THE EFFECT OF
TELEPHONE ENUMERATORS
and
EVALUATING A NEW
OPERATION DESCRIPTION

by

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ABSTRACT

This report summarizes the significant impact of enumerators on
telephone interviews and the preliminary use of a new operation
description section.

Key words: Analysis of variance, enumerator effects.

ACKNOWLEDGMENTS

CONTENTS

SUMMARY

A. Telephone enumerators have an impact on the level of data that is reported on ESCS surveys. At the seven state level the enumerator effect is only significant for one variable -- expected first quarter farrowings. Differences do exist among enumerators for both response rate and other variables for some individual states.

B. A new version of the operation description section on Multiple Frame Surveys shows promise of being more effective in detecting joint operating arrangements. This new version was used on a small, nonrandom group of operators in order to pretest and refine it.

The Effect of Telephone Enumerators
and
Evaluating a New Operation Description Section

Part A - The Effect of Telephone Enumerators

Background

Telephone enumeration is one of the three major data collection methods currently employed by ESCS and is the primary method of nonresponse follow-up used by this agency. There is an intuitive feeling throughout the agency that enumerators cause different response rates; however, the impact of individual enumerators on response rates and the data given by farm operators is an area which has not been tested by rigorous, statistical methods.

Numerous other studies indicate that individual enumerators do influence the answers they receive from respondents as well as the response rate. For example, Robert Hanson and Eli Marks [2] examined various enumerator characteristics that affected responses on the 1950 census. To detect whether some of the differences found in the Census study were also present among ESCS telephone enumerators was the goal of the present study.

Seven states cooperated with the Statistical Research Division on the September, 197ò Multiple Frame Hog Survey to collect the necessary test data. The states were: Illinois, Indiana, Iowa, Minnesota, Missouri, North Carolina and Wisconsin. The testing of the telephone enumerator effect was only one of several phases of this research project. A test of a new operation description is included in Part B of this report. Other phases will be covered in separate reports.

The current operational sample in the strata of interest (see Table 1 below) were systematically assigned to one of four treatment or data collection groups. If an operator does not have any hogs, one would not expect the answers of the operator to be affected by the enumerator. Thus, only those strata where operators are expected to have hogs were included in the analysis. Operators in the larger "Extreme Operator" strata were excluded because of small population sizes. Twenty percent of the sample was put in the telephone treatment group. After operators had been assigned to this group, they were screened for operators without telephone numbers. Those operators with telephone numbers were then systematically assigned to telephone enumerators while the operators without telephone numbers were sent to field enumerators for enumeration and excluded from the test of enumerator effects. All telephone interviews were conducted by ESCS telephone enumerators, who made calls from the state office in the evenings during a one to three day period.

To conduct a valid test among enumerators, each of them must interview a random or systematic sample of farm operators from the treatment group in a stratum. This restriction explains why only telephone enumerators were tested and not personal enumerators. To test for enumerator effects within the personal interview treatment, the interviews of each enumerator would have to be assigned randomly or

systematically from a stratum. Thus, travel expenses and consequently the cost of data collection would increase substantially. Telephone interviewing, however, does not incur this extra expense.

Table 1

Strata Analyzed in the Project and the Sample Sizes

State	Strata	Sample Size (All Data)	Sample Size (Positive Reports)	Number of Telephone Enumerators
Illinois	83, 84, 85, 86, 93	133	91	4
Indiana	84, 85, 86, 87, 93	122	54	3
Iowa	82, 83, 84, 85, 86	97	64	9
Minnesota	84, 85, 86, 87, 88	116	74	8
Missouri	82, 83, 84, 85, 86	157	121	7
North Carolina	82, 83, 84, 85, 93	214	143	7
Wisconsin	85, 86, 87, 93, 94	207	156	8
Total		1046	703	46

Analysis

Five variables were selected for statistical analysis purposes. These were:

1. Total hogs
2. Number of sows farrowed during the previous three months
3. Number of sows expected to farrow during the next three months
4. Number of sows expected to farrow during the next four to six months
5. Response code.

Despite the small sample size in each state (see Table 1), individual variables in some states showed a significant enumerator effect. The sample size is small enough that one or two large operations could make it appear as if one enumerator is significantly different from the others. This was considered and investigated during analysis.

Mean values for each of the variables (except response code) were calculated for "all data" and "positive data only". "All data" values are based on all completed reports. "Positive data only" values exclude those operations that reported no hogs. The justification for examining positive reports separately is that respondents who have no hogs will quickly inform the enumerator of this and the interview is terminated. Thus, the enumerator has little effect on the level of data reported.

Nonresponse rates were calculated by weighting each report by the population size in its respective stratum. This method is used to approximate the expected response rate that each enumerator would incur if a census had been conducted.

Table 2

Multivariate Test for Significance of Differences
Between Enumerators

(This test is only on four hog variables and does not include the
response rate.)

State	Multivariate Test (Wilk's Statistic)	
	All Data	Positive Data
Illinois	0.64	0.91
Indiana	0.79	**
Iowa	0.57	0.65
Minnesota	0.17	0.24
Missouri	0.60	0.03*
North Carolina	0.52	0.59
Wisconsin	0.69	0.74

7 States Combined	0.10*	0.70

*
Significant differences between enumerators are indicated by an
α value of ≤ .10.

**
The error matrix was singular.

Table 3

Significance Levels (α) of the Data When Testing the Hypothesis That the Enumerators Do Not Affect the Data They Collect

State	All Data					Positive Data			
	Total Hogs	Previous Farrowings	Expected Farrowings First Quarter	Expected Farrowings Second Quarter	Refusal Rate	Total Hogs	Previous Farrowings	Expected Farrowings First Quarter	Expected Farrowings Second Quarter
Illinois	0.28	0.81	0.75	0.95	.47	.63	.85	.88	0.57
Indiana	0.62	0.27	0.22	0.01*	.06*	.37	.33	.20	0.09*
Iowa	0.66	0.42	0.06*	0.91	.96	.62	.52	.24	0.77
Minnesota	0.57	0.93	0.54	0.69	.33	.07*	.21	.02*	0.37
Missouri	0.80	0.69	0.94	0.34	.72	.68	.88	.28	0.18
North Carolina	0.55	0.64	0.50	0.73	.63	.14	.43	.23	0.58
Wisconsin	0.54	0.61	0.67	0.82	.26	.28	.87	.43	0.90
7 States Combined	0.79	0.39	0.01*	0.99	.99	.48	.58	.13	0.75

*Significant differences between enumerators are indicated by an α value $\leq .10$.

Results

The results indicate that when hog and pig reports for all seven states are combined, significant differences exist among enumerators for "all" data. When one examines only the positive data, differences are not significant . Table 2, on the next page, gives the results of Wilk's multivariate test. (See Appendix B for technical details.) This lack of significance for positive data may be a result of the smaller sample size when "zeros" are deleted. However, the more likely explanation is that the enumerator is affecting whether the respondent does or does not report a positive number of first quarter farrowings. Given that the respondent does report a positive number of farrowings, then the enumerator does not significantly affect the value reported.

The univariate test of all data, which included the reports of "no hogs", indicates that significant differences only exist between the enumerators at the seven state level for "expected first quarter farrowings". This is attributable primarily to Iowa -- the state which was heavily weighted in the overall analysis -- but other states also showed some evidence of this relationship.

The univariate test of the positive data indicated no significant differences exist between the enumerators for individual variables on the seven state level, even for expected first quarter farrowings. (See Table 3 for the results of the univariate test.)

On the state level, differences between enumerators were significant in several instances. For example the refusal rate, one factor currently used in state offices to indicate differences between enumerators, proved to be significant in Indiana where one enumerator stands out from the other two. Using this variable as a way of rating enumerators may be a valid practice, but it must be done with caution. Statistical tests should be included in the analysis to insure that the differences are significant and not attributable to sample fluctuation.

In Minnesota two variables (total hogs and expected farrowings during the first quarter) were significant for positive data. The source of the differences can be attributed, to a large degree, to one or two reports completed by enumerator 28. One operation, recorded by enumerator 28, had 836 hogs, which was large enough to be classified as an "Extreme Operator". Enumerator 26, who recorded a much lower average number of hogs than did the other enumerators, (42 for enumerator 26 vs. 152 for all enumerators) did not complete any positive reports in the largest strata. All of the others completed one or more in these strata, and had at least one operation report more than one hundred hogs. In this case, sample fluctuation as well as misstratification caused most of the differences.

Two outlying reports caused the second quarter farrowings to show significant differences among enumerators in Indiana for both "positive" and "all" data. Enumerator 21 had one report that indicated 50 sows were to farrow in the second quarter and another that showed 30. The largest number that either of the other enumerators recorded was 10. This may indicate extreme sample values but actual differences between the enumerators is also possible.

Missouri rates special examination. In Missouri, no individual variables showed a significant difference, but when all the variables are tested together in a multivariate test, significance did exist. No individual enumerator or report stands out from the others. Some enumerators received reports that generally had a larger number of hogs than did those completed by others.

Conclusions and Recommendations

The major conclusion of this study is that evidence does indicate a difference among the telephone enumerators. This study was designed as a small, exploratory project, but these differences are important enough to warrant an expanded study in the future. These differences can be detected using regular analysis of variance techniques and the Wilk's multivariate statistic. Differences among enumerators might surface for other variables if the test were conducted using a larger sample size.

Differences among enumerators that appear to be major often were not classified as significant because of the small sample size. For example, in Iowa, differences between the enumerators on the "total hogs" variable appear substantial, but are not significant. A larger sample size would make the tests more sensitive to the differences.

At the same time, significant differences among enumerators in a particular state could sometimes be attributed to one enumerator completing a report for an extremely large operation, one much larger than any of the others contacted in that state in the strata included in the test. A larger sample size would increase the number of reports completed for large operations, thereby, reducing the impact of individual reports.

An expanded project in a state could readily be accomplished if the entire quarterly hog survey sample were systematically divided among the telephone enumerators. Certain strata should be excluded from the test for the same reasons that they were excluded from this project. Operations which were not contacted by telephone after several attempts would be sent to field enumerators. Each state could conduct a more accurate test of enumerators in the context of an operational survey.

Part B - Evaluation of the New Operation Description

An additional aspect of the research project on the September, 1978 Quarterly Hog Survey in seven states was a test of a new farm operation description. The farm operation description is an important part of all ESCS Multiple Frame Surveys since the information obtained in this section of the questionnaire affects the survey indications used to set the state and national estimates.

The most immediate objectives of testing the new operation description were to: a) design a form that farmers would more easily understand, b) provide check questions to insure the report was consistent with survey concepts, and c) ask questions that farmers would complete more accurately. Fullfillment of these objectives would provide statisticians with better information to improve the editing of questionnaires.

Under the editing rules currently used, hogs should not be duplicated among report-ing units. If the possibility exists that a group of hogs could be reported by two or more people, data reported on the questionnaire is changed to reflect this multiple chance of being reported. Partnerships involving hogs are the primary reason that reported data is changed. Data entered would be more "correct" if true partnerships would be consistently reported and questionable partnerships identified and verified. It is also desirable to detect hogs that are often "incorrectly" reported due to their location (i.e., on or off the acres operated by the selected reporting unit.)

The study of the operation description section is to be viewed primarily as a pretest, designed to detect and correct any major problems inherent with the new operation description before a formal test against the current operation description is conducted. The formal test would involve splitting the sample into a control and an experimental group and applying comparable data collection procedures to both groups, so that one group would receive the current operation description and the other the new one.

This study was not designed to test a hypothesis of differences caused by the current operation description vs. the proposed operation description. Data was gathered from those operators who were in a 20 percent subsample of the current operational sample and who did not respond to a hog questionnaire they received in the mail. In a followup visit, an enumerator asked the respondent to complete the original questionnaire without enumerator assistance. After this, the enumerator interviewed the respondent with the new operation description. Conclusions, then, should be drawn only about the effectiveness of this form in interview situations as a check on the current operation description section.

Results indicate that the form tested on this project (Illustration 1) did detect errors that occurred with the current form (Illustration 2). However, additional changes are suggested before split sample testing (see Illustration 3).

Most operations included in the test were not involved in any type of problem operation. However, the new form did detect individual operators who did not report hogs on their land, even though they had been instructed to include all

hogs and pigs on their operations regardless of ownership. Hogs owned by the operator's children for FFA or 4-H projects were often not counted. For the subsample administered the new operation description, there were seven incidents of hogs that were not originally reported, or a total of 113 head.

If respondents take time to read the survey instructions, they usually report hogs they do not own but are on their land (which is the proper procedure). However, respondents often do not bother to read the instructions. For example, in Missouri only two of the six respondents who had hogs owned by others on their farm correctly reported them. Pigs that the other four should have reported were only detected by the new operation description. In one instance, a father, the operator, originally said that his son had hogs on his operation, but he felt that the son should report these hogs and refused to disclose any information about the son's hogs. Comments about this general situation are fairly frequent.

A primary aim of the new operation description is to detect hogs which a respondent reports inspite of the fact these hogs are not on land owned by the respondent. The new approach only detected three respondents who made this error, but these three incorrectly reported 223 hogs.

Questions 4 and 5 of the new operation description queried the respondent about his connections with corporate farming ventures and whether or not he was a hired manager for an operation. These questions did not find anyone in the subsample who was involved in either type of arrangement. Though few in number, these operations tend to be large and there is a special provision for handling them in the editing manual. However, the current operation description section has no provision for detecting these types of operations and thus these questions were included in the alternative form.

Partnerships have always been a problem in editing. The rules on how to handle partnership situations are clear but detecting "true" partnerships is the problem. Often the farmer will call landlord/tenant and sharecropping arrangements a partnership, although such arrangements are not partnerships according to the ESCS definitions. Father-son operations are also difficult to classify. The dividing line between a true parthership and an operation in which the father is the operator and the son a "hired hand" is rather nebulous. The problem arrangements would most likely be reported correctly if the respondent carefully read and followed the instructions, but many complete the questionnaire without reading them. This source of bias is most prevelent on questionnaires returned by mail. Collecting partner-ship data during telephone and personal interviews is a more controllable task since enumerators can be instructed to always ask these questions. Check questions would help reveal how they reported partnership data.

The new operation description appeared to be more effective in correctly classifying joint operations than the form currently in use. Six "true" partnerships that were not reported on the original form were detected by the new operation description, whereas four partnerships that were originally reported were not true partnerships according to additional information received on the new form. One true partnership was correctly reported on the current form, but not mentioned on the new.

Asking the respondent only for the name of the partnership operation rather than his partners' names, is the major difference between the new form and the old one. Strictly speaking, only the operation name and number of partners are needed for editing purposes on list questionnaires under the partial nonoverlap procedure. But often, if the statistician has the alleged partner's name and address, he can detect landlord/tenant arrangements or father-son operations that were mistakenly reported. The Indiana and Iowa SSO's also felt that having the names and addresses of partners aided list building and maintenance. The Missouri SSO felt, however, it was much easier to gather accurate partnership data when the respondent does not have to reveal names and addresses of partner: They felt this makes it easier for the respondent to believe that our reports have no link with IRS and taxes.

On the new operation description, one person reported his operation as a partnership, as well as a corporation with which he had connections, plus being a hired manager for the same operation. This type of reporting mistake may occur, but can easily be screened out by the statistician as he edits the questionnaires. Questionable situations will require a phone call to the respondents for further clarification just as is currently the case.

Conclusions

The study suggested further adaptations of the operations description which should be tested.

Any form is of value only if the respondent fills it out properly. Many farmers are willing to give out information about their hogs, but do not see why the information about their operation is very important. Consequently, this section is often overlooked. To get a maximum number of farmers to complete this section, it is imperative that it appear to be very short, simple and fast to complete.

Enumerators delivering questionnaires to farmers, but not conducting an interview found several farmers who could not read and many others who did not bother to read the instructions. The latter can result in a misinterpretation of the questions.

After examining all of the comments and test forms from all of the states involved in the experiment, a new form is suggested for future testing. (See Illustration 3).

Suggestions from one state often contradicted those from another. Some states said that the new operation description looked more complicated, some said less All comments were considered and are reflected in the suggested form.

The study was informative and fulfilled its purpose. Further testing needs to be done until a better operation description unveils itself.

ILLUSTRATION 1

EXPERIMENTAL OPERATION DESCRIPTION

The following questions are important to avoid duplicate counting of hogs and pigs.

1. Does anyone else have any hogs or pigs on land you (addressee) operate?

   ☐ NO - Go to question 2

   ☐ YES - Number head............ [　　　　]

   1a. Are these INCLUDED IN the hogs reported? ☐ NO ☐ YES

2. Are any of your hogs or pigs on <u>land</u> operated by someone else?

   ☐ NO - Go to question 3

   ☐ YES - Number head............ [　　　　]

   2a. Are these EXCLUDED FROM the hogs reported? ☐ NO ☐ YES

3. Are you in a partnership on any <u>land</u> where hogs and pigs are located?
   (<u>Exclude</u> landlord - renter arrangements or partnerships <u>only</u> on the livestock)

   ☐ NO - Go to question 4

   ☐ YES - Number head on partnership land........... [　　　　]

   a. Are these included in the hogs reported? ☐ NO ☐ YES

   b. Name of partnership operation_____

   c. Total number of full partners in land (including yourself).... [　　　　]

4. Are you employed as the manager of any land where hogs and pigs are located?

   ☐ NO - Go to question 5

   ☐ YES - Number head............ [　　　　]

5. Are you associated with a corporate farming operation having hogs or pigs?

   ☐ NO - Turn to page 4

   ☐ YES - Number head............ [　　　　]

   Name of Corporation_____

Comments:

OPERATION DESCRIPTION OF LAND

Additional information is needed on your operation to assist in detecting possible duplication in reporting. (Please make any necessary corrections when operation description information has been entered below.)

18. Do you (the individual or operation listed on the face page) operate AGRICULTURAL LAND in a partnership or joint operating arrangement? *(Exclude landlord-tenant, cash rent or share crop arrangements.) (Check One)* ☐ YES - *Continue* ☐ NO - *turn to page 4.*

19. Who are the persons in this partnership or joint land arrangement with you?

Name _____ Telephone Number _____
       (Last)   *(First)*   *(Middle)*

Address _____
      (Route or Street)   *(City)*   *(State)*   *(Zip)*

Partnership or Operation Name _____

Name _____ Telephone Number _____
       (Last)   *(First)*   *(Middle)*

Address _____
      (Route or Street)   *(City)*   *(State)*   *(Zip)*

Partnership or Operation Name _____

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20. How many acres of land are in this partnership or joint operating arrangement? .... **Acres** [_____]

   a. How many of these acres were included in Item 1, page 1? .... **Acres** [_____]

21. How many hogs and pigs are now on the Item 20 acres? .... **Number** [_____]

   a. How many of these hogs and pigs were included in Item 5, page 2? .... **Number** [_____]

SUGGESTED FORM FOR FUTURE TESTING:

TO AVOID DUPLICATE COUNTING OF HOGS AND PIGS, PLEASE ANSWER THE FOLLOWING QUESTIONS.

1. Does anyone else have hogs or pigs on the land you operate?

   ☐ No - Go to Question 2

   ☐ Yes - Number of Head .... ☐

   1a. Are these hogs INCLUDED IN the hogs reported on page 2? ☐ No ☐ Yes

2. Are any of your hogs or pigs on <u>land</u> operated by someone else?

   ☐ No - Go to Question 3

   ☐ Yes - Number of Head .... ☐

   2a. Are these hogs INCLUDED IN the hogs reported on page 2? ☐ No ☐ Yes

3. Are you involved in a partnership or other joint operating arrangement of agricultural land?

   ☐ No - Go to next page

   ☐ Yes - Name of operation _____

4. Which of the following best describes this joint arrangement? (Check one)

   _____ a. Landlord/tenant on a cash rent or crop share basis

   _____ b. Partners jointly operate land and share in decision

   _____ c. Partnership in livestock but not in land

   _____ d. Hired manager of land owned by someone else

   _____ e. Other (specify)

5. Are there hogs or pigs on the land in this joint arrangement?

   ☐ No - Go to page 4   ☐ Yes - Continue

   a. Number of participating partners in land operated .... ☐

   b. Number of acres in this joint arrangement .... _____

   c. Number of hogs and pigs on land in this joint arrangement ...... _____

   d. Are these hogs and pigs included in your report on page 2? _____ No _____ Yes

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APPENDIX A

Tables showing mean reported values of total hogs, previous farrowings, and second quarter expected farrowings as well as refusal rates for telephone enumerators, by state.

Table 4

Mean Reported Values and Refusal Rates by Enumerator

ILLINOIS

Telephone Enumerator	All Data					Positive Data				Number of Operations Contacted
	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	Refusal Rate	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	
21	152.6	7.6	16.4	9.2	0.04	414.6	23.4	36.8	25.2	31
22	208.4	10.6	14.5	9.1	0.08	448.4	25.3	30.0	21.2	36
23	178.0	8.6	13.5	9.1	0.03	491.6	25.1	35.7	28.9	32
24	131.4	7.8	9.3	9.2	0.07	500.5	29.0	34.8	34.2	33
All Enumerators	167.6	8.7	13.4	9.1	0.06	463.8	25.7	34.3	27.4	132

Table 5

Mean Reported Values and Refusal Rates by Enumerator

INDIANA

Telephone Enumerator	All Data					Positive Data				
	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	Refusal Rate	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	Number of Operations Contacted
21	102.4	6.6	6.7	6.1	0.03	203.8	12.4	12.7	12.7	35
22	81.7	4.2	3.7	3.0	0.00	238.0	12.9	11.4	9.5	36
23	59.1	2.7	3.6	2.1	0.16	152.0	6.3	7.9	6.4	42
All Enumerators	81.1	4.5	4.7	3.7	0.06	198.0	10.6	10.7	9.6	113

Table 6

Mean Reported Values and Refusal Rates by Enumerator

IOWA

Telephone Enumerator	All Data					Positive Data				Number of Operations Contacted
	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	Refusal Rate	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	
21	175.3	11.1	11.6	8.2	0.19	196.3	12.9	12.5	10.2	11
22	146.4	13.1	8.3	4.2	0.02	161.9	12.5	8.0	5.5	9
23	310.9	17.1	31.3	7.7	0.22	360.2	20.6	30.3	7.9	12
24	189.2	8.3	5.4	5.0	0.10	212.5	7.3	5.7	2.7	10
25	204.6	10.1	13.9	6.7	0.22	169.0	10.7	12.6	6.0	13
26	168.2	4.3	14.6	9.3	0.24	189.0	5.7	15.0	11.9	11
27	136.4	4.8	11.1	0.9	0.46	185.3	7.0	15.1	1.9	10
28	118.8	6.9	5.1	6.5	0.50	160.1	6.6	6.9	7.5	11
29	63.7	2.7	3.5	0.9	0.23	94.0	3.6	6.5	2.4	10
All Enumerators	168.2	8.7	11.6	5.5	0.24	192.0	9.6	12.5	6.2	97

Table 7

Mean Reported Values and Refusal Rates by Enumerator

MINNESOTA

Telephone Enumerator	All Data					Positive Data				
	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	Refusal Rate	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	Number of Operations Contacted
21	103.5	6.3	9.4	3.0	0.11	196.6	12.8	17.8	7.3	16
22	99.3	9.4	10.8	8.9	0.04	178.7	15.8	17.9	15.8	14
23	86.0	6.9	4.1	4.0	0.00	136.9	11.2	6.5	6.9	15
24	85.2	7.0	6.9	5.8	0.11	116.4	8.8	8.4	7.7	15
25	61.7	4.3	1.5	2.4	0.32	117.3	7.5	3.1	6.1	13
26	29.8	2.8	3.2	0.9	0.09	42.0	3.7	4.2	1.4	12
27	98.6	4.5	3.5	5.7	0.07	136.1	4.7	3.5	5.7	15
28	191.8	9.3	9.0	10.7	0.09	291.9	16.0	15.8	19.2	16
All Enumerators	94.5	6.3	6.0	5.2	0.10	152.0	10.1	9.6	8.8	116

Table 8

Mean Reported Values and Refusal Rates by Enumerator

MISSOURI

Telephone Enumerator	All Data					Positive Data				Number of Operations Contacted
	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	Refusal Rate	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	
21	69.3	3.8	7.0	3.3	0.06	140.0	7.4	14.3	6.1	22
22	78.6	5.4	7.1	1.8	0.14	162.8	10.9	15.2	3.7	27
23	125.9	7.3	6.2	5.0	0.05	215.0	12.8	9.2	8.6	22
24	73.4	4.4	6.6	6.5	0.02	167.1	9.9	14.3	13.9	21
25	116.6	3.7	7.1	2.8	0.00	220.7	9.4	17.2	6.2	23
26	74.3	3.8	9.0	5.7	0.31	166.9	8.1	17.6	11.1	17
27	92.0	6.5	7.3	4.9	0.13	119.7	7.6	10.9	5.6	24
All Enumerators	90.0	5.0	7.2	4.3	0.10	170.3	9.4	14.1	7.9	156

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Table 9

Mean Reported Values and Refusal Rates by Enumerator

NORTH CAROLINA

Telephone Enumerator	All Data					Positive Data				Number of Operations Contacted
	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	Refusal Rate	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	
21	27.6	2.2	2.1	1.6	0.08	186.7	21.1	20.4	18.5	28
22	47.7	2.4	3.4	2.6	0.00	333.9	17.0	24.5	15.5	28
23	39.4	2.3	3.7	2.8	0.00	379.0	21.9	30.8	27.9	29
24	24.5	2.3	2.0	1.7	0.00	259.6	23.8	21.8	17.6	30
25	60.1	3.6	2.7	3.4	0.01	483.9	13.6	14.3	14.1	28
26	56.1	2.9	3.6	3.0	0.01	454.1	24.1	30.3	24.6	25
27	84.3	4.3	5.5	4.6	0.11	207.5	12.9	14.8	11.4	27
All Enumerators	48.5	2.9	3.3	2.8	0.03	329.2	19.1	22.2	18.5	195

Table 10

Mean Reported Values and Refusal Rates by Enumerator

WISCONSIN

Telephone Enumerator	All Data					Positive Data				Number of Operations Contacted
	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	Refusal Rate	Total Hogs (Mean)	Previous Farrowings (Mean)	Expected Farrowings First Quarter (Mean)	Expected Farrowings Second Quarter (Mean)	
21	90.3	6.3	6.7	4.6	0.01	278.9	18.5	23.1	17.4	27
22	33.9	2.8	3.1	3.6	0.16	173.6	15.2	16.1	16.7	25
23	40.6	3.9	4.9	2.6	0.00	172.3	12.3	17.6	11.5	23
24	95.3	5.9	4.3	3.8	0.01	429.2	20.3	14.1	15.6	27
25	73.1	4.9	6.0	4.9	0.00	281.3	23.8	23.8	17.4	27
26	89.5	4.7	7.8	5.1	0.00	356.0	15.4	24.2	20.5	25
27	60.9	3.9	3.8	3.5	0.00	205.8	15.2	15.9	15.6	26
28	81.0	5.0	5.7	5.1	0.07	395.2	25.1	26.4	24.0	23
All Enumerators	70.6	4.7	5.3	4.2	0.03	286.6	17.6	20.3	17.4	203

Appendix B

Data Analysis Techniques

1. **Weighting the data:**

   Weights were assigned to each variable to reflect the relative expansion factors. Weights indicate relative importance of each stratum in each state across all seven states.

2. **Replication:**

   The data was ordered by state, enumerator, stratum, crop reporting district, county and reporter. This ordering was systematically divided into two replicates for analysis purposes. Mean values for each enumerator were calculated within each replicate, and combined in the following manner.

   $\bar{x}_{sr}$ = sample estimate of the weighted mean in the rth replicate,

   $r = 1, 2$ in the sth state, state $= 1, 2, \ldots 7$

   $\bar{x}_s$ = sample estimate of the weighted mean in state s

   $$\bar{x}_s = \frac{\sum\limits_{r=1}^{2} \bar{x}_{sr}}{2}$$

   $\bar{x}_r$ = sample estimate of the weighted mean of the rth replicate over all states

   $$\bar{x}_r = \frac{\sum\limits_{s=1}^{7} \bar{x}_{sr}}{7}$$

   $\bar{x}$ = sample estimate of the weighted mean over all states and strata

   $$\bar{x} = \frac{\sum\limits_{s=1}^{7} \bar{x}_s}{7} = \frac{\sum\limits_{r=1}^{2} \bar{x}_r}{2}$$

   The unbiased estimate of the standard error for each state estimate is:

   $$SE(\bar{x}_s) = \left[\frac{\sum\limits_{r=1}^{2} (\bar{x}_{sr} - \bar{x}_s)^2}{2} \right]^{\frac{1}{2}}$$

Besides simplifying the calculation of standard errors, the use of replicate values in the statistical analysis:

1: assured equal cell sizes in the analysis of variances
2: yielded distributions which are fairly normal.

These benefits of replication make the analytical exploration of data from a complex survey design much more straightforward and accurate.

Univariate and multivariate tests were conducted using the SAS computer package. The processes involved in this analysis are outlined below, although more details are available in the SAS 76 User's Guide.[1]

A general linear model was constructed to fit the values from the replications $\hat{Y} = X B + E$, where E is the residual error matrix, $\hat{Y}$ is the vector of estimated means for four (quantitative) hog variables X is the data matrix and B is the fector of model parameters. The model parameters consist of two effects: the state and the estimators within a given state. The enumerator effect refers to the influence of enumerators on the data they collect, discussed in the background section of this paper.

The MANOVA procedure in SAS was used to test the hypothesis that there is no difference among enumerators. Both univariate and multivariate tests were executed on the four hog variables, and a univariate test was executed on the response rate.

Wilk's Λ criterion, which was used for the multivariate tests, is essentially a multivariate extension of the F test used in univariate analysis of variance. Full details on Wilk's Λ criterion are in Timm's book.[2]

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[1] A User's Guide to SAS 76, by Anthony J. Barr, James H. Goodnight, John P. Sall, and Jane T. Helwig, SAS Institute, Raleigh, North Carolina (1976)

[2] Multivariate Analysis with Applications in Educational Psychology, by Neil H. Timm, Brooks/Cole Publishing Co., Monterey, California, 1975.