1992 CENSUS OF AGRICULTURE QUALITY ASSURANCE PROGRAM

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1. INTRODUCTION

The Census Bureau conducts a census of agriculture every 5 years. Most recently the census was conducted for 1992. The census of agriculture is the only source of statistics on American agriculture which provides comparable county level figures, classifying farms by several characteristics, including acreage, value of production, and type of organization. To ensure accurate results, the Census Bureau conducts a quality assurance program for the census of agriculture.

Quality assurance (QA) or quality control (QC) plans are used in key processing activities. An effective quality assurance program should have the following attributes:

- A well designed system or procedure (which maximizes quality and efficiency).
- An effective training program.
- A quality control program to insure the desired level of quality during the course of the operation.
- An evaluation program to measure the accuracy of the operation and identify areas where future improvements may be made.

The goal of the 1992 Census of Agriculture's overall quality assurance plan was to place a greater emphasis on preventing errors and to enhance our ability to detect and correct errors in key census processing activities. In the past, quality control plans placed more emphasis on identifying and correcting defective products rather than on preventing errors. By using the new quality assurance plan on certain processing activities, we can help produce the most reliable and accurate data possible for the 1992 Census of Agriculture.

Quality control inspections began in December 1992 when the Census Bureau mailed self-administered report forms for the 1992 census to approximately 3.5 million names and addresses assembled in the census of agriculture mail list. Mail and telephone follow-up to nonrespondents continued over a period of 6 months after the initial mailing. Much of the preparatory work, mailout, and data collection, as well as keying of the respondents' completed census report forms took place at the Census Bureau's processing center in Jeffersonville, IN.

Staff in the Data Preparation Division (DPD) in Jeffersonville checked in and reviewed the report forms when they were received. The review process consisted of several steps that were performed in the different units. Each separate unit was responsible for a specific function in the review and processing of the report forms. After the data entry process, each report form was subjected to a detailed item-by-item computer edit at census headquarters. As the Census Bureau "closed out" collection in each state or area (i.e., once an acceptable overall response level had been achieved), data were tabulated - including estimates for operations that did not respond - and the data publication for that state or area was prepared.

2. TRADITIONAL QUALITY CONTROL METHODS (Pre-1992)

GENERAL OVERVIEW

Prior to the 1992 Census of Agriculture, the major emphasis of the quality control process was on error correction rather than error prevention. Relying on correcting any errors found during inspection instead of concentrating on building quality into the process was the general practice. A lack of quality training within each census processing unit in Jeffersonville, insufficient involvement in the planning and design of the quality control system by DPD personnel, and a lack of immediate feedback to process clerks all caused communication barriers and were detriments to process quality at times. The quality control process was viewed by many as merely a barrier or obstacle to meeting production schedules.

TYPES OF VERIFICATION

1. In previous censuses, a substantial amount of the quality control process called for the use of acceptance sampling. Lot by lot and continuous sampling were the two types of acceptance sampling plans used for the census of agriculture. Acceptance sampling plans were chosen based on a specified acceptance criteria. Either a specific long term quality level using the average outgoing quality limit (AOQL) or the acceptable quality level (AQL) were used to determine the maximum number of defects that would be acceptable for the process average. Acceptance sampling required that batches of census report forms be sample inspected for errors by the verifier after the process was in the production mode. Any errors found in the sample were to be corrected at that time. Accept/Reject tables were used

by the verifier to make a decision on the quality of the batch being inspected. Rejected batches were submitted for rectification - either by the verifier or other production personnel. This process of rectification consisted of 100% verification of the work unit, where defective items were replaced by non-defectives. Rectified batches were assumed to be 100% correct and were sent to the next processing step. The verification results were not always used to monitor or improve the process. Continuous sampling plans were used in operations where it was not convenient to form lots. These plans were also usually based on a specific AOQL.

2. Whenever an acceptance sampling plan was not installed for verification, inspection by monitoring was used. This type of verification was usually employed for processes such as machine labeling of mailing pieces or telephone calls to respondents. The process was monitored to ensure that the clerks or machines were performing quality work. Feedback was to be provided to the clerks to improve quality over time.

METHOD OF VERIFICATION

Prior to the 1992 Census of Agriculture, dependent verification was used for each census process in which quality control was performed. Dependent verification consists of the verifier reviewing the clerk's action and making a judgment as to when an error should be charged. The possibility for bias is substantial under dependent verification.

CENSUS PROCESSES

Listed below are the census processes for which quality control procedures were usually applied.

1. Mail Package Preparation/Mailout of Report Forms

This process consists of address label printing, mail package labeling, package assembly, and mailout of census report forms for the initial mailout and any follow-up mailouts that take place. Acceptance sampling was usually employed in this process. The exception was the mail package labeling which was verified by continuous monitoring of the machine labeling operation.

2. Telephone Follow-up

This process consists of telephone follow-up calls to obtain data from large farm operators who did not file report forms. Verification was accomplished by a monitoring of a sample of telephone interviews to assess the performance of each clerk.

3. Data Entry

This process consists of converting the data from census report forms to machine readable form. Verification was accomplished through an acceptance sampling plan. Multiple verification stages for individual keyer control were also used in this process. A work unit decision was made for each sample verified work unit throughout all stages of verification. Rectification was required for all rejected work units.

4. Special Case Processing

Special case processing consists of a review and edit of report forms identified as possibly being out-of-scope to the census. They include report forms with attached correspondence or remarks on the front or back page, report forms with no data on the front page, or with no indication of agricultural activity. An acceptance sampling plan was used for verification of this process.

5. Duplicate Linkage Processing

This consists of processing performed to establish a linkage between duplicate or other related operations. Duplicates were identified when more than one report form was returned in the same envelope or when the respondent entered additional census file numbers on the front page of the report form. A continuous acceptance sampling plan was used for verification of this process.

6. Correction of Computer Edit Failures

This process involves the review and correction of problems with individual farm data records failing the computer edit. Verification was accomplished by an acceptance sampling plan.

3. 1992 QUALITY CONTROL / QUALITY ASSURANCE METHODS AND PRACTICES

GENERAL OVERVIEW

In past agriculture censuses, acceptance sampling QC plans were employed to inspect quality into the finished product through extensive sampling and review of completed work. With adequate verification and rectification procedures, these plans provided good outgoing quality, even if the process average or incoming quality was poor. However, a large amount of time was spent identifying and correcting errors and rectifying unsatisfactory work. For the 1992 Census of Agriculture, we moved toward a process control approach in which quality was planned into each census process. This was accomplished by using data to improve

the process, by insuring a better understanding of the overall process by the employee, and by an improved training program. Even as we moved toward this plan of quality assurance, there was still a review of completed work in most situations; however the number of cases reviewed was significantly smaller than under the former QC plans. Also, the quality assurance approach calls for having a quality control program that insures the desired level of quality during the course of the operation, and having an evaluation program to measure the accuracy of the operation and identify areas where future improvements may be made.

NEW PRACTICES FOR 1992

To implement the process control approach, we introduced several new practices for the 1992 census. These include Total Quality Management (TQM) principles, Statistical Quality Control (SQC) monitoring, independent verification, and quality controls on more processes.

1. Total Quality Management Principles

- Training

For the 1992 Census of Agriculture, a standardized format for training packages was developed for each census process. Proper training for each clerk would increase understanding of the particular census process assigned to the clerk and would enable the clerk to produce high quality work. Each training session provided an overview of the process, hands-on computer training when necessary, clerical exercises that were evaluated, an explanation of the quality assurance program, question and answer sessions, and an evaluation of the training.

- DPD Personnel Involvement

For the 1992 Census of Agriculture, the DPD staff were involved in several aspects of the QC/QA plan. Some members participated on the QC/QA Planning Committee, which met several times to discuss and plan various aspects of the quality control procedures. Also, some of the quality control and quality assurance process specifications were written by DPD personnel. They were also involved with preparing and administering the training packages.

- Quality Feedback

Although some feedback was used in certain processes in past censuses, in 1992 constant operational feedback was provided for each census process. The feedback was usually provided by processing unit supervisors, unit lead clerks, or by agricultural analysts. They would recommend "on the spot" operational changes when necessary. Also in 1992, we monitored processes by using interactively extracted reports and by using control charts and error code bar charts. Feedback could then be provided when necessary after monitoring these charts and reports.

- Employee Involvement

During the census processing in 1992, employees were encouraged on an ongoing basis to suggest ways to improve any aspect of any census process. Also, in some processes, production personnel were given responsibility for QA inspection.

2. Statistical Quality Control Monitoring Techniques

- Control Charts

The use of control charts to monitor certain census processes began for the 1992 Census of Agriculture. A control chart is used as a graphical representation of some characteristic of interest. Examining control charts helps in determining whether or not a process is in a state of statistical control. For the agriculture census, we used a p-chart, which is a type of attribute control chart. The p chart is used to monitor the average percent of defective items submitted over a period of time. Any change in this average can be detected by examining this control chart. The center line of the p-chart is considered the average proportion defective over time. The control limits are usually set at +3 standard deviations and -3 standard deviations from the process average. Data points that fall outside of the control limits are a result of special causes that should have corrective action taken and feedback provided to members of the clerical staff. We used the SAS/QC software package to generate the center-line, control limits, and data points for the p-chart for some processes.

- Error Code Bar Charts

Error code bar charts are very helpful in learning about a certain process and better characterizing the errors that are occurring. The SAS/GRAPH software package was used to generate these charts. The bar graphs provide the total number of errors (by monitoring period or cumulatively) for each process error type and the percentage of errors (by monitoring period or cumulatively) for each process error type.

3. Independent Verification

In the past, a dependent verification method was used for each census process. Under this method, a verifier examines the production clerk's output and decides whether it conforms to specification (correct) or not (incorrect). For the 1992 Census of Agriculture, we used an independent

verification method for some of the census processes. This task is performed by a production clerk, then repeated independently by the verifier. The two sets of output are then matched and cases which are determined to be different are adjudicated to determine which is correct. Although this is usually more costly than dependent verification, the work is considerably more accurate, since the verifier is not influenced by the production clerk's work.

4. New Processes in which QC Was Performed

Quality control procedures were applied to several processing operations for the first time in the 1992 census. These included mail package check-in, remove mail package contents and sort, coverage evaluation processing, and census nonrespondent processing.

CENSUS PROCESSES

Listed below are the census processes and the method of verification for each that was applied for the 1992 Census of Agriculture. Each operation's types of errors were determined before the process began and were included in the QC procedures.

1. Mail Package Preparation

Press inspections and quality checks of assembled mailing pieces were performed at the contractor's facility. The QC of each aspect of mail package preparation at DPD was implemented by the Quality Assurance Section (QAS) of the Statistical Methods and Quality Assurance Branch (SMQAB). Document Services Section (DSS) of the Data Systems Branch (DSB) was responsible for performing the quality assurance procedure (monitoring) for the mailings and of the labeling. This allowed QC to be performed concurrently with processing. QAS performed an independent sample inspection (after-the-fact) and was responsible for summarizing the QA verification records received from DSS. This method of verification gives the production unit more responsibility for quality. We plan to use similar procedures in the future.

2. Mail Package Check-in

In 1992, the method of quality control used for the check-in process consisted of running test decks of envelopes through a 56 pocket laser-sort machine. Verification was performed for the reading of the census barcode and for the correct pocket sort of the envelopes. The goal was to maintain the laser sorter's high level of performance through an early detection of problems and to collect information on the sorting process. If the test deck did fail for any reason, the machine was adjusted at that time. Daily records were kept of the test deck runs and the number of each type of error was summarized and used as feedback whenever necessary. We plan to use similar procedures in the future.

3. Remove Mail Package Contents and Sort

Quality control was performed for the first time in 1992 on the initial sort of checked in and sorted forms from the laser-sorter, as well as for forms that were manually sorted. The lead clerk of this processing unit performed spot checks on forms placed into each specific holding area. The number of each type of error was provided in summary reports and used as feedback when necessary. For future censuses, we are planning to do a more complete verification at the beginning of the process for new clerks and then continue with spot verification afterwards.

4. Interactive Incoming/Outgoing Telephone Calls

An interactive computer system was used for the first time for telephone calls in the 1992 census. This was a cost effective and time conserving process because interviewers had access to the respondent's computer record during the interview and could update the computer record immediately. Paperwork was reduced significantly and clerks were able to respond very quickly to callers. Quality control consisted of monitoring a sample of calls to assess the performance of each clerk. Supervisors and lead clerks monitored calls by listening to the call from a designated monitoring telephone. Also, by using the interactive computer screen monitoring package, the monitor was able to watch entries being made by the clerk. The monitor assessed the clerk's performance with regard to question asking, question answering, probing (if applicable), and overall accuracy. The unit supervisor provided immediate feedback when problems occurred. The number of each type of error was contained in error code bar charts and used as weekly feedback.

5. Correspondence Mailout

The correspondence mailout unit prepared special letters or other information to answer respondents' requests. One hundred percent verification was performed for the correspondence mailout preparations. This involved a check of the enclosures and the package labeling. Verification occurred after the packages had been assembled for mailing, but prior to the sealing of envelopes. The verifier corrected all errors detected during verification. Either the unit supervisor or lead clerks provided feedback on the number and types of errors when necessary.

6. Special Case Processing

An acceptance sampling plan with dependent verification was used for this process. The verification was performed

similarly to previous census methods. Verifiers recorded the number of errors by type and by clerk on the verification records. These verification records were used to produce control charts, error code bar charts, and attribute charts. The unit supervisor and analysts used these charts to provide feedback to the clerks. Because classification of report forms (census in-scope or census out-of-scope) accounted for most of the clerical errors made, this topic will be stressed heavily during training sessions in the next census. Also, since we had much lower error rates for 1992 than in the past, we will consider tightening the acceptance criteria in the QC plan in the future.

7. Duplicate Linkage Processing

A continuous acceptance sampling inspection plan with dependent verification was used for this process. The verification was performed similarly to previous census methods. Verifiers recorded the number of errors by error type and by clerk on the verification records. These verification records were used to produce control charts, error code bar charts, and attribute charts. The unit supervisor and analysts used these charts to provide feedback to the clerks.

8. Data Entry

An interactive computer-based automated QC system was used for the first time in the 1992 census for data entry. This system was used for keying, verification, production reporting, and quality control record keeping. An acceptance sampling plan with independent verification was used for the first time. A three-stage QC plan (training stage, prequalified stage, and qualified stage) provided for individual keyer control by imposing specific quality requirements during each stage. The number of each type of error by keyer was tallied in an error code bar chart each week and used as feedback. The new computer data entry system allowed for efficient use of staff resources in many quality control functions related to data entry. These functions included reviewing discrepancy listings after independent verification of a keyed batch of report forms, assigning error codes, entering quality decisions, maintaining verification records, monitoring the status of each keyer, and producing summary reports. Independent verification for the data entry process is an improvement in itself. A small study was performed to examine those entries in which the keyer and independent verifier keyed the same data for an item. The purpose was to estimate the level of error when both the keyer and verifier incorrectly keyed an item. In this study, there were no incorrect entries made when both the keyer and the verifier keyed the same data for an item.

Some possible improvements for future censuses would be to generate better screen layouts and build more edits into the keying process. We will also consider tightening the acceptance criteria in the future due to a low process error rate and a low amount of rework (only 3% of work units failed QC and required rework). We recommend continued use of the computer data entry system and the automated QC process with independent verification.

9. Correction of Computer Edit Failures

A combination process control/acceptance sampling quality control procedure was used to verify the correction of computer edit failures for 1992. The goal was to reduce the amount of inspection from previous censuses. Dependent verification with an automatic interactive sample selection was used. Small samples were verified from each work unit. Each work unit usually consisted of 95 report forms. Rectification was required when excessive errors were detected in the sample. Error code bar charts and attribute charts were used to record the number of errors by error type and clerk. The unit supervisor and analysts used these charts as part of the feedback to the clerks. An improved and more extensive training program was implemented for this process. This, along with the use of the computer system for interactive verification, reduced the amount of inspection and provided cost savings as compared to previous censuses.

10. Microfilming Report Forms

Quality control for this process involved the review of microfilm roll legibility, correct linkage of the microfilm identification number to the census file number as read by the bar code scanner on the microfilm camera, and presence of census file number and microfilm roll number. Report forms were microfilmed in an effort to reduce the amount of paper in processing. A Microfilm Access Device (MAD) machine was used to display forms for review. Quality control was performed on both coverage evaluation microfilming and on Film Optical Sensing Device for Input to Computers (FOSDIC) microfilming. An interactive computer program was used for this verification process. The microfilm verifier notified the microfilm processing unit as soon as any errors were detected. The number of each type of error was provided in summary reports and used as feedback. In the future, we will look into the possibility of verifying each page of a selected report form instead of just the first page.

11. Coverage Evaluation Processing/Nonresponse Processing

This operation includes the clerical processing of the June Agricultural Survey (JAS), the Classification Error Survey

(CES), and the Nonresponse Survey (NRS). The JAS and CES are used to measure list and classification error, respectively, in the census while the NRS is used to estimate the percent of census nonrespondents that are farm operators, for nonresponse imputation purposes. Because the coverage evaluation program for the agriculture census is an important means of assessing the completeness and accuracy of the data, quality control was implemented for the first time in 1992. Independent verification was used for quality control for these processes. Along with normal responsibilities, the unit supervisor performed the independent verification, while analysts in the Census Bureau's Agriculture Division provided adjudication. Control charts, error code bar charts, and attribute charts were used to record the number of errors by error type and by clerk. The analysts used these charts to provide feedback to the clerks. Because the unit supervisor had so many responsibilities, in the future we plan to assign one clerk the sole responsibility for independent review.

4. SUMMARY

The QC/QA plan that was used for the 1992 Census of Agriculture achieved the goal of building quality into the processing operations. The use of several innovations including methods to incorporate TQM principles, use of new methods of process control, new methods of feedback, more involvement of processing unit personnel in implementing the QC and QA procedures, QC on more processes than in the past, and increased use of independent verification, played a significant role in changing the QC emphasis from detection and correction of errors to error prevention. In the future, we intend to move even more towards a complete process control plan.

We will continue to recommend more and better training and to use more independent verification. Implementation of control charts for more processes will be considered. Also, we will recommend that a limit be placed on the number of clerical details to other processing units in operation at the same time. This would contribute toward an increase in quality. If clerks come to view QC as a tool to help them (and thus the Census Bureau) produce a better product rather than a means for checking up on them, then the traditional perception of QC as an obstacle to be overcome will be erased.

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