

# THE EFFECT OF REFUSALS AND INACCESSIBLES ON LIST FRAME ESTIMATES



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LIST FRAME ESTIMATES

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ABSTRACT

The nature and source of biases to ESCS-Statistics survey estimates caused by nonresponse are investigated in this research report. The concept of relative bias is introduced and discussed for three states (Colorado, Minnesota and Nebraska) and two surveys. Data is taken from hog and cattle list frame surveys. It is shown that ESCS-Statistics estimates are likely to be biased downward due to a) high nonresponse rates and b) generally smaller stratum means for respondents than nonrespondents.

## INTRODUCTION

Several states in the Hog and Cattle Multiple Frame (MF) survey are experiencing a large percentage of refusals and inaccessibles. Current survey procedures delete refusals and inaccessibles from the sample and adjust the expansion factor to reflect only completed reports for estimating population parameters. This would be an acceptable procedure with a very high response rate, say larger than 95 percent. However, when refusal/inaccessible rates are close to 20 percent and in some cases 30 percent in the large operation strata, the assumption that the distribution of refusals and inaccessibles is the same as those who respond may not be valid. Three states agreed to cooperate in a research project to test this assumption: Colorado, for the January and July 1, 1977 cattle surveys, and Minnesota and Nebraska for June and September 1, 1977 hog surveys. The strata definitions and sample allocations for the strata included in this study are presented for each state in Table A1 in the Appendix. Note that the extreme operator (EO) strata were not analyzed in this study due to the current policy of rotation sampling with no overlap between survey periods.

## METHODOLOGY

### Data Collection

These States were asked to identify refusals/inaccessibles from the previous survey and assign their best enumerators to conduct the interview in person. Refusals and inaccessibles can be identified in the previous survey by the response code on the multiple frame data file. The following codes summarize the type of response associated with each name selected in the sample:

	<u>Response Code</u>	<u>Description</u>
"Responded" for this Analysis	1	Mail return for most of report
	2	Telephone for most of report
	3	Interview for most of report
	4	Estimated for most of report
	5	Known Zero
"Nonresponse" for this Analysis	6	Mail refusal
	7	Telephone refusal
	8	Interview refusal
	9	Inaccessible

Each state was also asked to keypunch the control data associated with the sampling unit (hog or cattle index) with the survey data. The current survey's data was then merged with the previous survey's data by strata and operator identification number.

Table 1 defines the response domains of the study and gives the number of observations in each domain for the three states. "Responded" for this analysis will mean any type of response, mail, phone, interview, known  $\emptyset$ , or estimated. "Refusal" similarly is any type of refusal.

Table 1: Number and Percentage of Observations in Each Response Domain, Colorado, Nebraska, Minnesota 1977

Domain Number	Respondent Description	Colorado (Jan., July Cattle)		Nebraska (June, Sept. Hogs)		Minnesota (June, Sept. Hogs)	
		No.	%	No.	%	No.	%
1	Responded both surveys	1098	81.4	915	71.5	1464	81.6
2	Responded then refused	45	3.3	94	7.3	79	4.4
3	Responded then inaccessible	32	2.4	10	.8	10	.6
4	Refused then responded	64	4.7	94	7.3	80	4.5
5	Inaccessible then responded	26	1.9	29	2.3	16	.9
6	Refused or inaccessible both surveys	85	6.3	138	10.8	144	8.0

The special enumerator assignments undertaken for this study were an attempt to reduce nonresponse by concentrating on those missing in the previous survey. From Table 1 it may be seen this effort resulted in the conversion of 40 to 50 percent of earlier nonrespondents (domains 4 and 5 vs 6). However, almost as many reports were then lost from the first survey to the second (domains 2 and 3 vs 4 and 5). Therefore, the effect of the special enumeration effort on the overall response rate was quite small.

A question then arises about the impact of enumerators on the willingness to cooperate. Apparently a change in enumerators coupled with a personal visit will result in some success at converting former refusals. On the other hand, diverting attention from former respondents may lose reports. It therefore, seems advisable to try different approaches or different enumerators with refusals while maintaining consistency in contacting respondents according to their preference--telephone or in person and perhaps even time of day. It would also seem worthwhile to analyze the effectiveness of each enumerator in avoiding refusals or inaccessibles. This would necessitate coding the enumerators on their assigned questionnaires to match with response codes, measuring their ability to convert previous nonrespondents and isolating the enumerator effect in high refusal areas. These steps mean additional book-keeping and analysis for the SSO but they become increasingly important with the rising nonresponse rate.

Following a discussion of the concept of relative bias in estimates due to nonresponse, the impact of differences in the above domains on the survey indications of the three states and two survey periods studied will be analyzed.

#### Concept of Relative Bias

Currently ESCS summarizes only those who responded to the current list frame livestock survey to estimate totals and reduces the sample size for nonrespondents. To estimate the nonresponse bias in these procedures consider the following formulation from Platek, et al [2].

Consider estimating the population total  $X$  for some characteristic "X", such as total cattle in Colorado. Then the entire population can be classified as respondents and nonrespondents according to the following, two-way table.

	Respondents (Cooperators)	NonRespondents (Missing)	Total Population
Total for 'X'	$X_C$	$X_M$	$X = X_C + X_M$
Number of units	C	M	$N = C + M$

Of course  $X_M$  is not known and must be adjusted for, using some compensation procedure. Let  $Z_M$  be the value imputed for  $X_M$ . Then

$$\hat{X} = X_C + Z_M \text{ estimates } X.$$

The bias of  $\hat{X}$  is:

$$\begin{aligned} (1) \quad B(\hat{X}) &= \hat{X} - X = (X_C + Z_M) - (X_C + X_M) \\ &= Z_M - X_M \\ &= M(\bar{Z}_M - \bar{X}_M) \quad (1) \end{aligned}$$

The current policy essentially lets  $\bar{Z}_M$  be represented by  $\bar{X}_C$  so the bias becomes the number of nonrespondents (M) times the difference between the respondent mean and nonrespondent mean, i.e.,  $B(\hat{X}) = M(\bar{X}_C - \bar{X}_M)$ .

The relative bias of  $\hat{X}$  may then be represented by:

$$(2) \quad RB(\hat{X}) = \frac{M(\bar{X}_C - \bar{X}_M)}{C(\bar{X}_C) + M(\bar{X}_M)}.$$

This expression may then be represented in terms of response rates ( $r = \frac{C}{N}$ )

and ratio of means ( $\ell = \frac{\bar{X}_M}{\bar{X}_C}$ ) by the following:

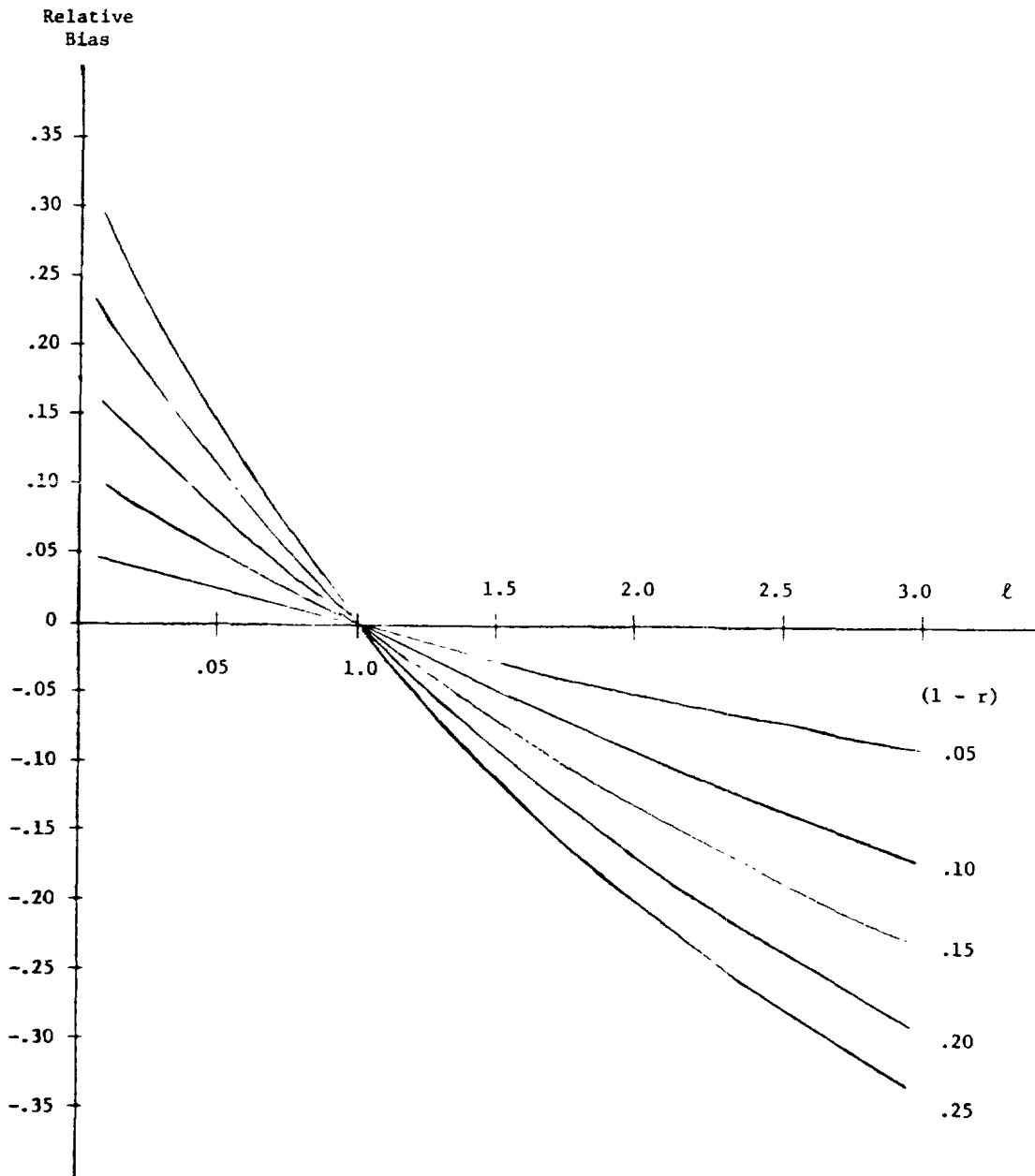
$$(3) \quad RB(\hat{X}) = \frac{(1-r)(1-\ell)}{r + \ell(1-r)}, \text{ where } 1-r = \text{nonresponse rate,}$$

$$\ell = \bar{X}_M / \bar{X}_C, \quad \bar{X}_C = \frac{X_C}{C} \text{ and } \bar{X}_M = \frac{X_M}{M}.$$



This representation then allows the relative bias  $RB(\bar{X})$  to be shown graphically for various values  $(1 - r)$  and  $\ell$  in Figure 1. It is obvious from Figure 1 that the more the ratio  $\ell$  departs from 1 and the higher the nonresponse rate the greater the relative bias.

Figure 1: Relative Bias as a Function of Nonresponse Rate  $(1 - r)$  and Ratio of Means  $(\ell = \bar{X}_M / \bar{X}_C)$ .



ANALYSIS

Relative Bias in Survey Indications

Now, for the Colorado, Minnesota and Nebraska data sets, consider the potential impact of nonrespondents on the respective estimates. That is, what is the likely relative bias in the January and July Colorado cattle indications and the June and September hog indications in Minnesota and Nebraska? To measure this, the following computations are needed:

- a) the mean of those reporting both surveys ( $\bar{X}_B$ )--first survey ( $\bar{X}_{B1}$ ) and second survey ( $\bar{X}_{B2}$ ),
- b) the mean of those who reported only for a single survey ( $\bar{X}_S$ )--reported only for first survey ( $\bar{X}_{S1}$ ) or only for second ( $\bar{X}_{S2}$ ),
- c) the combined mean of all who reported in a given survey ( $\bar{X}_C$ )--combination of  $\bar{X}_B$  and  $\bar{X}_S$ --corresponds to the mean number of cattle or hogs reported in each respective survey-- $\bar{X}_{C1}$  and  $\bar{X}_{C2}$ ,
- d) a ratio estimate of the nonrespondent mean ( $\bar{X}_M$ )-- $\bar{X}_{M1}$  and  $\bar{X}_{M2}$ --based on the relationship between  $\bar{X}_S$  and  $\bar{X}_B$  for the one survey where comparable data were available.

The above means are presented with their respective number of observations by strata in Tables A2-A4 in the Appendix. It may be readily seen from these tables that the mean values for those who responded in both surveys ( $\bar{X}_B$ ) are generally below the level of those who would only cooperate in one survey ( $\bar{X}_S$ ). The estimated means for the survey where the reports were missing ( $\bar{X}_M$ ), based on comparable data in the other survey, are considered a reasonable

approximation due to the favorable correlations achieved between survey periods in most strata for those respondents common to both surveys. This assumes the change between surveys was similar for consistent respondents and single time respondents. The between survey correlations are presented in Table A5 in the Appendix.

Control data, available for the entire sample, were of little value for estimating nonrespondents (missing in one survey or both) due to poor correlations between reported data and control data (See Appendix Table A6).

It is now possible to estimate the relative bias in each survey by stratum and for the combined strata based on equation (3) given the total nonresponse rate  $[(1 - r) = (1 - \frac{\text{Tabulated Reports}}{\text{Total Sample}})]$  and the ratio of the expected nonrespondent mean to the respondent mean  $[\ell = \frac{\bar{X}_M}{\bar{X}_C}]$ . These are given in the following tables (2, 3, 4). Since those who did not respond to either survey are included in the nonresponse rates, it is tacitly assumed that these nonrespondents are more nearly like the single occasion nonrespondents than the respondents to both surveys.

Table 2: Relative Bias, Colorado, Jan. and July, 1977 Cattle

Stratum	Nonresponse Rate (1 - r)		Nonrespondent Est. Mean ( $\bar{X}_M$ )		Respondent Mean ( $\bar{X}_C$ )		Ratio ( $\ell$ )		Relative Bias (%)	
	Jan.	July	Jan.	July	Jan.	July	Jan.	July	Jan.	July
1	.10	.05	1.9	-	2.0	12.4	.95	-	+ .5	0
2	.11	.10	53.1	48.6	37.8	38.2	1.40	1.27	- 4.2	-2.6
3	.15	.14	100.5	150.3	129.8	133.1	.77	1.13	+ 3.6	-1.8
4	.16	.14	258.5	279.5	210.9	242.1	1.23	1.15	- 3.5	-2.1
5	.12	.14	843.8	510.6	417.3	424.0	2.02	1.20	-10.9	-2.7
Combined	.13	.12							- 3.5	-2.3

Table 3: Relative Bias, Nebraska, June and September, 1977 Hog and Pig Surveys

Stratum	Nonresponse Rate (1 - r)		Nonrespondent Est. Mean ( $\bar{X}_M$ )		Respondent Mean ( $\bar{X}_C$ )		Ratio ( $\ell$ )		Relative Bias (%)	
	June	Sept	June	Sept	June	Sept	June	Sept	June	Sept
10	.10	.04	0.0	20.0	6.6	5.0	0	4.00	+11.1	-10.7
20	.10	.05	3.4	4.2	5.6	4.2	.61	1.00	+ 4.1	0
30	.18	.17	25.2	60.3	40.0	39.4	.63	1.53	+ 7.1	- 8.3
40	.28	.28	141.9	105.8	133.8	116.2	1.06	.91	- 1.7	+ 2.6
50	.30	.33	206.7	191.4	194.2	190.8	1.06	1.00	- 1.8	0
Combined	.20	.18							+ 1.4	- 1.5

Table 4: Relative Bias, Minnesota, June and September, 1977 Hog and Pig Surveys

Stratum	Nonresponse Rate (1 - r)		Nonrespondent Est. Mean ( $\bar{X}_N$ )		Respondent Mean ( $\bar{X}_C$ )		Ratio ( $\ell$ )		Relative Bias (%)	
	June	Sept	June	Sept	June	Sept	June	Sept	June	Sept
11	.06	.04	0	0	5.5	4.0	0	0	+ 6.4	+4.2
12	.05	.04	22.8	0	5.3	5.2	4.30	0	-14.2	+4.2
31	.06	.02	0	0	.5	2.2	0	0	+ 6.4	+2.0
61	.13	.10	46.0	20.1	22.4	26.6	2.05	.76	-12.0	+2.5
62	.20	.17	106.1	81.2	60.1	62.1	1.77	1.31	-13.3	-5.0
63	.21	.25	180.4	187.1	157.1	161.2	1.15	1.16	- 3.1	-3.8
64	.21	.22	136.9	299.2	197.1	226.0	.69	1.32	+ 7.0	-6.6
65	.22	.30	424.7	388.3	378.4	388.7	1.12	1.00	- 2.6	0
Combined	.13	.12							- 5.1	-1.6

In tables (2, 3, 4) wide variations can be seen in the estimated relative bias between strata and between surveys due to differences in the nonresponse rates and ratios of nonrespondent means to respondent means. This disturbs the comparability of the direct expansions between surveys. As one would expect, the greater the nonresponse rate and the larger the differences between the means, the larger the relative bias. A negative relative bias means the original estimate was too low when nonrespondents were ignored and a positive sign means the estimate was too high. Values ranged from -14 percent relative bias to +11 percent. However, most of the major cattle strata in Colorado and hog strata in Nebraska and Minnesota were biased downward (negative relative bias) so the overall estimates for these strata were generally too low when based only on respondent data.

Although offsetting biases between strata reduced overall bias it would be a mistake to assume any consistency in the net effect. The prevailing direction of the bias is downward but the amount depends on the wide fluctuations in individual strata. It must also be remembered that the mean for all nonrespondents was estimated based on what was known about those who failed to respond to only one of the two surveys. Differences may be even larger if those who didn't respond to either survey had mean values further from the respondent mean than the single time nonrespondents.

Based on the available data, the Colorado cattle inventory indications for the five strata analyzed may have been biased downward for January and July by 3.5 percent and 2.3 percent respectively. These strata account for 40 - 45 percent of the total inventory so if there were no further bias from extreme operator nonrespondents the multiple frame survey indications would have been too low by 1 to 1½ percent. This source of nonsampling error (negative bias) compares to sampling error of  $\pm$  3.9 percent in Colorado for these surveys.

Nebraska hog indications for five strata (excepting extreme operator samples which were rotated between surveys) were estimated to be biased upward by 1.4 percent in June and biased downward by 1.5 percent in September. These strata account for about 55 percent of the Nebraska hog estimate. A shift like this in the bias between surveys could result in a three percentage point shift in the indicated percent change between quarters from the multiple frame surveys. The relative sampling error was  $\pm 5.2$  percent in June and  $\pm 3.8$  percent in September for Nebraska.

Minnesota hog indications for the strata analyzed account for 55 percent of the inventory and may have been biased downward by as much as 5 percent in June and 1.6 percent in September. Sampling error was approximately  $\pm 7$  percent of the estimated inventory in these two months. Overall nonresponse rate was 12 - 13 percent but the major hog producing strata had 20 to 30 percent nonresponse. Even small differences between the means of respondents and nonrespondents at these nonresponse rates have considerable impact on the relative bias.

The effect of the special enumeration efforts undertaken for this study appears to have been a reduction in the relative bias of the second survey in Colorado and Minnesota and a reversal of the nature of the bias in Nebraska. Close examination of the stratum nonresponse rates shows the greatest impact of the increased emphasis on former refusals occurred in the lower size group strata with little effect on nonresponse in the larger strata. This is probably because there is already a concerted effort made to get data for large operations while those in lower size groups have not previously been emphasized. However, the largest differences in the means between respondents and nonrespondents often occurred in the lower strata so reducing these nonresponse rates becomes important to reducing overall bias.

### Nature of the Nonrespondents

In the previous section it was shown that the overall list frame indications tend to be biased downward. In this section certain aspects of the refusals and inaccessibles who comprise the nonrespondent group are studied.

Insufficient observations for inaccessibles alone prevent a meaningful comparison of means between refusals and inaccessibles. However, as a minimum, the presence or absence of livestock on these operations may be noted. Table 5 summarizes the proportion of positive reports among respondents and nonrespondents (refusals and inaccessibles) for each state. For all three states the proportion of positive reports among sometime refusals was much higher than for those who consistently responded. However, the proportion of positive reports among those who were inaccessible one survey was generally found to be very low. The exception came from cattle operators in Colorado who reported in January with a large proportion having cattle but were inaccessible for some reason in the July survey.

Overall the proportion of one-time nonrespondents who had livestock was higher than those who reported both times, especially for hogs. These differences between respondent groups and between surveys suggest that refusals and inaccessibles are not distributed like respondents and that supplementary information would be beneficial to suggest the possible impact of nonresponse on each survey indication. A study by Crank [8] in the March 1978 Nebraska hog survey showed 63 percent of nonrespondents had hogs compared to only 28 percent with hogs among respondents (weighted average of all strata). That study included information about the presence or absence of hogs for 80 percent of all nonrespondents (including extreme operators) on a current basis compared to 40-50 percent determined here for non-E0 strata. By substituting the mean

Table 5: Percent Positive Livestock Reports by State and Survey

DOMAIN	Colorado Cattle			Nebraska Hogs			Minnesota Hogs		
	No.	Jan Srvy Wtd. Pct.	July Srvy Wtd. Pct.	No.	June Srvy Wtd. Pct.	Sept Srvy Wtd. Pct.	No.	June Srvy Wtd. Pct.	Sept Srvy Wtd. Pct.
	Reports	Positive	Positive	Reports	Positive	Positive	Reports	Positive	Positive
	#	%	%	#	%	%	#	%	%
Responded to both Surveys	1354	62		941	25		1478	16	
	1354		62	941		23	1478		16
Nonrespondents 2nd Survey	77	79		105	60		89	35	
Nonrespondents 1st Survey	90		63	123		32	96		29
Refused 2nd Survey	45	82		95	61		79	41	
Refused 1st Survey	64		80	94		43	80		33
Inaccessible 2nd Survey	32	74		10	*		10	14	
Inaccessible 1st Survey	26		28	29		13	16		13

\* Observations for this domain not available for all strata to combine for comparison purposes.



of the respondents with hogs for non-respondents who were known to have hogs and zeros for those without hogs, he found the survey indication increased nearly 6 percent for the list sample. Thus, both studies indicate the prevailing direction of bias due to nonresponse is downward. However, as evidenced by the two survey periods in this study, the amount of the downward bias may not be consistent so that supplementary information on a current basis for each survey becomes important to monitor changes in the bias.

Conclusions/Recommendations

Several observations concerning enumeration techniques and the impact of nonrespondents on list frame livestock indications arose from this study:

1. Approximately 40-50 percent of previous refusals can be converted through personal enumeration in the following survey. However, special efforts will also have to be made to avoid losing former respondents.
2. More work is needed to evaluate the role of individual enumerators (phone or personal) in either causing or preventing refusals and inaccessibles.
3. Control data were of little value in estimating for nonrespondents due to poor correlations between reported data and control data. However, between survey correlations are high enough to be of assistance in estimating for previous respondents who did not respond in the current survey.
4. Multiple frame livestock estimates are generally biased downward because nonrespondent means on the list frame tend to be larger than respondent means.
5. Nonrespondent means are larger for two reasons:
  - a) larger operations tend to refuse more than smaller operations [Tables 2, 3 & 4] (evidenced by the increasing refusal rates for the larger size group strata and larger means for sometime refusals within strata).
  - b) the proportion of operations actually having the cattle or hogs of interest is higher among refusals than it is for respondents [Table 5] (a reason operator refuses is because he has livestock and doesn't want to reveal the number).

6. Emphasis is currently on increasing the response among large operations. This is necessary because high nonresponse rates among these strata accentuate even small differences between respondent and nonrespondent means and increase bias. However, it is no less important to further improve the response among the operations in smaller size strata because large differences between the means of respondents and nonrespondents in these strata also have a sizeable impact on the bias even with low nonresponse rates.
7. Large changes in the means of the smaller size group strata can occur because a few positive livestock reports among the large number of zeros in these strata coupled with large expansion factors can have a considerable effect.
8. Because nonrespondent means differ from respondent means, changes in survey procedures regarding nonrespondents will affect comparability of survey indications between surveys.
9. Occasional refusals had a consistently larger proportion of positive reports for the livestock of interest than did those who responded to both surveys. Inaccessibles generally, though not consistently, had a greater proportion of zero reports. Nonrespondents in the second survey period had a larger proportion of positive reports than did first survey nonrespondents even though those who reported in both surveys remained constant. This change from one survey period to another among nonrespondents is significant since the between survey comparability of the estimates is affected.

Consistent estimators of change plus estimators which compensate for non-response should be developed and implemented to control nonsampling errors in livestock surveys. One possible approach is the use of a successive sampling

regression or ratio estimator for the portion of the sample matched between survey periods coupled with an indication of effect of nonresponse such as the estimator based on supplementary evidence of livestock discussed by Crank [8].

APPENDIX A

Tables Referenced in Text

Table A1: Strata Definitions and Sample Allocations for Those States and Strata Studied

<u>Colorado (Jan/July, 1977)</u>			<u>Nebraska (June/Sept, 1977)</u>			<u>Minnesota (June/Sept, 1977)</u>		
<u>Stratum Number</u>	<u>Stratum Definition</u>	<u>Sample Allocation</u>	<u>Stratum Number</u>	<u>Stratum Definition</u>	<u>Sample Allocation</u>	<u>Stratum Number</u>	<u>Stratum Definition</u>	<u>Sample Allocation</u>
1	0 Cattle	39	10	No Livestock	104	11	No Information	68
2	1-124 Cattle	566	20	No Hogs	289	12	No Livestock	358
3	125-274 Cattle	334	30	1-99 Hogs	314	31	No Hogs	228
4	275-499 Cattle	219	40	100-199 Hogs	343	61	1-74 Hogs	362
5	500-999 Cattle	192	50	200-299 Hogs	230	62	75-149 Hogs	273
						63	150-299 Hogs	208
						64	300-399 Hogs	155
						65	400-699 Hogs	141

Table A2: Comparisons Between Means for Respondents to Both Surveys ( $\bar{X}_B$ ), Respondents to a single Survey ( $\bar{X}_S$ ), and the Estimated Mean for Nonrespondents ( $\bar{X}_M$ ), Colorado, January and July, 1977.

Stratum	Respondents Both Surveys -January-		Respondents Only in January		All January Respondents		Estimated January Nonrespondents	
	No.	$\bar{X}_{B1}$	No.	$\bar{X}_{S1}$	No.	$\bar{X}_{C1}$	No.	$\bar{X}_{M1}$
1	35	2.0	-	-	35	2.0	1	1.9
2	475	37.2	28	48.6	503	37.8	33	53.1
3	261	128.8	23	142.3	284	129.8	28	100.5
4	171	208.4	12	245.9	183	210.9	17	258.5
5	156	407.9	14	522.9	170	417.3	10	843.8

Stratum	Respondents Both Surveys -July-		Respondent Only in July		All July Respondents		Estimated July Nonrespondents	
	No.	$\bar{X}_{B2}$	No.	$\bar{X}_{S2}$	No.	$\bar{X}_{C2}$	No.	$\bar{X}_{M2}$
1	35	12.7	1	12.0	36	12.4	-	-
2	475	37.2	33	53.1	508	38.2	28	48.6
3	261	136.0	28	106.1	289	133.1	23	150.3
4	171	236.9	17	293.8	188	242.1	12	279.5
5	156	398.3	10	823.9	166	424.0	14	510.6

Table A3: Comparisons Between Means for Respondents to Both Surveys ( $\bar{X}_B$ ), Respondents to a Single Survey ( $\bar{X}_S$ ), and the Estimated Mean for Nonrespondents ( $\bar{X}_M$ ), Nebraska, June and September, 1977.

Stratum	Respondents Both Surveys -June-		Respondents Only in June		All June Respondents		Estimated June Nonrespondents	
	No.	$\bar{X}_{B1}$	No.	$\bar{X}_{S1}$	No.	$\bar{X}_{C1}$	No.	$\bar{X}_{M1}$
10	92	6.2	2	23.0	94	6.6	8	0.0
20	249	5.6	10	5.5	259	5.6	26	3.4
30	230	38.0	29	55.9	259	40.0	31	25.2
40	212	135.3	34	124.0	246	133.8	35	141.9
50	132	193.8	29	196.4	161	194.2	23	206.7

Stratum	Respondents Both Surveys -September-		Respondents Only in September		All September Respondents		Estimated September Nonrespondents	
	No.	$\bar{X}_{B2}$	No.	$\bar{X}_{S2}$	No.	$\bar{X}_{C2}$	No.	$\bar{X}_{M2}$
10	92	5.4	8	0.0	100	5.0	2	20.0
20	249	4.3	26	2.6	275	4.2	10	4.2
30	230	41.0	31	27.2	261	39.4	29	60.3
40	212	115.4	35	121.0	247	116.2	34	105.8
50	132	188.9	23	201.5	155	190.8	29	191.4



Table A4: Comparisons Between Means for Respondents to Both Surveys ( $\bar{X}_B$ ), Respondents to a Single Survey ( $\bar{X}_S$ ), and the Estimated Mean for Nonrespondents ( $\bar{X}_M$ ), Minnesota, June and September, 1977.

Stratum	Respondents Both Surveys -June-		Respondents Only in June		All June Respondents		Estimated June Nonrespondents	
	No.	$\bar{X}_{B1}$	No.	$\bar{X}_{S1}$	No.	$\bar{X}_{C1}$	No.	$\bar{X}_{M1}$
11	63	5.6	1	0.0	64	5.5	2	0.0
12	332	5.5	9	0.0	341	5.3	12	22.8
31	210	.5	4	0.0	214	.5	13	0.0
61	306	22.5	10	18.1	316	22.4	19	46.0
62	207	58.2	13	81.6	220	60.1	20	106.2
63	143	153.5	22	180.7	165	157.1	13	180.4
64	111	191.6	12	247.6	123	197.1	10	136.9
65	92	378.0	18	380.9	110	378.4	7	424.7

Stratum	Respondents Both Surveys -September-		Respondents Only in September		All September Respondents		Estimated September Nonrespondents	
	No.	$\bar{X}_{B2}$	No.	$\bar{X}_{S2}$	No.	$\bar{X}_{C2}$	No.	$\bar{X}_{M2}$
11	63	4.2	2	0.0	65	4.0	1	0.0
12	332	4.7	12	19.5	344	5.2	9	0.0
31	210	2.4	13	0.0	223	2.2	4	0.0
61	306	25.0	19	51.1	325	26.6	10	20.1
62	207	57.9	20	105.7	227	62.1	13	81.2
63	143	158.9	13	186.7	156	161.2	22	187.1
64	111	231.5	10	165.4	121	226.0	12	299.2
65	92	385.3	7	432.9	99	388.7	18	388.3

Table A5: Between Survey Correlation Coefficients for Respondents to Both Surveys by Strata, 1977.

Colorado		Nebraska		Minnesota	
Stratum	Jan-July Cattle Correlations	Stratum	June-Sept Hog Correlations	Stratum	June-Sept Hog Correlations
1	-.04	10	.59	11	.98
2	.34	20	.88	12	.93
3	.59	30	.79	31	.19
4	.60	40	.88	61	.80
5	.68	50	.45	62	.75
				63	.83
				64	.64
				65	.84

Table A6: Correlation Coefficients Between Reported Data and Control Data, by State and Stratum, 1977<sup>1/</sup>

Colorado			Nebraska			Minnesota		
Stratum	Jan. Reported to Control	July Reported to Control	Stratum	June Reported to Control	Sept. Reported to Control	Stratum	June Reported to Control	Sept. Reported to Control
2	.18	.29	30	.43	.33	61	.18	.28
3	.19	.22	40	.22	.23	62	.09	.07
4	.09	.11	50	.13	.09	63	.12	.12
5	.20	.15				64	.08	.01
						65	.25	.26

<sup>1/</sup>Correlations not possible in strata where control data equal zero.

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