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# Survey of Farm Slaughter of Hogs in North Carolina

By Jack Fleischer and Alva L. Finkner

*The study reported in the following paper was based on a survey conducted by the Institute of Statistics, North Carolina State College. The survey was designed to assist the Livestock and Poultry Statistics Branch of the Agricultural Estimates Division to isolate factors that may account for total disposition in their national balance sheet for hogs.*

**D**URING WORLD WAR II and thereafter, the Livestock and Poultry Statistics Branch of the Agricultural Estimates Division had difficulty in keeping the national balance sheet for hogs "in balance." As imports and exports of hogs are negligible, the beginning inventory plus farrowing, minus slaughter and other deaths, should equal the closing inventory. It was believed that estimates of hogs on hand, pigs farrowed, and part of the total slaughter—both federally and nonfederally inspected—were reliable, but that other items of disposition, mainly farm slaughter, were consistently underestimated. This belief was apparently sustained by the results of the study.

Two personal interview surveys were conducted during January and April 1953, with the universe defined as 16 counties in northeastern North Carolina. Each county was assigned to 1 of 3 geographic strata as follows:

<i>Stratum I</i>	<i>Stratum II</i>	<i>Stratum III</i>
Greene	Edgecombe	Bertie
Johnston	Martin	Chowan
Lenoir	Nash	Gates
Wayne	Pitt	Halifax
	Wilson	Hertford
		Northampton
		Perquimans

The surveys were planned in three stages covering 25 master sample segments located in 6 of the 16 counties: (1) An interview survey with approximately 200 respondents to cover the period from October 1 to December 31, 1952; (2) a follow-up mail survey of the same respondents immediately after the interview survey was completed; and (3) another interview survey with the same respondents in April to cover the period from January 1 to March 31, 1953.

The 3-point purpose of the survey was to:

Account for all hogs of a given respondent during a 3-month period by recording the inventories for the opening and closing periods and all possible sources of acquisition and disposition.

Compare results of identical questions asked of identical respondents by a mailed inquiry following a personal interview.

Evaluate a new sampling technique that involved selection from a given stratum of two primary sampling units with probability proportional to their combined sizes.

## Balance Sheet of Hogs

When the respondent answered questions concerning his balance sheet for hogs, the first answers he gave were recorded. If the balance sheet did not check he was asked later in the interview to give revised figures that would make it check. A study was made of these changes to see what effect they had on the various components of the balance sheet (table 1).

Evaluating the differences by "t" tests indicated no significance for supply and ending inventory, but the differences in disposition were significant at the 5-percent level. This significant underestimation in disposition amounts to 1.06 percent of the ending inventory. As the percentage of underestimation has been 2 to 6 percent during the last 8 years, the use of first answers for estimating may account for part of the overall underestimation. Revised answers resulted in an increase in ending inventory which amounts to 2.40 percent of ending inventory. Although this component is not significant, the total increase of 3.46 percent is close to the average underestimation for total hogs and pigs in the United States during the last 8 years.

The April survey failed to substantiate the

TABLE 1.—*Frequency distribution of changes in supply, disposition and ending inventory of individual balance sheets in the period October 1 to December 31, 1952*

Difference (Balanced-first) answers	Supply <sup>1</sup>		Disposition		Ending inventory	
	Frequency <sup>2</sup>	Sum of difference	Frequency <sup>2</sup>	Sum of difference	Frequency <sup>2</sup>	Sum of difference
-21	1	-21			0	0
-15	0	0			1	-15
-11	1	-11			0	0
-8	1	-8			0	0
-6	0	0			1	-6
-3	1	-3			2	-6
-2	1	-2			0	0
-1	3	-3			2	-2
0	137	0	158	0	149	0
1	5	5	3	3	3	3
2	4	8	0	0	1	2
3	5	15	1	3	1	3
4	2	8	0	0	2	8
5	3	15	1	5	0	0
6	1	6	0	0	0	0
8			2	16	0	0
9					1	9
30					1	30
35					1	35
Sum	165	9	165	27	165	61
Mean		0.0545		0.1636		0.3697

<sup>1</sup> Supply included beginning inventory October 1, 1952, plus acquisitions.

<sup>2</sup> Does not include reports that had no hogs during the 3-month period.

Agricultural Marketing Service and North Carolina State College Farm Slaughter Survey, January 1953.

underestimation in disposition and ending inventory. A possible explanation of the failure is that the respondents, having been interviewed in January, were on their guard in April and anticipated the questions; thus during the April survey they gave more correct answers the first time the questions were asked. There were 51 changes in supply, disposition, and ending inventory in January, and only 25 total changes for the same components in April.

Another survey, in which different farmers were interviewed, should have been conducted concurrently with the April survey in which the same respondents were revisited. This would have given us another measure of the differences between first and corrected answers, without the bias of the respondents who had been "educated" to the questions being asked.

Confidence limits on the estimated percentage of farmers who would have made changes in the January survey were 11 percent and 25 percent for supply, 1 percent and 9 percent for disposition,

and 6 percent and 17 percent for ending inventory. These values were obtained from the binomial chart of Clopper and Pearson (1934).<sup>1</sup> The percentage of changes for the April survey were at the lower limits of these confidence intervals but, as previously explained, the circumstances of the respondents answering were not the same in both surveys.

#### Comparison of Personal Interview With Mail Survey

The inquiry on "Disposition of Livestock During 1952" was mailed only to the farmers whose names and addresses were obtained on the personal interview schedules. This inquiry contained three questions, among others, that were identical with questions asked on the interview schedule. Out

<sup>1</sup> CLOPPER, C. J., and PEARSON, E. S. THE USE OF CONFIDENCE OR FIDUCIAL LIMITS ILLUSTRATED IN THE CASE OF BINOMIAL. *Biometrika*. 26: 404. 1934.

of the 172 mail inquiries (which correspond to the 172 farmers interviewed in the January survey) 18 responded within 2 weeks. Although this was more than 10 percent response, it was not enough for purposes of comparison. Therefore, a second request was mailed. The second request brought a response of 46 for a total of 64 schedules.

For the purpose of comparing the results of these two methods of obtaining data, we believed that 64 farmers would give enough information, and we did not want to irritate any of the mail nonrespondents with further requests as they were to be visited again in April (table 2).

Actually, three questions were compared, but two of them were on 1952 slaughter, one referring to hogs of more than 150 pounds butchered, the other to pigs of less than 150 pounds butchered. It was difficult to disassociate these two questions and in some instances differences in one question were offset by differences in the other. For a hog that weighed approximately 150 pounds, it would be hard for the farmer to say definitely that it belonged in one or the other category, so these answers were combined. Offsetting answers were recorded as no differences.

Making paired comparisons and evaluating by means of "t" tests indicated no significant differences in answers between the two methods of obtaining the data. The mean differences in table 3 and the 95-percent confidence limits are given.

January 1 Inventory..... 0.2419±1.3773  
1952 Slaughter..... 0.4603±.7101

TABLE 2.—Number of hogs and pigs on farms and slaughtered, as given by personal interviews and mail inquiries to 64 farmers, 1952

Item	Answer given by—		Difference <sup>1</sup>	
	Personal interview	Mail inquiry	Quantity	Percentage
Hogs and pigs:				
Slaughtered in 1952....	275	246	29	11.79
On hand Jan. 1, 1953....	629	614	15	2.44

<sup>1</sup> The numbers given by the mailed inquiry were used to compute these percentages because the Agricultural Estimates Division obtains estimates from its mail survey.

Agricultural Marketing Service and North Carolina State College Farm Slaughter Survey, January 1953.

TABLE 3.—Frequency distribution of differences in number of hogs and pigs between personal interview and mail inquiries for 62 and 63 farms respectively

Difference enumeration—mail	Number of hogs and pigs			
	Slaughtered in 1952		On hand January 1, 1953	
	Frequency	Sum of difference	Frequency	Sum of difference
-16.....			1	-16
-13.....			1	-13
-11.....			1	-11
-10.....			1	-10
-8.....			1	-8
-7.....			1	-7
-6.....			1	-6
-5.....			2	-10
-4.....	2	-8	1	-4
-3.....	3	-9	2	-6
-2.....	2	-4	1	-2
-1.....	8	-8	2	-2
0.....	31	0	28	0
1.....	6	6	3	3
2.....	2	4	3	6
3.....	4	12	1	3
4.....	2	8	1	4
5.....	1	5	2	10
6.....	1	6	2	12
7.....	0	0	1	7
8.....	0	0	2	16
10.....	0	0	2	20
12.....	0	0	1	12
17.....	1	17	1	17
Total.....	63	29	62	15
Mean differences.....		0.4603		0.2419

Agricultural Marketing Service and North Carolina State College Farm Slaughter Survey, January 1953.

Confidence limits are also placed on *p* (the true proportion of farmers answering differently by mail and personal visitation). Normal theory approximation is used in this instance as recommended by Cochran (p. 41).<sup>2</sup> The formula is

$$p \pm \left( t \sqrt{\frac{N-n}{N-1} \frac{pq}{n} + \frac{1}{2n}} \right)$$

where *t* is a value taken for a specified confidence level,

*N* is the number in the population,  
*n* is the number in the sample,  
and *q*=1-*p*.

<sup>2</sup> COCHRAN, W. G. SAMPLING TECHNIQUES. John Wiley and Sons, Inc., New York, 1953. Although not strictly applicable, sampling from a binomial type of population is assumed.

The finite correction factor  $\left(\frac{N-n}{N-1}\right)$  is ignored in this case because the sample is less than 0.4 percent of the population. The 95-percent interval for the January 1 inventory is between 41.4 percent and 68.2 percent, and for 1952 slaughter, between 37.4 percent and 64.2 percent.

### Evaluation of the Sampling Technique

The theory for the selection of two primary sampling units from a stratum with probability proportional to their combined sizes is given by Sen.<sup>3</sup> To evaluate this sampling technique, estimates of various characteristics were made from an unbiased estimation equation.

$$Y' = \frac{Y'_i + Y'_k}{X_i + X_k} X$$

where

$Y'$  is the estimated total of a characteristic for the stratum

$Y'_i$  is the estimated total of the same characteristic in the  $i$ -th county

$X_i$  is the 1950 U. S. Census total for total number of hogs in the  $i$ -th county

$X$  is the stratum total number of hogs as given by the 1950 U. S. Census.

The variance of this estimate is given as

$$V(Y') = \sum_{i \neq j} \sum_j \frac{X}{2(N-1)} \frac{(Y_i + Y_j)^2}{X_i + X_j} - Y^2 + \frac{1}{2} \sum_{i \neq j} \sum_j \frac{Z_i + Z_j}{(N-1)(X_i + X_j)} X$$

where  $Z_i = M_i (M_i - m_i) \sigma_i^2 / m_i$ ,  $N$  is the number of psu (primary sampling units) in a stratum,  $Y_i$  is actual total of a characteristic in the  $i$ -th county, and  $M_i$  and  $m_i$  are the numbers of mss (master sample segments) in the  $i$ -th county, population and sample, respectively.

The results of computing estimates of various characteristics are presented in table 4, along with figures of the 1950 United States Census of Agriculture.

Variance formulas have been proposed for estimating the variance of a particular estimate  $Y'$ . The formula that Sen proposes resulted in negative estimates of variance in 2 of the 3 strata for

<sup>3</sup> SEN, A. R. FURTHER DEVELOPMENTS OF THE THEORY AND APPLICATION OF THE SELECTION OF PRIMARY SAMPLING UNITS, WITH SPECIAL REFERENCE TO THE NORTH CAROLINA AGRICULTURAL POPULATION. Unpublished Ph. D. Thesis. North Carolina State College, 1952.

number of farms, and therefore is not practical in this case. Research is being conducted at the North Carolina Institute of Statistics in this particular field. When practical estimates of variance are derived they will be applied to these data.

### Cost of Surveys

In the remaining space of this paper details of the cost of the two personal interview surveys are given and analyzed. The same areas were visited in each of the surveys, which were conducted by means of cluster sampling.

The schedule for the January survey consisted of 12 pages and contained 127 questions. For all farmers and for those nonfarmers who had hogs, 105 questions were applicable; for the nonfarmers who had no hogs, only 31 questions were applicable. These 31 questions are considered to represent a short form of the regular schedule. Several of the questions were asked all respondents, for screening purposes, regardless of whether they were farmers or had hogs. Schedules for January and April were similar except for the different periods covered by the questions.

Respondents were located in 25 master sample segments (mss) which were selected at random from 6 counties, which in turn had been selected from a universe of 16 counties. There were 207

TABLE 4.—Estimates of various farm characteristics, 1950 and 1952

Item	1950 <sup>1</sup> census of agricul- ture	Esti- mated January 1, 1953	Difference be- tween estimates and census	
			Quan- tity	Per- cent- age
Farms.....	Number 59, 048	Number 46, 175	Number -12, 873	Per- cent 21. 80
Acreage:	Acres	Acres	Acres	
Farms.....	3, 775, 763	3, 849, 723	73, 960	1. 96
Cropland.....	1, 699, 956	1, 751, 632	51, 676	3. 04
Hogs and pigs:	Number	Number	Number	
On farms.....	488, 351	516, 570	28, 219	5. 78
Slaughtered pre- ceding year...	198, 235	212, 231	13, 996	7. 06

<sup>1</sup> U. S. Bureau of the Census, 1950 U. S. Census of Agriculture, Vol. 1, part 16. United States Government Printing Office, Washington, D. C., 1952.

Agricultural Marketing Service and North Carolina State College Farm Slaughter Survey, January 1953.

TABLE 5.—Cost of farm slaughter surveys by specified items and by enumerators, conducted in 6 north-eastern counties in North Carolina, January and April 1953

JANUARY AND APRIL SURVEYS

Item	Sched- ules	Entire survey		Training school		Salary		Travel		Per diem	
		Total	Per sched- ule	Total	Per sched- ule	Total	Per sched- ule	Total	Per sched- ule	Total	Per sched- ule
Enumerator:	<i>Num- ber</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
1.....	213	478. 45	2. 25	28. 00	0. 13	242. 25	1. 14	192. 90	0. 91	15. 30	0. 07
2.....	26	116. 01	4. 46	40. 58	1. 56	46. 00	1. 77	26. 88	1. 03	2. 55	. 10
3.....	176	399. 52	2. 27	30. 01	. 17	182. 75	1. 04	169. 54	. 96	17. 22	. 10
Supervision.....		3. 43	. 01	3. 43	. 01						
Total.....	415	997. 41	2. 40	102. 02	. 25	471. 00	1. 13	389. 32	. 94	35. 07	. 08
JANUARY SURVEY											
Enumerator:											
1.....	92	233. 27	2. 54	12. 09	. 13	117. 50	1. 28	96. 72	1. 05	6. 96	. 08
2.....	26	116. 01	4. 46	40. 58	1. 56	46. 00	1. 77	26. 88	1. 03	2. 55	. 10
3.....	89	231. 86	2. 61	15. 18	. 17	107. 25	1. 21	98. 56	1. 11	10. 87	. 11
Supervision.....		1. 89	. 01	1. 89	. 01						
Total.....	207	583. 03	2. 82	69. 74	. 34	270. 75	1. 31	222. 16	1. 07	20. 38	. 10
APRIL SURVEY											
Enumerator:											
1.....	121	245. 18	2. 03	15. 91	. 13	124. 75	1. 03	96. 18	. 79	8. 34	. 07
2.....											
3.....	87	167. 66	1. 93	14. 83	. 17	75. 50	. 87	70. 98	. 82	6. 35	. 07
Supervision.....		1. 54	. 01	1. 54	. 01						
Total.....	208	414. 38	1. 99	32. 28	. 16	200. 25	. 96	167. 16	. 80	14. 69	. 07

Agricultural Marketing Service and North Carolina State College Farm Slaughter Surveys, January and April 1953.

and 208 respondents, respectively, in the January and April surveys, for an average of 8.3 respondents per mss.

Cluster sampling of this kind offers a large saving in time and money over list sampling, because, once the mss is located, the enumerator can obtain several interviews with little further expenditure of time and travel in finding each respondent on a list.

The average cost per schedule was \$2.84 for the January survey, and for the revisits to the same respondents in April the average cost per schedule was \$1.99. The training school cost \$102.02. As only one training session was necessary for both surveys, the cost was distributed to both in proportion to the number of schedules obtained in each. Table 5 gives a breakdown of the costs of interviewing into training school, salary, travel, and

per diem. Rate of pay for the training school was as follows:

- (1) Salary of \$1 an hour for the time spent in class;
- (2) Bus fare from the home of the interviewer to the campus of North Carolina State College, Raleigh, and return, or 3½ cents a mile if any other mode of transportation was used;
- (3) Actual per diem expenses, such as hotel and meals.

For the actual enumeration work, the rate of pay was as follows:

- (1) Salary of \$1 an hour from the time the interviewer left his home until he returned from interviewing, excluding any time spent at night in a hotel;
- (2) Actual mileage at 7 cents a mile, which included travel from the home of the interviewer to the segment, and return;
- (3) Actual per diem expenses, such as meals and telephone calls.

TABLE 6.—Cost of interviews, excluding training school, for farm slaughter surveys by enumerators, conducted in 6 northeastern counties in North Carolina, January and April, 1953

JANUARY AND APRIL SURVEYS

Item	Sched- ules	Entire survey		Interview		Between inter- views <sup>1</sup>		Travel outside <sup>2</sup> segs and per diem	
		Total	Per school	Total	Per school	Total	Per school	Total	Per school
Enumerator:	Number	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
1.....	213	449.95	2.11	76.89	0.36	38.62	0.18	334.44	1.57
2.....	26	75.93	2.92	17.58	.68	9.71	.37	48.14	1.85
3.....	176	369.51	2.10	102.64	.58	37.38	.21	229.49	1.30
Total.....	415	895.39	2.16	197.11	.47	85.71	.21	612.07	1.48
JANUARY SURVEY									
Enumerator:									
1.....	92	220.68	2.40	39.50	.43	19.18	.21	162.00	1.76
2.....	26	75.93	2.92	17.58	.68	9.71	.37	48.14	1.85
3.....	89	216.68	2.44	59.76	.67	20.32	.23	136.60	1.54
Total.....	207	513.29	2.48	116.84	.56	49.21	.24	346.74	1.68
APRIL SURVEY									
Enumerator:									
1.....	121	229.27	1.89	37.39	.31	19.44	.16	172.44	1.43
2.....									
3.....	87	152.83	1.76	42.88	.49	17.06	.20	92.89	1.07
Total.....	208	382.10	1.84	80.27	.39	36.50	.18	265.33	1.28

<sup>1</sup> Includes travel between interviews within the segment and salary for time spent for traveling between interviews.  
<sup>2</sup> Includes salary for time spent traveling from point of origin to segments and returns, for time spent traveling between segment and corresponding travel expenses.

Agricultural Marketing Service and North Carolina State College Farm Slaughter Surveys, January and April 1953.

Further Breakdown of Costs

Excluding the cost of the training school, table 6 gives a breakdown, by survey, of the cost of obtaining the interview, the cost of travel between interviews within a segment, and the cost of travel outside the segment, plus per diem. The per diem costs are included with travel outside the segment because these costs are inversely proportional to each other. If an interviewer stayed in a hotel near a segment his per diem was greater, but he saved the time and mileage that he would otherwise have taken to travel the distance to his home and back.

The cost of obtaining the interview is made up of the time, at \$1 an hour, actually spent for the interview as recorded in the appropriate space on

the heading of the schedule. Also included is salary for time spent in making corrections to schedules already taken. "Between interview" cost is made up of the time, at \$1 an hour plus mileage at 7 cents a mile, that it took the interviewer to get from one respondent to the next. Time spent between interviews necessarily includes the cost of calling on people who were not at home, for whom no schedule was obtained until the second or third call. "Callbacks" are what makes this component a substantial part of the entire cost. Travel outside the segment includes salary for the time spent getting to the segment from the home of the interviewer and return, travel from segment to segment, travel to nearby towns for meals, and mileage for this travel.

A cost function that could be applied to these surveys is:

$$C = a + bn + cn + dn$$

where  $C$  = Total cost of both surveys.

$a$  = Training school cost.

$b$  = Interviewing cost per schedule.

$c$  = Between interview cost per schedule.

$d$  = Travel outside segment and per diem per schedule.

$n$  = Number of interviews.

The cost function in this case would be  $997.41 = 102.02 + (0.47)n + (0.21)n + (1.48)n$

where the first 2 amounts appear in table 5 and the rest are in table 6.

### Time and Cost for Actual Interview

As there were two types of respondents—(1) nonfarmers with hogs and all farmers and (2) nonfarmers with no hogs—the length of time spent in obtaining the regular 12-page schedule and the short 3-page schedule varied. Table 7 breaks down the interview costs of obtaining both types of schedules. Actual minutes spent in obtaining complete interviews were recorded. Average time as well as cost is given.

### Further Comparisons

The agreement between enumerators 1 and 3 in terms of cost per schedule is interesting—the difference between the two for the average of both surveys was only 2 cents per schedule.

On the average, enumerator 3 spent more time per schedule but traveled less than interviewer 1. These observations were consistent for both surveys. Enumerator 2, who had to move unexpectedly after the survey began, showed a higher cost per schedule on the 26 interviews taken. The comparison looks somewhat more favorable for enumerator 2 if the training school costs are removed from consideration, but the cost remains higher than for the other two. The difference between 2 and the others, ignoring costs of training school, is primarily in salary. This difference may be accounted for partly by the average length of time actually spent in interviewing (table 3).

The cost function as given previously  $C = a + bn + cn + dn$  where, in this survey (table 6)  $b = 0.47$ ,  $c = 0.21$ ,  $d = 1.48$ .

It should be emphasized that these coefficients are not constants but might vary from survey to

TABLE 7.—Time spent and cost in obtaining short and regular size schedules, by enumerator, from farm slaughter surveys, January and April 1953, conducted in 6 northeastern North Carolina counties

JANUARY SHORT SCHEDULE					
Item	Sched- ules	Time		Cost	
		Total	Aver- age per sched- ule	Total	Aver- age per sched- ule
Enumerator:	<i>Number</i>	<i>Minutes</i>	<i>Minutes</i>	<i>Dollars</i>	<i>Dollars</i>
1-----	13	248	19.1	4.13	0.32
2-----	2	90	45.0	1.50	.75
3-----	11	340	30.9	5.67	.52
Total---	26	678	26.1	11.30	.43
JANUARY REGULAR SCHEDULE					
Enumerator:					
1-----	79	2,122	26.9	35.37	.45
2-----	24	965	40.2	16.08	.67
3-----	78	3,245	41.6	54.09	.69
Total---	181	6,332	35.0	105.54	.58
APRIL SHORT SCHEDULE					
Enumerator:					
1-----	16	203	12.7	3.38	.21
2-----	22	530	24.1	8.83	.40
Total---	38	733	19.3	12.21	.32
APRIL REGULAR SCHEDULE					
Enumerator:					
1-----	105	2,041	19.4	34.01	.32
2-----	65	2,043	31.4	34.05	.52
Total---	170	4,084	24.0	68.06	.40

survey. Thus they would be applicable for planning purposes only when conducting a similar survey or repeating the same type of survey. Of course, the value of all coefficients depends upon the specified salary and mileage rates.

The quantity,  $a$ , depends upon three factors: Time spent in training, number of interviewers, and distance interviewers must travel to attend the training school. It should be possible to estimate these items rather closely for any given survey. The  $b$  coefficient is the salary for the time spent in actual conversation with the respondent.



This value can also be considered to have two components: (1) Time necessary to explain the objectives of the survey and establish rapport, and (2) time required to ask specific questions and to record respondents' answers. Evidence that both of these components exist is given in table 7.

Although 31 questions were listed on the short schedule, an average of only 18 were asked per respondent, because of the inapplicability of some questions. Similarly, of the 105 possible questions on the regular schedule, an average of 68 were asked. Thus, almost 4 times as many questions were asked on the regular schedule yet it took only 35 percent longer to administer, on the average. It is evident that information from the additional questions was obtained at little extra cost. The shorter interview time in April probably reflects both the enumerator's increased skill due to practice and the fact that less explanation to the respondent was necessary.

The *c* is the cost of traveling between farms within a segment; it includes both mileage and salary. This factor would presumably be subject only to differences between enumerators and segment sizes. The value of 0.21 might be considered as the best estimate of this travel cost per schedule for the area surveyed. The cost of "call backs" is included in this item. Of course, the *c* term is applicable only to an area sampling design. The coefficient, *d*, is the cost of travel to the segment and includes per diem rates. This factor would seem to be a function of the sample size. Jessen (1942)<sup>4</sup> considers that, in Iowa, the total distance traveled in a given survey is proportional to the square root of the sample size. It is doubtful that this relationship holds in North Carolina.

It is well known that probability area or cluster sampling represents a considerable saving in cost over probability list sampling. A comparison of the cost of this survey with a list sample<sup>5</sup> having approximately the same sampling rate, the same salary rate, and the same length and complexity of schedule, further substantiates this premise. The comparable costs per schedule with training school costs excluded are given in table 8. Also excluded

<sup>4</sup> STATISTICAL INVESTIGATION OF A SAMPLE SURVEY FOR OBTAINING FARM FACTS. Iowa Agr. Expt. Sta. Res. Bull.

<sup>5</sup> KASTENBAUM. A SAMPLE OF NONRESPONDENTS TO A MAILED INQUIRY ON FARM MACHINERY, HARVESTING METHODS, AND STRAWSAVING PRACTICES. Progress Report No. 10, March 1951. Institute of Statistics. North Carolina State College.

are the lower costs of the April survey as farmers enumerated in April had been identified and visited in January.

The major difference is undoubtedly in the cost of travel involved in locating the sampling units. In both surveys, the salary cost includes the time spent in traveling to the unit. In these 2 surveys average cost was at least 3 times as much to locate and identify a farm from a list sample as from an area sample.

TABLE 8.—Average cost per schedule for farm slaughter and farm machinery surveys, by area and list-sampling

Item	Area survey— Farm slaughter, 1953	List-survey— Farm machinery, 1951
Cost:	<i>Dollars</i>	<i>Dollars</i>
Salary.....	1.31	2.91
Mileage.....	1.07	3.10
Meals per diem.....	.10	.38
Total.....	2.48	6.39
	<i>Number</i>	<i>Number</i>
Respondents.....	207	486

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An additional table (table 9) is given which reflects the number of hours and the miles traveled. This information may be of value in comparing this survey with others with respect to these specific items.

For the January survey, the average time per schedule is almost 1½ hours, while for the April survey, the average time per schedule is only a little over 1 hour. The enumerators had to travel 4.18 miles more per schedule to complete the first survey than to complete the second. Only an average of 5.4 schedules per 8-hour day was completed during the January survey compared to 7.7 schedules per 8-hour day during the April survey.

### Conclusions

Memory bias may have been a factor in obtaining significant differences in disposition between balanced and first answers on the individual balance sheets. That the confidence limits on the mean difference encompass only positive values indicates that an underestimation exists. The discrepancies for all items of the balance sheet obtained by subtracting first answers from balanced

TABLE 9.—Hours per schedule, miles traveled per schedule and number of schedules per 8-hour day, by enumerator, by survey of farm slaughter surveys, conducted in January and April 1953 in 6 northeastern North Carolina counties

Item	Sched- ules	Hours				Miles traveled				Sched- ules per 8-hour day
		Train- ing school	Inter- view- ing and travel	Total	Per sched- ule	Train- ing school	Inter- view- ing	Total	Per sched- ule	
Enumerator:	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number
1.....	213	16	242	258	1.21	144	2,756	2,900	13.62	6.6
2.....	26	20	46	66	2.54	84	384	468	18.00	3.1
3.....	176	16	183	199	1.13	150	2,422	2,572	14.61	7.1
Total.....	415	52	471	523	1.26	378	5,562	5,940	14.31	6.3

JANUARY SURVEY

Enumerator:										
1.....	92	7	118	125	1.36	62	1,382	1,444	15.70	5.9
2.....	26	20	46	66	2.54	84	384	468	18.00	3.1
3.....	89	8	107	115	1.29	76	1,408	1,484	16.67	6.2
Total.....	207	35	271	306	1.48	222	3,174	3,396	16.41	5.4

APRIL SURVEY

Enumerator:										
1.....	121	9	125	134	1.11	82	1,374	1,456	12.03	7.2
2.....	87	8	75	83	.95	74	1,014	1,088	12.51	8.4
Total.....	208	17	200	217	1.04	156	2,388	2,544	12.23	7.7

<sup>1</sup> Training school hours and miles are allocated to both surveys in proportion to the number of schedules obtained in each, although the actual training session preceded the January survey.

Agricultural Marketing Service and North Carolina State College Farm Slaughter Survey, January and April 1953.

answers resulted in net positive changes, indicating that net errors in answers were errors of omission and underestimation by the farmer. For ending inventory, the net discrepancy is relatively large and may be a major part of the underestimation. The changes in disposition and ending inventory were 3.46 percent of the corrected ending inventory. Although only the disposition changes of 1.06 percent were significant, the other 2.40 percent is the best estimate available of underestimation in ending inventory.

No significant difference between the answers by personal interview and mail inquiry was found. However, it should be remembered that this statement is based on the results of the test in which mail schedules followed personal interview only.

The many changes in answers between the personal interviews and mail inquiries indicate con-

fusion on the part of respondents as to the implications of the questions. The questions should be reworded to avoid ambiguity; the inquiry on disposition should be mailed out more often than once a year, preferably every 3 months; and the respondent should be asked to record his answers by the month. We believe that this would reflect more accurate results than we get from the method now used.

With the sampling technique of selecting 2 psu's per stratum with probability proportional to their combined sizes, all estimations were reasonable except that of number of farms. The estimate of number of farms was not adjusted for farms in urban and rural places, which, together with the possible difference in the definition of a farm, may account for much of the 22 percent underestimation in the January survey.