list. The sampling rate varied among census geographic regions as follows:

Region	Sampling rate
Northeast	1 in 187
Midwest	1 in 1,250
South	1 in 1,250
West	1 in 375

These rates yielded a sample of about 4,700 names and addresses, with approximately equal numbers from each region, which was sufficient to provide acceptable regional-level estimates of classification error.

The second stage of the sample selection was carried out after enumeration. Cases selected for the CES had an "alpha" symbol—"A," "B," or "C"—on the second line of the printed address labels. When the report forms returned through the mail, the symbols were used to identify the CES cases and separate them from regular returns for photocopying, after which the original report forms were returned to the processing cycle. Agriculture Division staff reviewed the photocopies and classified the sample as: 2,700 farms, 1,400 nonfarms, 500 nonrespondents, and 100 PMR's. A systematic sample of 1 in 2 of the farm cases then was selected for matching to the census mail list to identify any duplicates. Nonduplicate farm cases then were systematically subsampled by geographic region at a rate of 1 in 5 in the Midwest, Northeast, and South, and 1 in 7 in the West. Subsampling reduced the initial CES sample of 4,700 addresses to approximately 1,800 cases selected for re-enumeration (1,400 nonfarms, 300 farms, and 100 PMR's; nonresponse cases were deleted from the file).

Data collection—The area-segment sample was enumerated by field interviewers. Beginning in February 1983, the field staff from the Bureau's regional offices canvassed each segment, listing the name of the reference person (usually the owner or renter) in each household, and asking a series of screening questions to determine whether the household was involved in agricultural operations. The enumerators completed a form 82-A90, "Evaluation of the 1982 Census of Agriculture" questionnaire for each household having agricultural activity. The field operation was closed in May 1983; 4,276 completed A90 report forms were returned to Suitland, MD, headquarters for processing.

Data for the CES were collected primarily by telephone. Experienced Census Bureau telephone interviewers in Suitland attempted to place calls to each address on the CES sample list. When a farm operator was contacted by telephone, the interviewer re-enumerated the household, completing a form 82-A90. When households could not be contacted by telephone, they were mailed an evaluation report form with a request for response. Data collection continued until all 1,800 cases were enumerated.

Processing

Processing procedures were similar for *all* coverage evaluation cases. Upon receipt, the A90 forms were reviewed and classified as farm or nonfarm cases according to the census farm definition. (About 4 percent of the evaluation surveys addresses could not be classified because of refusals, incomplete data, or failure to contact for data collection. This caused a slight downward bias in estimates for misclassified and overcounted farms, and in the estimated totals.) Once classified, the evaluation report forms were matched to the census mail list. Area-segment sample farms matched to farms on the mail list were classified as *matched* farms, while nonmatched farms were classified as farms *not on the mail list.* The CES report forms were compared to the census report forms received for the same farms to identify farms misclassified as nonfarms, farms that were PMR in the census, nonfarms incorrectly classified as farms in the census, and duplicate report forms for the same farm.

After matching and comparison, the forms were reviewed clerically again, and coverage classification codes were assigned for census errors identified. The data then were keyed to tape, edited by computer, and tabulated in February 1984 to provide estimates of the undercount and overcount of farms, and characteristics of farms not on the census mail list.

Estimation Procedures

The coverage evaluation provided estimates of the undercount and overcount for the census. The undercount estimates included farm counts and totals for selected characteristics, while the overcount estimates were made only for the farm counts. Estimates of the total for some characteristics of all farms were calculated by combining the census published number and the undercount minus the overcount. The undercount was split into two components— farms not on the census mail list and farms on the mail list but misclassified as nonfarms. Estimates for farms not on the mail list also were derived from the area-segment survey, while estimates for the overcount and for totals of selected characteristics for misclassified farms were derived from the CES.

Publication of Results

The results of the coverage evaluation program were published in April 1985 in the 1982 Census of Agriculture, Volume 2, *Subject Series,* Part 2, *Coverage Evaluation.* The publication included text outlining the coverage evaluation program and describing estimation techniques employed, and charts and tables showing estimates of census farm coverage, farms by selected characteristics and components of coverage, selected items for undercounted farms, land in farms by sales group and components of coverage, and value of agricultural products sold by sales group and components of coverage. Since the samples used were too small to provide reliable county- or State-level data, estimates were published only for regions and the United States.

RESEARCH PROJECTS

Mail Variation Test

Introduction—The objective of the mail variation test was to determine whether there was a statistical difference in the mail

response obtained by the census between a report-form followup and a letter followup. Addresses selected for the mail variation test sample were included in the initial census mailout and the first mail followup. The mail variation test procedures were carried out as part of the second and third census mail followups, reversing, for the test sample, the usual report form/followup letter mailing order.

Sample design—The test sample was designed to detect a variation of 2 percent or more in response. The sampling frame employed was the census nonrespondent mailing lists for 13 States, 7 in the South (Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, and Virginia) and 6 from the Midwest (Illinois, Indiana, Iowa, Kansas, Nebraska, and Ohio). These States were chosen because they represented very different areas in terms of farm size and historical response to the census.

A total of approximately 100,000 cases—both census nonsample and sample—were selected by a systematic sample designed to reflect the ratio of nonsample to sample cases in the census mail file. The resulting file was split into a test sample of approximately 42,000 names and addresses, and a control sample of about 58,000. The test sample would be subject to the mail variation test, while the control-sample nonrespondents were subject to the same followup procedures as the census nonrespondents. Once the test period was completed, the response rates achieved for the test and control cases were compared and analyzed.

Mailout and followup—The initial mailing for the variation test was carried out as part of the second census mail followup in the week following March 18, 1983. While the regular mail followup consisted of a complete enumeration package, the variation test sample—41,461 addresses—was sent only a form 82-A01(L4) followup letter requesting response.

The followup to the variation test mailing was carried out as part of the third census mail followup in the third week of April 1983. All nonrespondent cases on the variation test sample mail list were sent complete enumeration packages, including the appropriate report form, a cover letter, instruction sheet, and return envelope.

Results—The responses to the samples were compared at the time of the second, third, and fourth followup mailings. Analysis of response achieved in the test and control samples indicated (1) significantly better response rates were achieved by report-form followups; (2) the level of response to the mail variation test differed between the Southern and Midwestern States, with somewhat better response obtained from the latter; and (3) there was no significant difference in response achieved between sample and nonsample forms (i.e., between "long" and "short" forms).

The CATI Test

General information—Computer-assisted telephone interviewing (CATI) is a method of data collection that employs an interactive computer system to centralize telephone interviewing, data entry, editing, and coding. CATI systems already were used in a wide range of data collection activities, and the Bureau of the Census became interested in the possible census applications of CATI in the early 1970's, beginning active research in 1980. The first major test of a Census CATI system was part of the nonresponse followup to the 1982 National Survey of Natural and Social Scientists and Engineers. The second large-scale test was part of the telephone followup of 1982 Census of Agriculture nonrespondents.

The CATI system used in the agriculture census followup employed telephone interviewers who read to each respondent questions appearing on a computer display terminal. Responses were recorded by means of a keyboard entry system and the computer performed selected consistency and validity checks as the responses were entered. The computer could request additional data or corrected information as necessary. Once a response was accepted by the computer, it was stored and the next appropriate question appeared on the screen. The interactive system automatically followed any "skip pattern" built into the census report form.

Sample selection—The Bureau selected a test sample of approximately 10,000 nonrespondents with expected value of sales of between $100,000 and $999,999, and fewer than 30,000 acres. (Expected sales and acreages were based on 1978 census data.) A comparison sample of 10,000 similar cases also was selected; the test sample was to be followed up using CATI techniques, but the comparison sample by conventional telephone interviewing.

The Bureau used a stratified cluster sample within each of the 48 contiguous States to assemble the CATI test and comparison sample. The number of cases selected in each State was proportional to the number of nonrespondents in each. The address list for each State was stratified on the basis of source, mail size code (i.e., estimated value of sales and/or acreage), and type of operation (crop or livestock). The strata were sorted by State, county, and ZIP Code. A systematic sample of pairs of nonrespondents was selected and then the cases in each pair were randomly assigned to either the CATI or comparison samples. The cases from 12 States were deleted prior to the start of interviewing because of their early closeout dates, so the actual size of the samples was reduced to approximately 8,500 cases each.

Adaptation of the census report form for use with CATI—Modifications to the standard "sample" form for use in telephone interviewing produced the form 82-A0313, Telephone Enumeration Report Form (see p. 32 for a description of the changes made to the regular form). The computer terminal screens used for CATI usually displayed only 20 to 24 lines of text at once, so long question sequences had to be broken into shorter sets, tables had to be rearranged, and the "skip" instructions of the regular form had to be rewritten for the telephone questionnaire to be used with the CATI system. To program the modified questionnaire to "run" on the CATI system, the Bureau's CATI Project staff utilized a user language—Questionnaire Implementation System—Census (QISC)—based on several questionnaire implementation system (QIS) languages developed by the Universities of California at Los Angeles and Berkeley. The questionnaire was set up in QISC, usually section by section, and then a translator program converted QISC to FORTRAN and compiled the FORTRAN program for a running version for production interviewing.

Staffing and training—The Bureau established a CATI test facility at its headquarters in Suitland in the summer of 1982, and in April 1983, the Agriculture and Field Divisions began selecting interviewers for the agriculture census CATI test. The staff consisted of a facility manager (a Field Division survey statistician), three "unit managers," and 20 interviewers. Interviewer training

was carried out at the Suitland facility and consisted of a 2-week course, the first week devoted to subject-matter review (i.e., familiarization with the agriculture census forms, terminology, and so on), and the second covering CATI procedures. Training was carried out in the last two weeks of April 1983. Six replacements were trained in early August for interviewers who had left the CATI staff.

CATI operations—Production interviewing began on May 9—the Monday following completion of interviewer training—and continued until the operation closed on September 16. (A telephone-numbers research unit in Jeffersonville obtained numbers from the telephone companies' directory assistance for each sample case and attempted to contact operators between 9:00 a.m. and 9:00 p.m. local [operator's] time.) The distribution of the final resolution of both the CATI and the comparison samples were:

Type	CATI sample	Comparison sample
Total	8,512	8,523
Enumerated by mail (deleted)	824	3,096
Completed interview (farm and nonfarm)	4,159	2,499
Partial interview	174	—
Refusal	337	535
Claimed filed	715	582
Other noninterview	1,094	670
Unlocatable (no telephone number)	1,142	819
No contact	67	322

Results—Resolution of the "average" CATI case required approximately 5.0 telephone calls, while an average of 3.4 calls were required to resolve a comparison sample case; completing an interview with a farm operator required an average 4.6 telephone calls and 36 minutes for CATI cases, and 3.3 calls and 26.2 minutes for comparison sample cases. Completing an interview for a nonfarm operator required an average 3.8 calls and 10.8 minutes (CATI) or 3.0 calls and 11.4 minutes (comparison sample).

Specific problems encountered in the CATI test included incompatibility between the CATI computer data file format and that of the Bureau's mainframe computers. This required programming conversion and reformatting routines for the CATI file before it could be merged with the census data file. There also were difficulties in maintaining a smooth flow of cases to CATI interviewers. Cases were referred to the CATI staff by State and, in several instances, groups of cases for States were not always ready to be entered in the call scheduler when the previous set had been completed or nearly completed. The requirement that CATI data for States be transmitted back to Jeffersonville before the closeout date for each State meant the CATI test closeout date for that State had to be 3 days earlier than for Jeffersonville. This resulted in some cases that had not reached the call cutoff limits being designated "unresolved," and their referral by Jeffersonville for resolution from secondary sources. In general, the separate sites for the CATI sample and main processing operations required special procedures to handle transmissions of data between the two facilities. Clerks reviewing CATI cases that failed computer edit at Jeffersonville also received special training.

Comparability Study

One of the basic objectives of a continuing census program is to maintain data series for historical comparisons. A variety of factors affect comparability, including farm definition and enumeration methods. The definition of a farm for census purposes was different in the 1974 census than in previous enumerations, so that data for the 1974, 1978, and 1982 censuses, when compared with earlier censuses, are not consistent in the "all farms" categories. More direct comparability of data was possible in the categories of farms with sales of $2,500 or more.

The 1982 Census of Agriculture used the same basic mailout/mailback data collection procedures as were used in the 1969, 1974, and 1978 censuses. However, the 1978 census State- and national-level estimates, included data derived from both the census mail list and the 1978 Census of Agriculture Area Segment Survey (CAAS)—a field canvass of some 6,400 geographically defined area segments. This difference in the method of enumeration used affects data comparisons between the 1974 and 1978, and between the 1978 and 1982 censuses. The Bureau, believing that differences in universe coverage were an important factor contributing to comparability of the data between recent censuses, initiated a study to evaluate 1982 census coverage in relation to the coverage attained in earlier censuses.

The Bureau's coverage evaluation program provided measures of the number and characteristics of farms not accounted for in the census. (For details of the 1982 coverage evaluation, see pp. 55-56.) The 1974 coverage evaluation program was designed to provide State-level estimates of the components of coverage—i.e., farms included in the census, overcounted in the census, and missed in the census—while the 1978 and 1982 programs developed regional estimates only. The 1978 census included the CAAS as a supplement to the census mail list, and coverage estimates for the 1978 census indicated that the 1978 census enumeration procedure provided better coverage than was obtained in the previous census.

To compare coverage of the 1978 mail list with coverage of the 1974 and 1982 mail list censuses, coverage estimates for 1978 were calculated for the 1978 "mail list only" totals. This enabled the Bureau to evaluate data produced by more nearly equivalent methodologies for all three agricultural censuses, as well as providing some measure of the impact the CAAS had on the coverage estimates of the 1978 census. Estimates were calculated (using the same coverage-error estimator employed in the 1982 coverage evaluation program) for three categories within each of the major coverage components: (1) All farms, (2) farms with sales of less than $2,500, and (3) farms with sales of $2,500 or more.

The comparability study indicated that in terms of results based only on census mail list procedures, the net coverage error for "large" farms (with sales of $2,500 or more) for 1982 was small and was relatively close to that achieved by the 1978 mail-list/area sample. No statistical adjustment of 1982 data for undercoverage of large farms seemed necessary to achieve comparability between published data from these two censuses. For farms with sales of less than $2,500, coverage attained varied considerably by regions between the censuses. Thus, the difference in data collection methodology between the 1978 and 1982 censuses primarily affected the comparability of the data on numbers of farms with sales of less than $2,500 and total numbers of farms, but had relatively little effect on farm characteristics or on numbers of "large farms."