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United States
Department of
Agriculture

National
Agricultural
Statistics
Service

Research and
Applications
Division

SRB Research Report
Number SRB-91-01

February 1991

# RESPONSE BIAS IN THE QUARTERLY AGRICULTURAL SURVEY CROP ACREAGE DATA: DECEMBER 1988 AND 1989

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**RESPONSE BIAS IN THE QUARTERLY AGRICULTURAL SURVEY CROP ACREAGE DATA: DECEMBER 1988 AND 1989.** By Michael R Pallesen. Research and Applications Division, National Agricultural Statistics Service, U.S. Department of Agriculture, Washington, D.C. 20250. February, 1991. NASS Research Report No. SRB-91-01.


## ABSTRACT

Reinterview surveys were conducted in Indiana, Iowa, Minnesota, Nebraska, Ohio and Pennsylvania in December 1988 and 1989. A subsample of Computer Assisted Telephone Interview (CATI) respondents was selected in each State and reinterviewed within 10 days of the original CATI response. Survey procedures were consistent between operational and reinterview surveys. Differences between the original (edited) responses and the reinterview responses were reconciled to determine the final values. If differences were found, reasons for the differences were obtained during the reconciliation process. This paper presents the results of acreage data bias estimates using the reconciled values as the proxies for the truth. Significant biases were found in the 1989 survey total cropland acres at the six State level, Indiana cropland acres and Pennsylvania corn planted acres. The precision of the bias estimates was low, as coefficients of variation were relatively large. The reasons for individual report biases were categorized into "definitional", "estimating" or "other" classes. "Definitional" reasons accounted for the majority of the absolute bias and indicated overreporting. "Estimating" reasons were more frequent and usually resulted in underreporting.



Keywords: Reinterview, subsample, reconciliation, bias and precision.





## ACKNOWLEDGEMENTS

Special thanks to the State Statistical Offices, headquarters staff, enumerators and supervisory enumerators who participated in these projects.

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## SUMMARY

Reinterview surveys were conducted in Indiana, Iowa, Minnesota, Nebraska, Ohio and Pennsylvania following the 1988 and 1989 December Agricultural Surveys (DAS). The purpose of the surveys was to provide a measure of quality in the Agricultural Surveys (AS) by estimating response bias. A subsample of Computer Assisted Telephone Interview (CATI) respondents was selected for personal (face to face) reinterviews. The reinterview survey samples covered 18% of the CATI sample in 1988 and 16% in 1989. It covered 7% of the overall DAS sample for both years. The six States in the study account for 15% of the total land in farms at the national level [6,7]. The CATI strata direct expansions (DE) for total land across all six States covered nearly 60 percent of the six State operational survey DE for both years.

Questionnaire content and enumeration procedures for the reinterview surveys were virtually the same as for the DAS. Reinterviews were to be completed within ten days of the CATI interview. Enumerators asked specific questions about total land, cropland, individual crop acreages planted, grains in storage and hog inventories. The reinterview data were then compared to the original data and any differences were reconciled to determine a "true" value. The reconciled value was used as the proxy for the truth. Bias estimates were calculated as the average difference between the original answer and the reconciled value. Reasons for differences, provided by the respondent, were then recorded by the enumerator. This report contains the analysis of the acreage data.

Univariate and multivariate tests were utilized to determine if the acreage biases were significantly different from zero. Univariate tests for most items indicated that bias was evident, but it was less than 5% for every item. A significant bias of +2.4% of the DAS (p value=.03) was found in the 1989 six State total cropland indication. This bias is chiefly attributed to the significant bias found in the Indiana cropland estimate. Significant bias was also found in Pennsylvania's 1989 corn planted acreage. The biases of the combined State acreage indications were negative for 1988 but were positive for 1989, except for winter wheat seeded which was negative for both years. Multivariate test results for 1988 data revealed a statistically significant bias (p value=.02). This was not unexpected since the bias estimates for all five variables used in the test were negative and there is strong dependence among the variables.

The precision of the bias estimates was low, with all of the standard errors large compared to the estimated biases. This was due primarily to a small portion of the sample contributing heavily to the bias estimate for each acreage item. In 1989 for example, the average absolute value of the total land bias was 43 acres for all observations. By contrast, the average absolute bias of those reporting a difference was 144 acres. There were 283 observations with total land biases out of the total response of 942. Several large positive biases counter-balanced by several large negative biases, increased the standard error. The low precision of the bias estimates limits their direct use as adjustments to survey indications. However, certain characteristics of the reported biases (frequency, type and size) are informative. The

"reason for difference" summaries can be used to improve weaknesses in survey procedures, training and design.

Reported "reasons for difference" were divided into three classes, "definitional", "estimating", and "other". "Definitional" reasons contributed most to the absolute value of the total bias. "Estimating" reasons described nearly 50 percent of the total number of differences in both years. The single most frequent reason for bias was that the respondent estimated an acreage. The average bias from this error source, however, was relatively small. The largest biases occurred when the respondent included acres from another operation or did not report correctly for the sampled name. This points to a weakness in the screening portion of the interview.

Bias estimates by size of operation (final reconciled total land) were computed. The average absolute bias increased as farm size increased. The relative bias, i.e., the size of the bias in relation to the amount of crop acreage planted, was larger for the smaller farms.

It is recommended that the reinterview project continue, in order to measure bias level changes over time. Larger sample sizes or an improved sample design should be utilized to improve the precision of the bias estimates, currently the principal weakness in the reinterview program. Continued analysis of the bias and reasons for bias can lead to improvements in training, enumeration procedures and questionnaire design.

## INTRODUCTION

The National Agricultural Statistics Service (NASS) has conducted a series of reinterview surveys to measure possible bias in data collected during the December Agricultural Survey (DAS). The purpose of these surveys is to provide a quantitative, longitudinal measure of quality for the Agricultural Surveys (AS). The first reinterview survey was conducted in December 1987 in Indiana, Minnesota and Ohio. Previous papers from NASS reinterview surveys reported negative biases (underreporting) of grain stocks and hogs [3,4,5]. The author suggests the reader become familiar with these reports for a complete description and overview of specific procedures, training manuals, questionnaires, and reconciliation forms. This paper presents the results of bias estimates for total land, cropland, winter wheat seeded, and corn and soybean planted acres from the 1988 and 1989 DAS in Indiana, Iowa, Minnesota, Nebraska, Ohio and Pennsylvania.

The biases illustrated in this study were not in the anticipated direction (i.e., positive) for all acreages. The December reinterview survey questionnaire was primarily designed as an instrument to collect data to measure hog and grain stock biases. In order to measure acreage biases, more probing questions are needed regarding acres owned, rented, rented out, etc. A reinterview survey more appropriate to measuring acreage bias was conducted in June 1990 in Ohio and Indiana [8]. The design of the June 1990 survey should result in a better "proxy to truth" for acreage items. The December reinterview results may be a better representation of response variance than of response bias for acreage items.

## SURVEY PROCEDURES

The reinterview surveys conducted by NASS over the past 3 years have followed the same procedures initially implemented in the December 1987 survey [3]. The reinterview/reconciliation technique used by NASS is based on similar techniques used at the U.S. Census Bureau. The objective of NASS' surveys is to identify response bias rather than the variance or consistency of response targeted by the U.S. Census Bureau. In each survey, the final reconciled value is considered the true value for computing estimates of bias.

The NASS reinterview surveys feature a 'face to face' reinterview of a subsample of DAS respondents. Computer Assisted Telephone Interviewing (CATI) was used for the original DAS contact, providing a platform for the reinterview subsample. Reinterview subsample enumeration was conducted within ten days of the original DAS interview by an experienced field enumerator or supervisor. Questionnaire wording and survey procedures were kept as close to operational DAS procedures as possible [3]. The reinterview questionnaire's crops section was an abbreviated version of that of the operational questionnaire (see Appendix A). The original CATI response was not revealed until after the reinterview was completed and the reconciliation process initiated. The reconciliation of differences between the original CATI response and the reinterview response was designed to determine the true value. Reasons for these differences were given by the respondent and recorded by the enumerator.

## STATISTICAL MEASURES

Bias and variance estimates were based on a stratified sample design [3]. Estimates and tests of significance were computed on the differences between the final Survey Processing System (SPS) edited CATI data and the final reconciled value or 'truth'. Bias estimates for original unedited CATI data were also summarized and the results were similar to the SPS edited CATI results. These results were not published in this report in order to minimize repetitive information.

For the $i^{th}$ observation in strata h, bias was measured as

$$B_{hi} = O_{hi} - F_{hi} \qquad \text{strata } h = 1,\ldots,L \text{ and unit } i = 1,\ldots,n_h$$

where $O_{hi}$ = Original SPS edited CATI data
$F_{hi}$ = Final or reconciled value

## THE SAMPLE

The reinterview sample was selected from the DAS CATI respondents in each of the selected States. Only completed interviews were considered, including 'out-of-business' respondents and interviews with item refusals or item 'don't knows'. Survey refusals were not eligible for reinterview. The reinterview subsample approximates a simple random sample of only the list sampling frame records chosen for CATI. The CATI sample does not include most extreme operator (EO) strata, area frame non-overlap (NOL) and operations with previous nonresponse habits. Table 1 illustrates the 1988 and 1989 December Reinterview Survey sample sizes and response rates.

**Table 1. Sample sizes and response rates, for the 1988 and 1989 December Reinterview Surveys.**

| State | Completes | Refusals | Inaccessibles | Total Sample Size |
|---|---|---|---|---|
| 1988 | | | | |
| Indiana | 82% | 4% | 14% | 162 |
| Iowa | 94% | 3% | 3% | 256 |
| Minnesota | 95% | 2% | 3% | 180 |
| Nebraska | 86% | 6% | 8% | 200 |
| Ohio | 93% | 3% | 4% | 188 |
| Pennsylvania | 87% | 7% | 6% | 71 |
| Total | 90% | 4% | 6% | 1,057 |
| 1989 | | | | |
| Indiana | 87% | 4% | 9% | 160 |
| Iowa | 89% | 4% | 7% | 244 |
| Minnesota | 95% | 2% | 3% | 197 |
| Nebraska | 86% | 6% | 8% | 204 |
| Ohio | 83% | 7% | 10% | 187 |
| Pennsylvania | 88% | 1% | 11% | 83 |
| Total | 88% | 4% | 8% | 1,075 |

Table 2 shows a comparison of the 1988 and 1989 DAS (list only) sample sizes, number of CATI responses and reinterview sample sizes. The reinterview survey sample size for 1988 covered 6.8% of the DAS sample. The 1989 reinterview sample covered 7.0% of the DAS sample. The CATI response covered 38% of the DAS sample in 1988, ranging from 23% in Indiana to 62% in Ohio. In 1989, the CATI response was 39% of the DAS, ranging from 17% in Indiana to 63% in Ohio.

**Table 2. DAS sample sizes, CATI response and reinterview survey sample sizes for 1988 and 1989**

| State | DAS Sample | CATI Response | Reinterview Subsample | Reinterview Usables |
|---|---|---|---|---|
| 1988 | | | | |
| Indiana | 2,737 | 676 | 162 | 129 |
| Iowa | 3,025 | 793 | 256 | 240 |
| Minnesota | 2,971 | 1,235 | 180 | 171 |
| Nebraska | 2,910 | 1,165 | 200 | 173 |
| Ohio | 2,354 | 1,456 | 188 | 174 |
| Pennsylvania | 1,453 | 571 | 71 | 62 |
| Total | 15,450 | 5,896 | 1,057 | 949 |
| 1989 | | | | |
| Indiana | 2,721 | 462 | 160 | 139 |
| Iowa | 3,050 | 1,048 | 244 | 217 |
| Minnesota | 2,949 | 1,058 | 197 | 189 |
| Nebraska | 2,917 | 1,261 | 201 | 175 |
| Ohio | 2,362 | 1,483 | 187 | 156 |
| Pennsylvania | 1,365 | 739 | 83 | 73 |
| Total | 15,364 | 6,051 | 1,075 | 949 |

## RESULTS

### Response Bias

Bias estimates for total land, cropland, winter wheat seeded, and corn and soybean planted acreages for the two survey periods are presented at the six State level in Table 3. Also shown in Table 3 are the biases as a percent of the DAS expansions. The estimated biases with p-values near .05 are shown in parentheses and any significant univariate test p-values are marked with an asterisk. Both univariate and multivariate analysis results are shown ($H_o$:Bias=0). In this table, a negative bias indicates underreporting of the survey item, while a positive bias indicates overreporting. Data for harvested acres and production were also collected and summarized for corn and soybeans. The results were similar to those for the planted acres and are illustrated in Appendix F. The formulas for the univariate and multivariate test procedures used in the analysis can be found in Appendix B.

**Table 3. Six State bias estimates for total land, cropland, winter wheat seeded, corn planted and soybeans planted.**

| | 1988 | | | 1989 | | |
|---|---|---|---|---|---|---|
| Crop | Acreage Bias | % of DAS | | Acreage Bias | % of DAS | |
| Total land | -1,903,777 | -1.6% | (.07) | 524,577 | 0.5% | |
| Cropland | -1,232,594 | -1.7% | | 1,901,473 | 2.4% | (.03)* |
| Wheat Seeded | -174,617 | -4.3% | (.09) | -146,456 | -2.7% | |
| Corn Planted | -357,309 | -1.4% | | 437,746 | 1.7% | (.07) |
| Soybeans Planted | -22,804 | -0.1% | | 356,201 | 1.9% | (.10) |
| Multivariate p-value | | | (.02)* | | | (.15) |

* indicates significant bias at $\alpha$=.05

The 1988 analysis indicates an overall negative bias (underreporting) in each of the six State totals. The absolute relative differences ranged from 0.1% for soybeans planted to 4.3% for winter wheat seeded. A multivariate test using the five variables shows a significant difference from zero with a p-value less than .05 in 1988. The viability of the multivariate test is weakened somewhat since the variables used in the test were highly correlated. Corn, soybeans and winter wheat are primary components of cropland and cropland makes up a substantial portion of the total land. Multivariate tests using different combinations of the five variables did not indicate any significant differences.

The biases in 1989 data are in the opposite direction of those of the previous year, indicating an overreporting of data (with the exception of wheat seeded). The cropland bias estimate was statistically significant, with a p-value less than .05. Most of the bias in the six State total cropland is attributed to the bias found in Indiana (Table 4).

Table 4 shows the six States' bias calculations for 1988 and 1989. The 1989 cropland acres bias in Indiana is significant (p-value=.03), as is the corn planted acres bias in Pennsylvania (p-value=.01). Indiana's 1989 cropland bias accounts for 53% of the six State cropland bias. Five observations in Indiana's 1989 reinterview sample accounted for a large portion of the individual and combined State biases. These five observations combined for 85% of the State's cropland bias and 45% of the six State cropland bias. In each case, land from another operation was incorrectly reported as part of the sampled unit. Without these five 'outliers', Indiana's cropland bias drops to 152,740 acres (1.3% of DAS, p-value of .41) and the six State cropland bias drops to 1,041,949 acres (1.3% of DAS, p-value of .16). These five observations had a substantial impact on the significance of the Indiana cropland and six State cropland biases. This type of instability in the bias estimates was rather characteristic of the acreage data.

The majority of biases in Table 4 show the change from negative (underreporting) in 1988 to positive (overreporting) in 1989. Of the five acreage biases studied, only the wheat seeded bias remained negative in both years for most States. The biases in Minnesota were negative in both years for all acreages, the only State with that characteristic.

**Table 4. State level bias estimates for total land, cropland, winter wheat seeded, corn planted, and soybeans planted.**

| | 1988 | | 1989 | |
|---|---|---|---|---|
| State | Acres Bias | % of DAS | Acres Bias | % of DAS |
| **Total Land** | | | | |
| Indiana | -410,868 | -2.5% | 1,152,801 | 7.2% (.06) |
| Iowa | -138,997 | -0.9% | 227,346 | 1.2% |
| Minnesota | -118,976 | -0.5% | -425,032 | -1.8% |
| Nebraska | -996,055 | -2.3% | -42,608 | -0.1% |
| Ohio | -121,077 | -0.9% | -262,858 | -1.8% |
| Pennsylvania | -147,802 | -2.4% | -125,074 | -2.0% |
| **Cropland** | | | | |
| Indiana | -658,771 | -5.0% (.12) | 1,012,265 | 8.0% (.03)* |
| Iowa | -178,748 | -1.4% | 432,978 | 3.0% (.10) |
| Minnesota | -61,676 | -0.3% | -558,655 | -3.1% (.12) |
| Nebraska | -107,445 | -0.7% | 367,212 | 1.9% |
| Ohio | -112,221 | -1.0% | 596,544 | 5.6% (.06) |
| Pennsylvania | -113,732 | -2.9% | 51,128 | 1.3% |
| **Wheat Seeded** | | | | |
| Indiana | 17,911 | 1.7% | -49,103 | -6.0% |
| Iowa | -5,922 | -12.2% | -6,570 | -29.0% |
| Minnesota | -1,504 | -1.3% | -29,251 | -25.9% |
| Nebraska | -110,398 | -8.1% (.06) | -21,268 | -0.7% |
| Ohio | -54,906 | -4.0% (.09) | -40,678 | -3.1% |
| Pennsylvania | -19,798 | -21.0% | -414 | -0.3% |
| **Corn Planted** | | | | |
| Indiana | -118,548 | -3.4% | 188,243 | 3.7% |
| Iowa | -13,027 | -0.2% | 102,822 | 1.6% |
| Minnesota | -35,776 | -0.7% | -32,772 | -0.7% |
| Nebraska | 16,324 | 0.3% | 69,381 | 1.1% |
| Ohio | -95,580 | -2.9% | 87,797 | 3.1% |
| Pennsylvania | -40,704 | -3.3% | 22,275 | 2.3% (.01)* |
| **Soybeans Planted** | | | | |
| Indiana | -6,220 | -0.2% | 248,617 | 5.5% (.08) |
| Iowa | -1,364 | -0.0% | 62,648 | 1.5% |
| Minnesota | -69,893 | -1.9% | -63,945 | -1.6% |
| Nebraska | -12,079 | -0.6% | 48,910 | 2.4% |
| Ohio | 97,370 | 2.6% | 60,007 | 1.7% |
| Pennsylvania | -30,618 | -14.0% | -37 | 0.0% |

* indicates significant bias at $\alpha$=.05

**Precision**

The precision of the acreage bias estimates is presented in Table 5. The variance formula for the percent bias can be found in Appendix C. The majority of the reconciled crop acreages indicated zero bias. A relatively small percentage of the responses contributed to the estimated bias for most acreage items. In addition, several large positive biases counterbalanced several large negative biases. This resulted in a small overall bias for that acreage item coupled with a large standard error (SE). This is illustrated in Appendix D where expanded actual bias for soybeans planted in 1988 is relatively small compared to expanded absolute bias.

**Table 5. Precision of crop bias estimates (SPS edited CATI data).**

| Crop | Estimated Percent Bias | Standard Error | 95% Confidence Interval for the Estimated Percent Bias |
|---|---|---|---|
| 1988 | | | |
| Total land | -1.6 | 0.9 | (-3.39, 0.17) |
| Cropland | -1.7 | 1.0 | (-3.67, 0.33) |
| Wheat Seeded | -4.3 | 2.7 | (-9.57, 0.97) |
| Corn Planted | -1.4 | 1.1 | (-3.44, 0.74) |
| Soybeans Planted | -0.1 | 1.4 | (-2.87, 2.63) |
| 1989 | | | |
| Total land | 0.5 | 1.1 | (-1.68, 2.58) |
| Cropland | 2.4 | 1.1 | ( 0.31, 4.53) |
| Wheat Seeded | -2.7 | 3.2 | (-8.91, 3.52) |
| Corn Planted | 1.7 | 0.9 | (-0.12, 3.42) |
| Soybeans Planted | 1.9 | 1.2 | (-0.37, 4.21) |

The widths of the confidence intervals for the estimated percent biases in Table 5 point out a severe lack of precision in the aggregate bias estimates. However, systematic biases apparently do exist and we can estimate their size as shown in the previous section. The lack of precision in their estimation, however, precludes our using these estimates as a direct adjustment to survey indications. Nevertheless, the information in this report can be a useful tool in improving survey procedures, questionnaire design and enumerator training.

Table 6 shows the average absolute biases by crop for all respondents in the survey and for only respondents reporting a bias. The number of respondents reporting a bias represents only a small portion of the total response. Looking at total land in 1988, the average absolute bias for all respondents was 43 acres. The average absolute bias for those reporting a bias was 144 acres.

**Table 6. Average absolute bias (unexpanded) per respondent for all survey respondents and for respondents with a response bias.**

| Crop | Total Number of Respondents | Average Absolute Bias | Number of Respondents with Bias | Average Absolute Bias |
|---|---|---|---|---|
| 1988 | | | | |
| Total Land | 952 | 33 | 308 | 103 |
| Cropland | 951 | 32 | 390 | 77 |
| Wheat Seeded | 954 | 2 | 107 | 22 |
| Corn Planted | 951 | 11 | 258 | 40 |
| Soybeans Planted | 952 | 6 | 224 | 24 |
| 1989 | | | | |
| Total Land | 942 | 43 | 283 | 144 |
| Cropland | 939 | 39 | 358 | 102 |
| Wheat Seeded | 943 | 2 | 97 | 14 |
| Corn Planted | 941 | 8 | 228 | 31 |
| Soybeans Planted | 942 | 6 | 195 | 27 |

**Proportion of Farm Population Studied**

As stated earlier, the reinterview samples were selected from CATI respondents. As such, the samples were restricted representations of the States' farm populations, since NOL area tracts and some list strata were not included in the CATI samples. Table 7 illustrates the reinterview CATI strata expansions as a percent of the total survey expansions. For both years, the CATI strata expansions covered just under 60% of the DAS (list only) total land expansions. However, the CATI strata representation in the overall DAS list expansions is fairly consistent year to year within State and crop classification.

**Table 7. Proportion of operational list expansions for crop acreages represented in the reinterview project, by State and survey period.**

| | CATI Strata Representation in the DAS Expansion 1/ | | | | | | |
|---|---|---|---|---|---|---|---|
| | IN | IA | MN | NE | OH | PA | Total |
| 1988 | | | (Percent) | | | | |
| Total Land | 77.8 | 44.5 | 52.4 | 70.9 | 59.1 | 61.1 | 59.7 |
| Cropland | 78.7 | 45.1 | 69.9 | 76.9 | 73.3 | 72.7 | 66.2 |
| Wheat Seeded | 85.2 | 35.8 | 85.1 | 81.4 | 78.8 | 75.3 | 80.3 |
| Corn Planted | 82.9 | 43.9 | 70.4 | 77.5 | 77.7 | 75.0 | 65.9 |
| Soybeans Planted | 82.9 | 48.4 | 69.4 | 74.2 | 78.1 | 52.7 | 66.0 |
| 1989 | | | | | | | |
| Total Land | 72.5 | 43.5 | 65.3 | 68.6 | 44.1 | 67.7 | 59.2 |
| Cropland | 76.5 | 42.7 | 91.4 | 76.5 | 69.9 | 162.7 | 71.5 |
| Wheat Seeded | 76.8 | 50.5 | 93.8 | 84.5 | 78.4 | 77.4 | 81.0 |
| Corn Planted | 77.6 | 43.0 | 74.1 | 75.5 | 77.1 | 78.6 | 64.3 |
| Soybeans Planted | 77.9 | 42.7 | 73.8 | 80.1 | 80.6 | 76.9 | 65.7 |

1/ (CATI Strata DE ÷ Total List DE) x 100.

Table 8 shows the proportion of the national estimates represented by each State estimate [6,7]. Winter wheat was lightly represented in the sample with only 10% of the crop sown in these six States. Coverage of the winter wheat seeded in the six States was high, with over 80% of the operational expansion coming from the CATI strata. Cropland acreage was omitted from Table 8 because NASS does not make national estimates of cropland acres.

**Table 8. Proportion of national estimate represented by each State in the reinterview study.**

| | State Estimate as a Percent of the National Estimate | | | | | | |
|---|---|---|---|---|---|---|---|
| Crop | IN | IA | MN | NE | OH | PA | 6 States |
| 1988 | | | | | | | |
| Total Land | 1.6 | 3.4 | 3.0 | 4.7 | 1.6 | 0.8 | 15.2 |
| Wheat Seeded | 1.9 | 0.2 | 0.3 | 5.1 | 2.5 | 0.5 | 10.2 |
| Corn Planted | 7.7 | 16.7 | 8.4 | 10.2 | 4.9 | 2.2 | 50.0 |
| Soybeans Planted | 7.3 | 13.7 | 8.3 | 4.1 | 6.6 | 0.4 | 40.2 |
| 1989 | | | | | | | |
| Total Land | 1.7 | 3.4 | 3.0 | 4.8 | 1.6 | 0.8 | 15.2 |
| Wheat Seeded | 1.9 | 0.1 | 0.2 | 4.5 | 2.6 | 0.4 | 9.8 |
| Corn Planted | 7.4 | 17.4 | 8.6 | 10.4 | 4.4 | 1.9 | 50.0 |
| Soybeans Planted | 7.6 | 13.7 | 8.3 | 4.3 | 6.6 | 0.5 | 41.0 |

**Bias Characteristics**

Specific reasons for differences between the original contact and the reinterview responses were provided by the respondent and recorded by the enumerator during the reconciliation process. Reasons were divided into three classes, "definitional", "estimating" and "other". Table 9 shows the frequencies and the average absolute biases by reason class. The frequency is the number of times each reason occurred within each class. The average absolute bias is the average of the absolute values of each unexpanded response bias.

**Table 9. Frequency of bias and average absolute bias by class of reason, "definitional", "estimating", or "other".**

| | Frequency | | | | Average Absolute Bias | | | |
|---|---|---|---|---|---|---|---|---|
| Crop | Def | Est | Oth | Total | Def | Est | Oth | Total |
| 1988 | | | | | | | | |
| Total Land | 98 | 123 | 87 | 308 | 168 | 47 | 110 | 103 |
| Cropland | 96 | 174 | 120 | 390 | 143 | 35 | 86 | 77 |
| Wheat Seeded | 14 | 55 | 38 | 107 | 19 | 15 | 32 | 22 |
| Corn Planted | 39 | 136 | 83 | 258 | 118 | 16 | 44 | 40 |
| Soybeans Planted | 32 | 116 | 76 | 224 | 91 | 20 | 45 | 39 |
| 1989 | | | | | | | | |
| Total Land | 108 | 126 | 49 | 283 | 115 | 32 | 497 | 144 |
| Cropland | 108 | 169 | 81 | 358 | 171 | 62 | 97 | 102 |
| Wheat Seeded | 11 | 55 | 31 | 97 | 55 | 24 | 61 | 39 |
| Corn Planted | 37 | 129 | 62 | 228 | 117 | 18 | 38 | 39 |
| Soybeans Planted | 31 | 113 | 51 | 195 | 95 | 17 | 62 | 41 |

In Table 9, the large "other" average absolute bias in 1989's total land indication came from a large operation in Ohio where the respondent did not remember the CATI interview. "Estimating" reasons accounted for a higher frequency of actual differences but "definitional" reasons accounted for the larger average absolute biases. Table 10 shows the reason class, frequency and biases for total land in 1988 and 1989. The actual bias and absolute bias were calculated by summing the strata level bias expansions for total land.

**Table 10. Bias frequencies by reason class for total land, 1988 and 1989, 6 State total.**

| Reason Class | Frequency Obs | (%) | Actual Bias | Absolute Value Bias | (%) |
|---|---|---|---|---|---|
| **1988** | | | | | |
| Definitional | 98 | (32%) | -535,249 | 3,924,216 | (53%) |
| Estimating | 123 | (40%) | -373,081 | 1,233,825 | (17%) |
| Other | 87 | (28%) | -995,446 | 2,200,807 | (30%) |
| Total | 308 | | -1,903,777 | 7,358,848 | |
| **1989** | | | | | |
| Definitional | 108 | (38%) | 1,537,806 | 5,953,090 | (67%) |
| Estimating | 126 | (45%) | -735,602 | 1,614,356 | (18%) |
| Other | 49 | (17%) | -277,627 | 1,317,148 | (15%) |
| Total | 283 | | 524,577 | 8,884,594 | |

Tables 11 and 12 list each reason that accounted for over 5% of the total land absolute bias for 1988 and 1989. Reasons for biases in cropland, corn and soybeans planted and winter wheat seeded acreages follow a pattern similar to that of the reasons for total land. Bias characteristics for cropland, corn planted, soybean planted, and winter wheat seeded acreages are found in Appendix D.

In both years, the reason "Figure was estimated" had the highest frequency but had little contribution to the actual or absolute bias. The largest portion of the bias for both years resulted from failure to identify the proper reporting unit. The reasons causing the largest absolute bias for both years were associated with determining whether the operation was in or out of business and with determining the correct amount of acreage to include. Both issues deal with the screening questions (Section 1 of the interviewing instrument) and the acres operated (Section 2). The largest individual reporting biases were in Nebraska where 2 respondents incorrectly included their AUM (fee per head basis) pasture in the total farm acres.

**Table 11. Reasons with absolute bias representing over 5% of the total absolute bias for 1988 total land.**

| Reasons | Frequency | Actual Bias | Absolute Bias | % of Absolute Bias |
|---|---|---|---|---|
| Problem determining 'in or out' of business. | 22 | -369,594 | 1,467,917 | 19.9% |
| Respondent gave no explanation. | 28 | -113,010 | 951,544 | 12.9% |
| Did not include acres rented. | 21 | -906,151 | 944,799 | 12.8% |
| Included acres from another operation. | 14 | -809,810 | 883,357 | 12.0% |
| Respondent was fatigued, or hurried on the phone. | 36 | -357,227 | 644,122 | 8.8% |
| Used records for correct answers. | 29 | -124,270 | 396,422 | 5.4% |
| Respondent forgot a field or parcel. | 20 | -379,367 | 379,367 | 5.2% |
| Figure was estimated. | 43 | 168,981 | 371,669 | 5.1% |

**Table 12. Reasons with absolute bias representing over 5% of the total absolute bias for 1989 total land.**

| Reasons | Frequency | Actual Bias | Absolute Bias | % of Absolute Bias |
|---|---|---|---|---|
| Included acres from another operation. | 30 | 2,411,915 | 2,708,327 | 30.5% |
| Problem determining 'in or out' of business. | 8 | -599,541 | 952,685 | 10.7% |
| Used records for correct answers. | 18 | -242,550 | 619,655 | 7.0% |
| Figure was estimated. | 52 | -176,582 | 546,345 | 6.1% |
| Forgot hay, pasture, idle or abandoned acres. | 14 | -477,365 | 492,946 | 5.5% |
| Included AUM pasture acres. | 2 | 491,187 | 491,187 | 5.5% |

In addition to the reasons listed above, there were 20 other reasons in 1988 that covered 17.9% of the absolute bias. In 1989, there were 26 other reasons that accounted for 34.6% of the total absolute bias.

**Bias by Size of Farm**

Crop acreage bias estimates were calculated based on the size of operation. Size groups were based on reconciled total land in farm from the reinterview surveys. The average percent bias by size group in Table 13 is a ratio of absolute crop bias to the reconciled crop acres for that item. Table 13 illustrates that as the size of the farm increased, the average bias also increased.

**Table 13. Average crop bias (unexpanded), by size of operation.**

| Total Land Size Groups | Crop-land Acres | Wheat Seeded Acres | Corn Planted Acres | Soybeans Planted Acres |
|---|---|---|---|---|
| 1988 | | | | |
| 0 - 99 | 6.4 | 0.7 | 4.2 | 5.4 |
| 100 - 249 | 9.8 | 0.6 | 4.1 | 2.6 |
| 250 - 499 | 33.5 | 1.4 | 11.6 | 8.9 |
| 500 - 999 | 35.3 | 1.7 | 13.5 | 11.6 |
| 1000+ | 79.0 | 9.9 | 26.9 | 19.8 |
| Missing 1/ | 14.6 | 25.0 | 20.0 | 50.0 |
| 1989 | | | | |
| 0 - 99 | 10.5 | 0.2 | 1.4 | 1.2 |
| 100 - 249 | 12.8 | 1.1 | 6.4 | 5.3 |
| 250 - 499 | 25.9 | 0.8 | 5.4 | 5.0 |
| 500 - 999 | 43.9 | 2.9 | 14.3 | 15.1 |
| 1000+ | 126.0 | 19.9 | 24.8 | 19.9 |
| Missing 1/ | 0.0 | 0.0 | 0.0 | 0.0 |

1/Total land acres were missing but crop biases were present.

Table 14 shows that the amount of bias is larger in the smaller farms relative to the amount of crop acres present. Since small farms usually fall into the lower strata that have large expansion factors, their reporting biases have a large influence on survey expansions.

**Table 14. Bias acres as a percent of crop acres, by size of operation.**

| Total Land Size Groups | Crop-land % | Wheat Seeded % | Corn Planted % | Soybeans Planted % |
|---|---|---|---|---|
| 1988 | | | | |
| 0 - 99 | 71.2 | 7.5 | 87.4 | 135.0 |
| 100 - 249 | 7.4 | 10.2 | 8.0 | 8.3 |
| 250 - 499 | 11.6 | 13.3 | 10.0 | 12.3 |
| 500 - 999 | 6.2 | 5.6 | 6.3 | 7.5 |
| 1000+ | 7.0 | 10.3 | 7.1 | 8.5 |
| Missing 1/ | 26.9 | 66.7 | 9.9 | 29.4 |
| 1989 | | | | |
| 0 - 99 | 48.4 | 23.5 | 28.1 | 26.1 |
| 100 - 249 | 9.9 | 17.7 | 13.6 | 16.6 |
| 250 - 499 | 9.9 | 8.1 | 5.0 | 6.7 |
| 500 - 999 | 8.1 | 10.1 | 6.3 | 9.1 |
| 1000+ | 10.2 | 12.0 | 7.1 | 9.4 |
| Missing 1/ | 0.0 | 0.0 | 0.0 | 0.0 |

1/Total land acres were missing but crop biases were present.

## DISCUSSION

The purpose of the reinterview surveys is to search for biases in the Agricultural Survey data, measure their magnitude if biases exist and identify the reasons for biases. Categories were created to characterize biases with respect to population coverage and size of farm. Previously, biases were observed and measured in the hog data [5] and in the grain stocks data [3,4] of the AS. These reports indicated biases were present in the grain stocks and hogs data series from underreported survey data. While bias appears to be present in the AS crop acreage indications as well, the actual level of bias is difficult to ascertain given the low level of precision in our bias estimates. Complete check data are not available for most crop acreages.

The biases found in the 1988 and 1989 Reinterview Surveys' acreage data are only approximations. Bias estimates were relatively small at the six State level for acreage items, ranging from -4.3% for wheat seeded in 1988 to 2.4% for cropland in 1989. Standard errors were large relative to the estimated biases. The standard errors were governed by a minority of large negative and positive differences surrounding a majority of zero or near zero biases, and their magnitudes limit any inferences about the effect of bias on the official estimates. Many other characteristics of the indicated biases were identified in the analysis, which can serve as a basis for future survey improvements and possible questionnaire redesign.

The samples for the reinterview surveys taken from the CATI responses, do not fully represent the DAS sample in any of the six States. All NOL area frame records and EO strata were excluded. CATI sample sizes are not easily manipulated, since CATI capabilities are dictated by office space, telephone connections, computer hardware, and enumerator staffing within each State Statistical Office. Larger samples should include area frame NOL and other non-CATI respondents, giving us a truer representation of the AS sample. Including more States in the project would broaden the coverage of the survey and would account for more major crop acreages. Comparing Table 2 (sample sizes and responses) and Table 7, indicates that the CATI strata for the reinterview States cover a majority (nearly 60% in both years) of their respective total land survey expansions, but represent only 38% of the total DAS responses in 1988 and 46% in 1989. Previous papers [3,4,5] have recommended greater coverage for the reinterview sample to improve the reliability of the bias estimates. The results from this analysis also point out the need for a larger and broader sample size in future reinterview studies.

The estimated total land biases in both years were relatively small, -1.6% in 1988 and 0.5% in 1989. These differences were not statistically significant. State level biases ranged from -2.5% to 1.2%, excluding Indiana's estimated bias of 7.2% explained earlier in the paper. The Indiana cropland bias illustrates the influence a few large errors can have on the reinterview data.

Looking at the tables in Appendix D, "definitional" reasons accounted for the greatest portion of the absolute bias in both years. These were the major contributors to the large CV's for the estimated total land bias. The largest biases resulted from including AUM acres in the total acres operated. The most frequent definitional reason across both years of the survey was "Included acres from another operation.", occurring 44 times, with an average absolute bias of 388 acres. This reason as well as other definitional reasons (Appendix D, Table 1 and Table 6) imply that the inclusions/exclusions from Section 2 (Acres Operated) in the interviewing instrument need to be emphasized by the enumerator during the interview.

Winter wheat seedings are initially set using the indications from end-of-season acreage surveys. Prior to 1987, the main vehicle for making the estimate was the December Enumerative Survey. Since the inception of the DAS in 1987, the six States' winter wheat seeded acres have been reported on the DAS. The estimated biases in this report for winter wheat seedings are negative for both years,making winter wheat the only crop to exhibit this consistency. The six States in the study account for about 10% of the national winter wheat seeded. The CATI strata expansions in the six States represented over 80% of their overall DAS expansions. Unlike corn and soybeans, the wheat seeded acreage bias came mostly from "estimating" and "other" type errors. A likely reason for a lower "definitional" type bias for winter wheat was a shorter recall time for this crop relative to that for either corn or soybeans. Winter wheat seedings are normally completed by early November.

Corn and soybean planted acreage biases, under 2% of the DAS expansions for each crop in both years, were not significant at the six State level. At the State level, Pennsylvania's 1989 corn planted acreage showed the only significant difference. The six State level bias for both corn and soybeans changed sign from negative (underreporting) in 1988 to positive (overreporting) in 1989. Treating each reinterview sample independently, a 95% confidence interval for the difference between the 1988 bias and the 1989 bias includes zero, indicating that the biases were not significantly different from 1988 to 1989 for corn and soybeans. Again, any inferences about the magnitude of the biases are weak due to a lack of estimation precision.

Total "definitional" bias was positive for all crop items, except for total land in 1988 where "definitional" bias was negative and "other" bias was dominant. This indicates overreporting generally occurred when "definitional" rules were broken. Many of the "definitional" errors may be corrected through training, interviewing instrument redesign or survey design improvements. Many of the "definitional" errors made in the DAS resulted from problems with Sections 1 and 2 of the interviewing instrument. The screening questions in the front of the instrument need to be emphasized for the sampled name. The inclusion/exclusion statements in Section 2 should be more noticeable.

Total "estimating" bias was negative in most cases, showing that when a respondent estimates, they tend to underreport their acreages. The "estimating" type errors were the most frequent, but had the smallest impact on overall bias compared to "definitional" and "other" type errors. "Estimating" errors will occur to some extent in any survey regardless of the amount of training and for any survey design. "Other" errors are also to some degree inevitable and depend on the respondent or enumerator action during the course of the CATI interview or face-to-face reinterview.

Minnesota was the only State to exhibit negative biases for both years, but it is difficult to draw inferences since the biases are not significant given the lack of estimation precision. However, unlike the characteristics of the other five States, reasons for differences in Minnesota showed that "estimating" type errors accounted for most of the bias.

## RECOMMENDATIONS

Statistically significant differences at the six State level were not evident for any crops in either year's reinterview survey because the precision of the bias estimates was less than desirable. If the bias estimates are to be used as a tool by the Agricultural Statistics Board in estimating acreages, the bias estimating precision must be increased. Larger sample sizes will be necessary to achieve this goal. Non-CATI respondents, including NOL samples, should be eligible for reinterview sample selection. More States should be included in the survey in order to broaden the coverage of major crop acreages.

Reinterviews following the DAS should continue since DAS acreage indications continue to be a concern. The change in estimated bias in the reinterview survey from year to year was not significant nor was it consistent. Bias measurement should continue on a regular basis so that data series can be developed over time.

Failure to identify the proper operating unit leads to many of the "definitional" errors for crop acreages. The interviewing instrument should highlight "The name or operation sampled." in each of the screening questions and stress the "land operated" reporting concept.

The "Include" and "Exclude" statements in Section 2 of the interviewing instrument should be highlighted. Enumerators should place heavy emphasis on obtaining the correct total acreage, since errors in Section 2 can invalidate all data collected in subsequent sections.

## REFERENCES


1. Cochran, W. G. (1977). Sampling Techniques, Third edition, Wiley & Sons, New York.

2. Fahimi, M., Kasala, S., Fecso, R. (1990). "Hypothesis Testing for Multivariate Stratified Sampling", draft paper, National Agricultural Statistics Service, U.S. Department of Agriculture.

3. Pafford, B. (1989). "USE OF REINTERVIEW TECHNIQUES FOR QUALITY ASSURANCE: The Measurement of Response Bias in the Collection of December 1987 Quarterly Grain Stocks Data Using CATI", SRB Research Report Number SRB-89-08, National Agricultural Statistics Service, U.S. Department of Agriculture.

4. McClung, G., Tolomeo, V., Pafford, B. (1990). "The Measurement of Response Bias in March 1988 Quarterly On-Farm Grain Stocks Data", SRB Research Report Number SRB-90-09, National Agricultural Statistics Service, U.S. Department of Agriculture.

5. Tolomeo, V., McClung, G. (1990). "Response Bias in the Quarterly Agricultural Survey Hog Data: December 1987 and March 1988", SRB Research Report Number-90-12, National Agricultural Statistics Service, U.S. Department of Agriculture.

6. Agricultural Statistics Board (1989). "Crop Production, 1988 Annual Summary", Publication CrPr 2-1 (89), National Agricultural Statistics Service, U.S. Department of Agriculture.

7. Agricultural Statistics Board (1990). "Crop Production, 1989 Annual Summary", Publication CrPr 2-1 (90), National Agricultural Statistics Service, U.S. Department of Agriculture.

8. Warren, F., (1991). "June 1990 Reinterview Survey, Acreage Analysis" draft paper, National Agricultural Statistics Service, U.S. Separtment of Agriculture.

## SECTION 2 - ACRES OPERATED

| | Acres |
|---|---|
| 1. How many total acres of land were in this operation on December 1? | 900 |

**Include:** Farmstead, all cropland, woodland, pastureland, wasteland, government program land, all land owned, rented or managed.

**Exclude:** Land rented to others and all grazing land used on an AUM *(fee per head)* basis.

| | |
|---|---|
| 2. Of the total acres in this operation, how many acres would be considered cropland, including land in hay and cropland in government programs? | 802 |

## SECTION 3 - CROPS

19

**How to complete this section.**
- - Report for all the land you operate, including land rented from others
- - If harvest is not complete, make your best estimate of acres and total production.
- - Production is equal to acres harvested and to be harvested times average yield per acre.
- - Total production should include the landlord's share.

1. The following information is needed for **CROPS HARVESTED DURING 1989**

**CORN** *(exclude popcorn and sweet corn)*:

| | | |
|---|---|---|
| a. Acres planted for all purposes | *acres* | 530 |
| b. Acres harvested and to be harvested for grain *(exclude seed corn)* | *acres* | 400 |
| c. Total grain production *(exclude seed corn)* | *bushels* | 401 |
| d. Acres harvested for seed corn | *acres* | 398 |
| e. Total seed corn production | *bushels* | 399 |

**SOYBEANS**:

| | | |
|---|---|---|
| f. Acres planted for all purposes | *acres* | 600 |
| g. Acres harvested and to be harvested for beans | *acres* | 763 |
| h. Total production | *bushels* | 227 |

2. Please report **WINTER WHEAT** seedings for the **1990 CROP YEAR.**

| | | |
|---|---|---|
| **WINTER WHEAT** acres seeded and to be seeded for all purposes | *acres* | 836 |

**Continue On Next Page**

## SECTION 2 - ACRES OPERATED

| | Acres |
|---|---|
| 1. How many total acres of land were in this operation on December 1? | 900 |

Include: Farmstead, all cropland, woodland, pastureland, wasteland, government program land, all land owned, rented or managed.

Exclude: Land rented to others and all grazing land used on an AUM *(fee per head)* basis.

| | |
|---|---|
| 2. Of the total acres in this operation, how many acres would be considered cropland, including land in hay and cropland in government programs? | 802 |

## SECTION 3 - CROPS

27

**How to complete this section.**
- - Report for all the land you operate, including land rented from others.
- - If harvest is not complete, make your best estimate of acres and total production.
- - Production is equal to acres harvested and to be harvested times average yield per acre.
- - Total production should include the landlord's share.

1. For the following **SMALL GRAIN CROPS**, please report for the **1989 CROP YEAR**.

| | | |
|---|---|---|
| **SPRING WHEAT:** | | |
| a. Acres planted for all purposes this past spring | *acres* | 550 |
| **OATS:** | | |
| b. Acres planted for all purposes this past fall or spring | *acres* | 533 |

2. The following information is needed for crops harvested during **1989**.

| | | |
|---|---|---|
| **CORN** *(exclude popcorn and sweet corn)*: | | |
| a. Acres planted for all purposes | *acres* | 530 |
| b. Acres harvested and to be harvested for grain and seed | *acres* | 531 |
| c. Total grain and seed production | *bushels* | 370 |
| **SOYBEANS:** | | |
| d. Acres planted for all purposes | *acres* | 600 |
| e. Acres harvested and to be harvested for beans | *acres* | 763 |
| f. Total production | *bushels* | 227 |

3. Please report **WINTER WHEAT** seedings for the **1990 CROP YEAR.**

| | | |
|---|---|---|
| **WINTER WHEAT** acres seeded and to be seeded for all purposes | *acres* | 836 |

**Continue On Next Page**

## SECTION 2 - ACRES OPERATED

| | Acres |
|---|---|
| 1. How many **total acres of land** were in this operation on **December 1**? | 900 |

**Include:** Farmstead, all cropland, woodland, pastureland, wasteland, government program land, all land owned, rented or managed.

**Exclude:** Land rented to others and all grazing land used on an AUM *(fee per head)* basis.

| | |
|---|---|
| 2. Of the total acres in this operation, how many acres would be considered cropland, including land in hay and cropland in government programs? | 802 |

## SECTION 3 - CROPS

31

**How to complete this section.**
- - Report for all the land you operate, including land rented from others.
- - If harvest is not complete, make your best estimate of acres and total production.
- - Production is equal to acres harvested and to be harvested times average yield per acre.
- - LAND IRRIGATED should include all land watered one or more times for the 1989 crop.
- - Report acreage and production for both irrigated and non-irrigated crops when listed separately.
- - Total production should include the landlord's share.

1. The following information is needed for **CROPS HARVESTED DURING 1989**.

| **CORN** *(exclude popcorn and sweet corn)*: | Non-Irrigated | Irrigated |
|---|---|---|
| a. Acres planted for all purposes | 532 ac | 621 ac |
| b. Acres harvested and to be harvested for grain and seed | 538 ac | 544 ac |
| c. Total grain and seed production | 372 bu | 371 bu |

| **SOYBEANS**: | Non-Irrigated | Irrigated |
|---|---|---|
| d. Acres planted for all purposes | 761 ac | 622 ac |
| e. Acres harvested and to be harvested for beans | 226 ac | 225 ac |
| f. Total production | 229 bu | 228 bu |

2. Please report **WINTER WHEAT** seedings for the **1990 CROP YEAR**.

| | |
|---|---|
| **WINTER WHEAT** acres seeded and to be seeded for all purposes | 836 ac |

**Continue On Next Page**

## SECTION 2 - ACRES OPERATED

| | Acres |
|---|---|
| 1. How many total acres of land were in this operation on December 1? | 900 |

**Include:** Farmstead, all cropland, woodland, pastureland, wasteland, government program land, all land owned, rented or managed.

**Exclude:** Land rented to others and all grazing land used on an AUM *(fee per head)* basis.

| | |
|---|---|
| 2. Of the total acres in this operation, how many acres would be considered cropland, including land in hay and cropland in government programs? | 802 |

## SECTION 3 - CROPS

39

**How to complete this section.**
- - Report for all the land you operate, including land rented from others.
- - If harvest is not complete, make your best estimate of acres and total production.
- - Production is equal to acres harvested and to be harvested times average yield per acre.
- - Total production should include the landlord's share.

1. The following information is needed for **CROPS HARVESTED DURING 1989**.

**CORN** *(exclude popcorn and sweet corn)*:

| | |
|---|---|
| a. Acres planted for all purposes ..... *acres* | 530 |
| b. Acres harvested and to be harvested for grain and seed ..... *acres* | 531 |
| c. Total grain and seed production ..... *bushels* | 370 |

**SOYBEANS**:

| | |
|---|---|
| d. Acres planted for all purposes ..... *acres* | 600 |
| e. Acres harvested and to be harvested for beans ..... *acres* | 763 |
| f. Total production ..... *bushels* | 227 |

2. Please report **WINTER WHEAT** seedings for the **1990 CROP YEAR.**

| | |
|---|---|
| **WINTER WHEAT** acres seeded and to be seeded for all purposes ..... *acres* | 836 |

**Continue On Next Page**

## SECTION 2 - ACRES OPERATED

| | Acres |
|---|---|
| 1. How many total acres of land were in this operation on December 1? | 900 |

**Include:** Farmstead, all cropland, woodland, pastureland, wasteland, government program land, all land owned, rented or managed.

**Exclude:** Land rented to others and all grazing land used on an AUM *(fee per head)* basis.

| | |
|---|---|
| 2. Of the total acres in this operation, how many acres would be considered cropland, including land in hay and cropland in government programs? | 802 |

## SECTION 3 - CROPS

42

**How to complete this section.**
- - Report for all the land you operate, including land rented from others
- - If harvest is not complete, make your best estimate of acres and total production.
- - Production is equal to acres harvested and to be harvested times average yield per acre.
- - Total production should include the landlord's share.

1. The following information is needed for **CROPS HARVESTED DURING 1989**.

**CORN** *(exclude popcorn and sweet corn)*:

| | |
|---|---|
| a. Acres planted for all purposes | 530 ac |
| b. Acres harvested and to be harvested for dry grain | 369 ac |
| c. Total dry grain production | 382 bu |
| d. Acres harvested for high moisture shelled corn *(usually 24 - 30% moisture)* | 383 ac |
| e. Total high moisture shelled corn production | 384 bu |
| f. Acres harvested for ground high moisture ear corn | 386 ac |
| g. Total ground high moisture ear corn production | 387 bu |

**SOYBEANS**:

| | |
|---|---|
| h. Acres planted for all purposes | 600 ac |
| i. Acres harvested and to be harvested for beans | 763 ac |
| j. Total production | 227 bu |

2. Please report **WINTER WHEAT** seedings for the **1990 CROP YEAR.**

| | |
|---|---|
| **WINTER WHEAT** acres seeded and to be seeded for **all purposes** | 836 ac |

**Continue On Next Page**

**Appendix B:** Stratified Multivariate and Univariate Tests

Stratified Multivariate Test: [2]

$H_o$: $\mu = \mu_o$ *vs* $H_A$: $\mu \neq \mu_o$

*If* $T^2 > \chi^2_p(\alpha)$ *then reject* $H_o$

$$T^2 = (\bar{\boldsymbol{x}} - \mu_o)\, \boldsymbol{S}^{-1} (\bar{\boldsymbol{x}} - \mu_o)'$$

where

$\bar{\boldsymbol{x}}$, $\mu$ are (1 x p) row vectors

$$\bar{\boldsymbol{x}} = \sum_{h=1}^{L} W_h \, \bar{\boldsymbol{x}}_h \qquad W_h = \frac{N_h}{N}$$

$$\bar{\boldsymbol{x}}_h = \frac{1}{n_h} \, \mathbf{1}'_{n_h} \boldsymbol{x}_h$$

$$\boldsymbol{S} = \sum_{h=1}^{L} W_h^2 (1 - f_h) \frac{1}{n_h} \, \boldsymbol{S}_h \qquad f_h = \frac{n_h}{N_h}$$

$$\boldsymbol{S}_h = \frac{1}{n_h - 1} (\boldsymbol{x}_h - \mathbf{1}_{n_h} \bar{\boldsymbol{x}}_h)' (\boldsymbol{x}_h - \mathbf{1}_{n_h} \bar{\boldsymbol{x}}_h)$$

$\boldsymbol{x}_h$ = an ($n_h$ x p) matrix of observations on p variables for stratum h

$\mathbf{1}_{n_h}$ = an ($n_h$ x 1) vector of 1's

Stratified Univariate Test:

$H_o: \mu = \mu_o \qquad vs \qquad H_A: \mu \neq \mu_o$

*if* $z > Z_{\frac{\alpha}{2}}$ *then reject* $H_o$

$$z = \frac{\hat{x}_{st} - \mu_o}{\sqrt{Var(\hat{x}_{st})}}$$

$$\hat{x}_{st} = \sum_{h=1}^{L} N_h \bar{x}_h \qquad \bar{x}_h = \frac{1}{n} \sum_{i=1}^{n_h} x_{hi}$$

$$Var(\hat{x}_{st}) = \sum_{h=1}^{L} N_h (N_h - n_h) \frac{s_h^2}{n_h} \qquad s_h^2 = \frac{1}{n_h - 1} \sum_{i=1}^{n_h} (x_{hi} - \bar{x}_h)^2$$

**Appendix C:** Variance Computation of the Percent Bias

The variance of the percent bias was calculated from the formula for a combined ratio estimate as described in Cochran [1].

$$V(\hat{R}) = \frac{\sum_{h=1}^{L}\left(\frac{N_h(N_h-n_h)}{n_h(n_h-1)}\sum_{i=1}^{n_h}(u_{hi}-\bar{u}_h)^2\right)}{(\sum_{h=1}^{L}N_h\bar{x}_h)^2}$$

where

$\hat{R}$ = Proportion of total bias to crop acreage (percent bias)

$$\hat{R}=\frac{\hat{Y}}{\hat{X}}$$

$f_h = n_h/N_h$

$$\hat{Y}=\sum_{h=1}^{L}N_h\bar{y}_h \qquad \bar{y}_h=\frac{\sum_{i=1}^{n_h}y_{hi}}{n_h}$$

$$\hat{X}=\sum_{h=1}^{L}N_h\bar{x}_h \qquad \bar{x}_h=\frac{\sum_{i=1}^{n_h}x_{hi}}{n_h}$$

$u_{hi} = y_{hi} - \hat{R}x_{hi}$

$y_{hi}$ = bias for $i^{th}$ observation in stratum h

$x_{hi}$ = crop acreage for $i^{th}$ observation in stratum h

**Appendix D.** Reinterview Survey Bias Reasons Summary (Six State Level).

Table 1. 1988 Total Land Bias by Reason

| Total Land Bias by Class | Frequency | Actual Bias (expanded) | Absolute Bias (expanded) | Average Abs. Bias (unexp) |
|---|---|---|---|---|
| Total Definitional Bias | 98 | -535,249 | 3,924,216 | 168 |
| Total Estimating Bias | 123 | -373,081 | 1,233,825 | 47 |
| Total Other Bias | 87 | -995,446 | 2,200,807 | 110 |
| Total | 308 | -1,903,848 | 7,358,848 | 103 |

| | Frequency | Average Absolute Bias (unexp) |
|---|---|---|
| Definitional Bias | | |
| Didn't report for name on label. | 2 | 514 |
| Included acres from another operation. | 14 | 438 |
| Problem determining 'in or out' of business. | 22 | 193 |
| Didn't include acres rented. | 21 | 144 |
| Included acres rented out. | 10 | 113 |
| Reported crop acres not total acres. | 2 | 90 |
| Forgot CRP acres and/or cover crop acres. | 1 | 30 |
| Didn't include silage acres. | 2 | 30 |
| Did not report as of December 1. | 3 | 28 |
| Forgot hay, pasture, abandoned and/or idle acres. | 19 | 28 |
| Problem with include/exclude of woods and waste. | 1 | 23 |
| Late planted acres were not included. | 1 | 7 |
| Estimational Bias | | |
| Forgot a field or parcel of land. | 20 | 79 |
| Used records for correct answer. | 29 | 62 |
| Figure was estimated. | 43 | 46 |
| Either answer was right. | 18 | 19 |
| Rounding. | 13 | 6 |
| Other Bias | | |
| Enumerator asked question wrong. | 3 | 353 |
| Respondent can't remember phone interview. | 4 | 202 |
| Respondent can't hear on the phone. | 1 | 192 |
| Respondent gave no explanation. | 28 | 138 |
| Respondent fatigued. | 36 | 90 |
| Respondent reported for wrong year. | 1 | 45 |
| Respondent thought it was reported the first time. | 4 | 42 |
| Respondent does not give accurate data on phone. | 2 | 23 |
| Enumerator did not reconcile. | 6 | 15 |
| Respondent did not think it was enough to report. | 2 | 9 |

**Appendix D.** Reinterview Survey Bias Reasons Summary (Six State Level).

Table 2. 1988 Cropland Bias by Reason

| Cropland Bias by Class | Frequency | Actual Bias (expanded) | Absolute Bias (expanded) | Average Abs. Bias (unexpanded) |
|---|---|---|---|---|
| Total Definitional Bias | 96 | 420,478 | 2,630,308 | 143 |
| Total Estimating Bias | 174 | -845,399 | 1,592,825 | 35 |
| Total Other Bias | 120 | -807,673 | 2,383,063 | 86 |
| Total | 390 | -1,232,594 | 6,606,196 | 77 |

| | Frequency | Average Absolute Bias (unexpanded) |
|---|---|---|
| Definitional Bias | | |
| Included acres from another operation. | 13 | 354 |
| Didn't report for name on label. | 4 | 202 |
| Problem determining 'in or out' of business. | 19 | 201 |
| Late planted acres not included. | 5 | 134 |
| Forgot CRP acres and/or cover crop acres. | 11 | 111 |
| Included acres rented out | 7 | 86 |
| Didn't include acres rented. | 16 | 78 |
| Forgot hay, pasture, abandoned and/or idle acres. | 6 | 53 |
| Did not report as of December 1. | 2 | 46 |
| Did not include silage acres. | 2 | 30 |
| Problem with include/exclude of woods & waste. | 8 | 28 |
| Included only acres owned, not operated. | 1 | 10 |
| Included only acres harvested, not planted. | 2 | 9 |
| Estimational Bias | | |
| Forgot a field or parcel of land. | 9 | 138 |
| Figure was estimated. | 71 | 38 |
| Used records for correct answer. | 53 | 32 |
| Either answer was right. | 26 | 15 |
| Rounding problem. | 15 | 11 |
| Other Bias | | |
| Enumerator asked question wrong. | 4 | 250 |
| Respondent can't remember phone interview. | 3 | 179 |
| Respondent can't hear on the phone. | 2 | 124 |
| Respondent fatigue. | 45 | 89 |
| Respondent gave no explanation. | 44 | 88 |
| Respondent forgot to report the first time. | 3 | 63 |
| Respondent reported for wrong year. | 1 | 60 |
| Respondent does not give accurate data on phone | 2 | 50 |
| Enumerator did not reconcile. | 5 | 41 |
| Respondent thought it was reported the first time. | 9 | 17 |
| Respondent did not think it was enough to report. | 2 | 7 |

**Appendix D.** Reinterview Survey Bias Reasons Summary (Six State Level).

Table 3. 1988 Wheat Seeded Bias by Reason

| Winter Wheat Seeded Bias by Class | Frequency | Actual Bias (expanded) | Absolute Bias (expanded) | Average Abs. Bias (unexpanded) |
|---|---|---|---|---|
| Total Definitional Bias | 14 | 340 | 44,305 | 19 |
| Total Estimating Bias | 55 | -8,918 | 202,433 | 15 |
| Total Other Bias | 38 | -166,039 | 243,908 | 32 |
| Total | 107 | -174,617 | 490,646 | 22 |

| | Frequency | Average Absolute Bias (unexpanded) |
|---|---|---|
| Definitional Bias | | |
| Included acres from another operation. | 1 | 38 |
| Problem determining 'in or out' of business. | 5 | 23 |
| Included acres rented out. | 4 | 20 |
| Forgot CRP acres and/or cover crop acres. | 1 | 6 |
| Problem with include/exclude woods and waste. | 2 | 5 |
| Did not report as of December 1. | 1 | 5 |
| Estimational Bias | | |
| Forgot a field or parcel of land. | 6 | 25 |
| Used records for correct answer.. | 13 | 23 |
| Figure was estimated. | 26 | 13 |
| Rounding problem. | 5 | 2 |
| Either answer was right. | 5 | 2 |
| Other Bias | | |
| Respondent forgot to report the first time. | 4 | 126 |
| Enumerator asked question wrong. | 3 | 61 |
| Respondent does not give accurate data on phone. | 3 | 46 |
| Respondent was not asked question on the phone. | 2 | 31 |
| Enumerator had problem with the computer. | 2 | 22 |
| Respondent gave no explanation. | 10 | 14 |
| Respondent fatigue. | 13 | 14 |
| Respondent did not think it was enough to report. | 1 | 10 |

**Appendix D.** Reinterview Survey Bias Reasons Summary (Six State Level).

Table 4. 1988 Corn Planted Bias by Reason

| Corn Planted Bias by Class | Frequency | Actual Bias (expanded) | Absolute Bias (expanded) | Average Abs. Bias (unexpanded) |
|---|---|---|---|---|
| Total Definitional Bias | 39 | 135,864 | 788,083 | 118 |
| Total Estimating Bias | 136 | - 79,780 | 496,150 | 16 |
| Total Other Bias | 83 | -413,392 | 795,014 | 44 |
| Total | 258 | -357,309 | 2,079,248 | 40 |

| | Frequency | Average Absolute Bias (unexpanded) |
|---|---|---|
| Definitional Bias | | |
| Didn't report for name on label. | 1 | 615 |
| Included acres from another operation | 9 | 236 |
| Problem determining 'in or out' of business. | 13 | 106 |
| Didn't include acres rented. | 9 | 39 |
| Included acres rented out. | 3 | 35 |
| Didn't include silage acres. | 2 | 19 |
| Problem with include/exclude woods and waste. | 1 | 14 |
| Reported acres harvested not planted. | 1 | 2 |
| Estimational Bias | | |
| Forgot a field or parcel of land. | 9 | 55 |
| Used records for correct answer. | 34 | 15 |
| Figure was estimated. | 63 | 15 |
| Either answer was right. | 15 | 14 |
| Rounding problem. | 15 | 2 |
| Other Bias | | |
| Respondent forgot to report the first time. | 1 | 198 |
| Respondent couldn't hear on the phone. | 1 | 133 |
| Reported for wrong year. | 1 | 100 |
| Enumerator asked question wrong. | 5 | 98 |
| Respondent can't remember phone interview. | 3 | 86 |
| Enumerator had problem with the computer. | 1 | 50 |
| Respondent fatigue. | 34 | 41 |
| Respondent gave no explanation. | 25 | 32 |
| Enumerator did not reconcile. | 6 | 23 |
| Respondent thought they reported the first time. | 5 | 11 |
| Respondent does not give accurate data on phone. | 1 | 10 |

**Appendix D.** Reinterview Survey Bias Reasons Summary (Six State Level).

Table 5. 1988 Soybeans Planted Bias by Reason

| Soybeans Planted Bias by Class | Frequency | Actual Bias (expanded) | Absolute Bias (expanded) | Average Abs. Bias (unexpanded) |
|---|---|---|---|---|
| Total Definitional Bias | 32 | 192,823 | 577,175 | 91 |
| Total Estimating Bias | 116 | 78,015 | 507,652 | 20 |
| Total Other Bias | 76 | -293,642 | 679,571 | 45 |
| Total | 224 | - 22,804 | 1,764,398 | 39 |

| | Frequency | Average Absolute Bias (unexpanded) |
|---|---|---|
| Definitional Bias | | |
| Included acres from another operation | 8 | 140 |
| Problem determining 'in or out' of business. | 15 | 96 |
| Didn't include acres rented. | 5 | 54 |
| Didn't include double crop acres. | 1 | 30 |
| Included acres rented out. | 1 | 20 |
| Reported acres harvested not planted. | 1 | 1 |
| Estimational Bias | | |
| Forgot a field or parcel of land. | 10 | 39 |
| Used records for correct answer. | 34 | 23 |
| Figure was estimated. | 46 | 20 |
| Either answer was right. | 12 | 10 |
| Rounding problem. | 14 | 6 |
| Other Bias | | |
| Enumerator asked question wrong. | 2 | 215 |
| Respondent can't remember phone interview. | 2 | 83 |
| Respondent fatigue. | 31 | 46 |
| Respondent gave no explanation. | 24 | 43 |
| Respondent couldn't hear on the phone. | 3 | 33 |
| Enumerator did not reconcile. | 4 | 31 |
| Respondent forgot to report the first time. | 3 | 27 |
| Respondent does not give accurate data on phone. | 3 | 20 |
| Respondent forgot to report. | 2 | 12 |
| Respondent did not think it was enough to report. | 2 | 7 |

**Appendix D.** Reinterview Survey Bias Reasons Summary (Six State Level).

Table 6. 1989 Total Land Bias by Reason

| Total Land Bias by Class | Frequency | Actual Bias (expanded) | Absolute Bias (expanded) | Average Abs. Bias (unexpanded) |
|---|---|---|---|---|
| Total Definitional Bias | 108 | 1,537,806 | 5,953,090 | 115 |
| Total Estimating Bias | 126 | -735,602 | 1,614,356 | 32 |
| Total Other Bias | 49 | -277,626 | 1,317,148 | 497 |
| Total | 283 | 524,577 | 8,884,594 | 144 |

| | Frequency | Average Absolute Bias (unexpanded) |
|---|---|---|
| Definitional Bias | | |
| Included AUM pasture acres. | 2 | 1418 |
| Did not report as of December 1. | 4 | 382 |
| Included acres from another operation | 30 | 364 |
| Problem determining 'in or out' of business. | 8 | 280 |
| Forgot hay, pasture, abandoned and/or idle acres. | 14 | 148 |
| Didn't include rented acres. | 14 | 124 |
| Included acres rented out. | 15 | 96 |
| Forgot CRP acres and/or cover crop acres. | 2 | 33 |
| Problem determining correct partnership data. | 1 | 29 |
| Problem with include/exclude woods and waste. | 11 | 27 |
| Didn't report for name on label. | 1 | 26 |
| Reported crop acres not total acres. | 5 | 21 |
| Late planted acres were not included. | 1 | 3 |
| Estimational Bias | | |
| Used records for correct answer. | 18 | 181 |
| Forgot a field or parcel of land. | 19 | 140 |
| Figure was estimated. | 54 | 68 |
| Either answer was right. | 17 | 13 |
| Rounding problem. | 18 | 9 |
| Other Bias | | |
| Respondent can't remember phone interview. | 1 | 1710 |
| Enumerator recorded answer incorrectly. | 4 | 529 |
| Respondent fatigue. | 5 | 253 |
| Respondent does not give accurate data on phone. | 3 | 133 |
| Respondent can't hear on the phone. | 2 | 101 |
| Enumerator asked question wrong. | 6 | 71 |
| Respondent thought they reported the first time. | 8 | 66 |
| Respondent gave no explanation. | 6 | 66 |
| Respondent added wrong. | 9 | 53 |
| Respondent said they were not asked on the phone. | 1 | 33 |
| Enumerator forgot to ask. | 2 | 25 |
| Enumerator did not reconcile. | 1 | 21 |
| Respondent did not think it was enough to report. | 1 | 1 |

**Appendix D.** Reinterview Survey Bias Reasons Summary (Six State Level).

Table 7. 1989 Cropland Bias by Reason

| Cropland Bias by Class | Frequency | Actual Bias (expanded) | Absolute Bias (expanded) | Average Abs. Bias (unexpanded) |
|---|---|---|---|---|
| Total Definitional Bias | 108 | 2,137,279 | 4,422,573 | 171 |
| Total Estimating Bias | 169 | -128,975 | 1,914,092 | 62 |
| Total Other Bias | 81 | -106,833 | 1,799,473 | 97 |
| Total | 358 | 1,901,471 | 8,136,138 | 102 |

| | Frequency | Average Absolute Bias (unexpanded) |
|---|---|---|
| Definitional Bias | | |
| Included acres from another operation | 23 | 362 |
| Problem with include/exclude woods and waste. | 2 | 354 |
| Did not report as of December 1. | 5 | 339 |
| Problem determining 'in or out' of business. | 6 | 189 |
| Included wild hay and/or pasture acres. | 11 | 129 |
| Included rented out acres. | 17 | 105 |
| Forgot hay, pasture, idle and/or abandoned acres. | 11 | 104 |
| Didn't include acres rented. | 11 | 100 |
| Forgot CRP acres and/or cover crop acres. | 11 | 50 |
| Problem determining correct partnership data. | 1 | 38 |
| Included AUM pasture acres. | 2 | 28 |
| Didn't report for name on label. | 1 | 24 |
| Reported total acres not crop acres. | 1 | 9 |
| Estimational Bias | | |
| Respondent forgot a field or parcel of land. | 16 | 117 |
| Respondent used records for correct answer. | 33 | 77 |
| Respondent indicated figure was estimated. | 81 | 71 |
| Rounding problem. | 16 | 11 |
| Either answer was right. | 23 | 7 |
| Other Bias | | |
| Respondent can't remember phone interview. | 1 | 1585 |
| Respondent thought they reported the first time. | 7 | 216 |
| Respondent does not give accurate data on phone. | 4 | 132 |
| Enumerator asked question wrong. | 7 | 104 |
| Respondent added wrong. | 21 | 67 |
| Respondent fatigue. | 9 | 64 |
| Enumerator recorded wrong answer. | 11 | 60 |
| Respondent reported for wrong year. | 2 | 55 |
| Respondent can't hear on the phone. | 5 | 41 |
| Respondent gave no explanation. | 10 | 36 |
| Enumerator typing error on CATI. | 3 | 31 |
| Enumerator did not reconcile. | 3 | 18 |
| Enumerator forgot to ask. | 1 | 2 |

**Appendix D.** Reinterview Survey Bias Reasons Summary (Six State Level).

Table 8. 1989 Wheat Seeded Bias by Reason

| Winter Wheat Seeded Bias by Class | Frequency | Actual Bias (expanded) | Absolute Bias (expanded) | Average Abs. Bias (unexpanded) |
|---|---|---|---|---|
| Total Definitional Bias | 11 | 63,847 | 96,261 | 55 |
| Total Estimating Bias | 55 | -117,357 | 193,659 | 24 |
| Total Other Bias | 31 | - 92,947 | 364,931 | 61 |
| Total | 97 | -146,457 | 654,851 | 39 |

| | Frequency | Average Absolute Bias (unexpanded) |
|---|---|---|
| Definitional Bias | | |
| Included acres from another operation | 4 | 113 |
| Didn't report for name on label. | 2 | 60 |
| Included acres rented out. | 1 | 12 |
| Did not report as of December 1. | 1 | 10 |
| Forgot CRP acres and/or cover crop acres. | 3 | 4 |
| Estimational Bias | | |
| Forgot a field or parcel of land. | 6 | 121 |
| Used records for correct answer. | 8 | 31 |
| Figure was estimated. | 21 | 15 |
| Either answer was right. | 11 | 2 |
| Rounding problem. | 9 | 2 |
| Other Bias | | |
| Respondent added wrong. | 5 | 156 |
| Respondent gave no explanation. | 6 | 85 |
| Enumerator recorded wrong answer. | 2 | 80 |
| Respondent does not give accurate data on phone. | 2 | 46 |
| Respondent fatigue. | 3 | 40 |
| Respondent was not asked question on the phone. | 2 | 30 |
| Respondent can't remember phone interview. | 1 | 22 |
| Respondent thought they reported the first time. | 3 | 19 |
| Respondent reported for wrong year. | 1 | 16 |
| Respondent did not think it was enough to report. | 2 | 15 |
| Enumerator asked question wrong. | 1 | 10 |
| Enumerator did not reconcile. | 2 | 3 |

**Appendix D.** Reinterview Survey Bias Reasons Summary (Six State Level).

Table 9. 1989 Corn Planted Bias by Reason

| Corn Planted Bias by Class | Frequency | Actual Bias (expanded) | Absolute Bias (expanded) | Average Abs. Bias (unexpanded) |
|---|---|---|---|---|
| Total Definitional Bias | 37 | 511,777 | 773,867 | 118 |
| Total Estimating Bias | 129 | - 84,890 | 416,227 | 18 |
| Total Other Bias | 62 | 10,859 | 500,242 | 38 |
| Total | 228 | 437,746 | 1,690,336 | 39 |

| | Frequency | Average Absolute Bias (unexpanded) |
|---|---|---|
| Definitional Bias | | |
| Didn't report for name on label. | 2 | 522 |
| Included acres from another operation | 11 | 158 |
| Included acres rented out. | 5 | 109 |
| Didn't include rented acres. | 9 | 64 |
| Problem determining 'in or out' of business. | 5 | 58 |
| Did not report as of December 1. | 1 | 50 |
| Forgot CRP acres and/or cover crop acres. | 2 | 36 |
| Problem with include/exclude woods and waste. | 1 | 20 |
| Included popcorn acres. | 1 | 8 |
| Estimational Bias | | |
| Forgot a field or parcel of land. | 11 | 37 |
| Figure was estimated. | 59 | 21 |
| Used records for correct answer. | 21 | 18 |
| Rounding problem. | 15 | 9 |
| Either answer was right. | 23 | 4 |
| Other Bias | | |
| Respondent can't hear on the phone. | 1 | 190 |
| Respondent does not give accurate data on phone. | 5 | 67 |
| Respondent thought they reported the first time. | 4 | 78 |
| Respondent gave no explanation. | 14 | 49 |
| Enumerator asked question wrong. | 6 | 36 |
| Enumerator recorded wrong answer. | 3 | 32 |
| Respondent gave wrong answer. | 17 | 21 |
| Respondent fatigue. | 9 | 15 |
| Respondent reported for wrong year. | 1 | 4 |
| Enumerator forgot to ask. | 1 | 1 |
| Respondent did not think it was enough to report. | 1 | 1 |

**Appendix D.** Reinterview Survey Bias Reasons Summary (Six State Level).

Table 10. 1989 Soybeans Planted Bias by Reason

| Soybeans Bias by Class | Frequency | Actual Bias (expanded) | Absolute Bias (expanded) | Average Abs. Bias (unexpanded) |
|---|---|---|---|---|
| Total Definitional Bias | 31 | 437,291 | 563,285 | 95 |
| Total Estimating Bias | 113 | 43,972 | 417,816 | 17 |
| Total Other Bias | 51 | -125,062 | 573,064 | 62 |
| Total | 195 | 356,201 | 1,554,165 | 41 |

| | Frequency | Average Absolute Bias (unexpanded) |
|---|---|---|
| Definitional Bias | | |
| Didn't report for name on label. | 2 | 593 |
| Included acres from another operation | 12 | 97 |
| Problem determining 'in or out' of business. | 2 | 83 |
| Didn't include acres rented. | 6 | 39 |
| Included acres rented out. | 4 | 37 |
| Problem with irrigated & nonirrigated acres. | 3 | 19 |
| Problem with include/exclude woods and waste. | 1 | 3 |
| Forgot CRP acres and/or cover crop acres. | 1 | 2 |
| Estimational Bias | | |
| Forgot a field or parcel of land. | 10 | 39 |
| Figure was estimated. | 44 | 24 |
| Used records for correct answer. | 19 | 13 |
| Rounding problem. | 12 | 10 |
| Either answer was right. | 28 | 3 |
| Other Bias | | |
| Respondent gave no explanation. | 7 | 163 |
| Enumerator recorded wrong answer. | 3 | 109 |
| Respondent does not give accurate data on phone. | 5 | 95 |
| Respondent thought they reported the first time. | 5 | 62 |
| Enumerator asked question wrong. | 2 | 52 |
| Respondent gave wrong answer. | 14 | 34 |
| Respondent fatigue. | 9 | 30 |
| Enumerator forgot to ask. | 2 | 26 |
| Respondent can't hear on the phone. | 1 | 14 |
| Enumerator did not reconcile. | 2 | 14 |
| Respondent did not think it was enough to report. | 1 | 2 |

**Appendix E.** Reinterview Survey frequency of unexpanded acreage biases. Zero biases are not included.

Table 1. 1988 Total land (Six States Combined).

| Acres bias interval | | Obs. | Percent |
|---|---|---|---|
| (1,000, 2,000] | ** | 3 | 0.97 |
| ( 750, 500] | | 0 | 0.00 |
| ( 500, 750] | *** | 6 | 1.95 |
| ( 400, 500] | * | 1 | 0.32 |
| ( 300, 400] | ** | 4 | 1.30 |
| ( 200, 300] | *** | 6 | 1.95 |
| ( 100, 200] | ********* | 17 | 5.52 |
| ( 90, 100] | | 0 | 0.00 |
| ( 80, 90] | ** | 4 | 1.30 |
| ( 70, 80] | * | 2 | 0.65 |
| ( 60, 70] | * | 1 | 0.32 |
| ( 50, 60] | *** | 6 | 1.95 |
| ( 40, 50] | ** | 3 | 0.97 |
| ( 30, 40] | **** | 7 | 2.27 |
| ( 20, 30] | ********* | 18 | 5.84 |
| ( 10, 20] | ******* | 13 | 4.22 |
| ( 0, 10] | *************** | 30 | 9.74 |
| ( -10, 0) | ******************************** | 59 | 19.16 |
| ( -20, -10] | *************** | 27 | 8.77 |
| ( -30, -20] | ****** | 11 | 3.57 |
| ( -40, -30] | ****** | 11 | 3.57 |
| ( -50, -40] | ******* | 13 | 4.22 |
| ( -60, -50] | **** | 8 | 2.60 |
| ( -70, -60] | * | 1 | 0.32 |
| ( -80, -70] | ** | 4 | 1.30 |
| ( -90, -80] | ** | 3 | 0.97 |
| ( -100, -90] | ****** | 11 | 3.57 |
| ( -200, -100] | ********** | 22 | 7.14 |
| ( -300, -200] | ** | 3 | 0.97 |
| ( -400, -300] | *** | 5 | 1.62 |
| ( -500, -400] | ** | 4 | 1.30 |
| ( -750, -500] | * | 1 | 0.32 |
| (-1000, -750] | * | 1 | 0.32 |
| (-2000, -1000] | ** | 3 | 0.97 |

10 20 30 40 50 60

FREQUENCY

**Appendix E.** Reinterview Survey frequency of unexpanded acreage biases. Zero biases not included.

Table 2. 1988 Cropland(Six States Combined).

| Acres bias interval | | Obs. | Percent |
|---|---|---|---|
| (1,000, 2,000] | * | 1 | 0.26 |
| ( 750, 1,000] | * | 1 | 0.26 |
| ( 500, 750] | *** | 5 | 1.28 |
| ( 400, 500] | ** | 3 | 0.77 |
| ( 300, 400] | *** | 5 | 1.28 |
| ( 200, 300] | *** | 6 | 1.54 |
| ( 100, 200] | ****** | 12 | 3.08 |
| ( 90, 100] | ** | 3 | 0.77 |
| ( 80, 90] | *** | 6 | 1.54 |
| ( 70, 80] | *** | 6 | 1.54 |
| ( 60, 70] | *** | 6 | 1.54 |
| ( 50, 60] | *** | 6 | 1.54 |
| ( 40, 50] | **** | 8 | 2.05 |
| ( 30, 40] | **** | 8 | 2.05 |
| ( 20, 30] | ******** | 15 | 3.85 |
| ( 10, 20] | ********** | 29 | 7.44 |
| ( 0, 10] | ********** | 58 | 14.87 |
| ( -10, 0) | ********** | 70 | 17.95 |
| ( -20, -10] | ********** | 34 | 8.72 |
| ( -30, -20] | ******* | 13 | 3.33 |
| ( -40, -30] | ******* | 13 | 3.33 |
| ( -50, -40] | ****** | 11 | 2.82 |
| ( -60, -50] | **** | 7 | 1.79 |
| ( -70, -60] | **** | 7 | 1.79 |
| ( -80, -70] | *** | 5 | 1.28 |
| ( -90, -80] | ** | 4 | 1.03 |
| ( -100, -90] | ***** | 9 | 2.31 |
| ( -200, -100] | ********** | 23 | 5.90 |
| ( -300, -200] | *** | 5 | 1.28 |
| ( -400, -300] | * | 2 | 0.51 |
| ( -500, -400] | *** | 5 | 1.28 |
| ( -750, -500] | * | 2 | 0.51 |
| (-1000, -750] | * | 1 | 0.26 |
| (-2000, -1000] | * | 1 | 0.26 |

10 20 30 40 50 60 70

FREQUENCY

**Appendix E.** Reinterview Survey frequency of unexpanded acreage biases. Zero biases not included.

Table 3. 1988 Winter wheat seeded (Six States Combined).

| Acres bias interval | | Obs | Percent |
|---|---|---|---|
| ( 300, 400] | | 0 | 0.00 |
| ( 200, 300] | | 0 | 0.00 |
| ( 100, 200] | * | 1 | 0.93 |
| ( 90, 100] | | 0 | 0.00 |
| ( 80, 90] | * | 1 | 0.93 |
| ( 70, 80] | | 0 | 0.00 |
| ( 60, 70] | * | 1 | 0.93 |
| ( 50, 60] | | 0 | 0.00 |
| ( 40, 50] | | 0 | 0.00 |
| ( 30, 40] | *** | 3 | 2.80 |
| ( 20, 30] | *** | 3 | 2.80 |
| ( 10, 20] | **** | 4 | 3.74 |
| ( 0, 10] | ****************** | 17 | 15.89 |
| ( -10, 0) | ****************************************** | 42 | 39.25 |
| ( -20, -10] | ************** | 14 | 13.08 |
| ( -30, -20] | ***** | 5 | 4.67 |
| ( -40, -30] | **** | 4 | 3.74 |
| ( -50, -40] | *** | 3 | 2.80 |
| ( -60, -50] | *** | 3 | 2.80 |
| ( -70, -60] | ** | 2 | 1.87 |
| ( -80, -70] | * | 1 | 0.93 |
| ( -90, -80] | | 0 | 0.00 |
| ( -100, -90] | * | 1 | 0.93 |
| ( -200, -100] | * | 1 | 0.93 |
| ( -300, -200] | | 0 | 0.00 |
| ( -400, -300] | * | 1 | 0.93 |

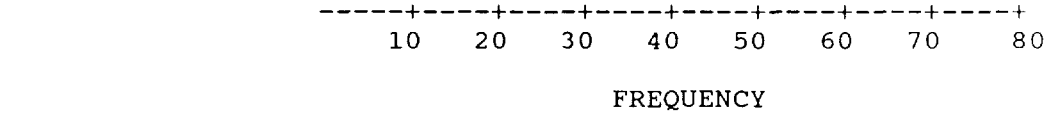
5 10 15 20 25 30 35 40

FREQUENCY

**Appendix E.** Reinterview Survey frequency of unexpanded acreage biases. Zero biases not included.

Table 4. 1988 Corn planted (Six States Combined).

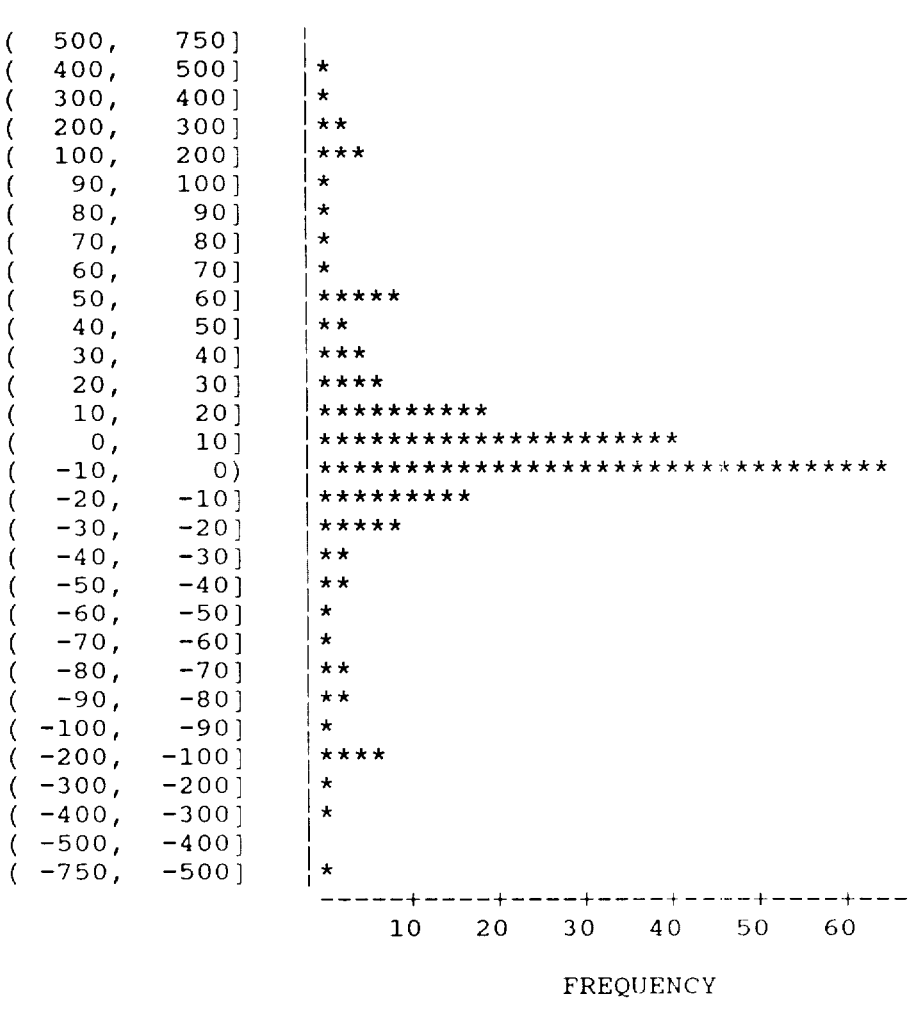
| Acres bias interval | | Obs. | Percent |
|---|---|---|---|
| ( 500, | 750] | 0 | 0.00 |
| ( 400, | 500] | 2 | 0.78 |
| ( 300, | 400] | 0 | 0.00 |
| ( 200, | 300] | 5 | 1.94 |
| ( 100, | 200] | 6 | 2.33 |
| ( 90, | 100] | 1 | 0.39 |
| ( 80, | 90] | 2 | 0.78 |
| ( 70, | 80] | 4 | 1.55 |
| ( 60, | 70] | 2 | 0.78 |
| ( 50, | 60] | 3 | 1.16 |
| ( 40, | 50] | 2 | 0.78 |
| ( 30, | 40] | 8 | 3.10 |
| ( 20, | 30] | 14 | 5.43 |
| ( 10, | 20] | 21 | 8.14 |
| ( 0, | 10] | 45 | 17.44 |
| ( -10, | 0) | 77 | 29.84 |
| ( -20, | -10] | 19 | 7.36 |
| ( -30, | -20] | 12 | 4.65 |
| ( -40, | -30] | 3 | 1.16 |
| ( -50, | -40] | 7 | 2.71 |
| ( -60, | -50] | 2 | 0.78 |
| ( -70, | -60] | 1 | 0.39 |
| ( -80, | -70] | 1 | 0.39 |
| ( -90, | -80] | 3 | 1.16 |
| ( -100, | -90] | 2 | 0.78 |
| ( -200, | -100] | 10 | 3.88 |
| ( -300, | -200] | 3 | 1.16 |
| ( -400, | -300] | 1 | 0.39 |
| ( -500, | -400] | 1 | 0.39 |
| ( -750, | -500] | 1 | 0.39 |



**Appendix E.** Reinterview Survey frequency of unexpanded acreage biases. Zero biases not included.

Table 5. 1988 Soybeans planted (Six States Combined).

| Acres bias interval | | Obs. | Percent |
|---|---|---|---|
| ( 500, | 750] | 0 | 0.00 |
| ( 400, | 500] | 1 | 0.45 |
| ( 300, | 400] | 1 | 0.45 |
| ( 200, | 300] | 3 | 1.34 |
| ( 100, | 200] | 6 | 2.68 |
| ( 90, | 100] | 1 | 0.45 |
| ( 80, | 90] | 2 | 0.89 |
| ( 70, | 80] | 2 | 0.89 |
| ( 60, | 70] | 1 | 0.45 |
| ( 50, | 60] | 9 | 4.02 |
| ( 40, | 50] | 4 | 1.79 |
| ( 30, | 40] | 5 | 2.23 |
| ( 20, | 30] | 7 | 3.12 |
| ( 10, | 20] | 19 | 8.48 |
| ( 0, | 10] | 42 | 18.75 |
| ( -10, | 0) | 65 | 29.02 |
| ( -20, | -10] | 18 | 8.04 |
| ( -30, | -20] | 9 | 4.02 |
| ( -40, | -30] | 4 | 1.79 |
| ( -50, | -40] | 4 | 1.79 |
| ( -60, | -50] | 2 | 0.89 |
| ( -70, | -60] | 1 | 0.45 |
| ( -80, | -70] | 4 | 1.79 |
| ( -90, | -80] | 3 | 1.34 |
| ( -100, | -90] | 1 | 0.45 |
| ( -200, | -100] | 7 | 3.12 |
| ( -300, | -200] | 1 | 0.45 |
| ( -400, | -300] | 1 | 0.45 |
| ( -500, | -400] | 0 | 0.00 |
| ( -750, | -500] | 1 | 0.45 |



**Appendix E.** Reinterview Survey frequency of unexpanded acreage biases. Zero biases not included.

Table 6. 1989 Total land (Six States Combined).

| Acres bias interval | | Obs. | Percent |
|---|---|---|---|
| (1,000, 2,000] | ***** | 5 | 1.77 |
| ( 750, 1,000] | **** | 4 | 1.42 |
| ( 500, 750] | **** | 4 | 1.42 |
| ( 400, 500] | ** | 2 | 0.71 |
| ( 300, 400] | *** | 3 | 1.06 |
| ( 200, 300] | ********** | 10 | 3.55 |
| ( 100, 200] | ******** | 8 | 2.84 |
| ( 90, 100] | * | 1 | 0.35 |
| ( 80, 90] | ** | 2 | 0.71 |
| ( 70, 80] | * | 1 | 0.35 |
| ( 60, 70] | *** | 3 | 1.06 |
| ( 50, 60] | **** | 4 | 1.42 |
| ( 40, 50] | ******** | 8 | 2.84 |
| ( 30, 40] | ******* | 7 | 2.48 |
| ( 20, 30] | ************* | 13 | 4.61 |
| ( 10, 20] | ************ | 12 | 4.26 |
| ( 0, 10] | ******************************** | 31 | 10.99 |
| ( -10, 0) | ********************************************** | 45 | 15.96 |
| ( -20, -10] | ********************* | 21 | 7.45 |
| ( -30, -20] | ***************** | 17 | 6.03 |
| ( -40, -30] | ********** | 10 | 3.55 |
| ( -50, -40] | ************** | 14 | 4.96 |
| ( -60, -50] | ***** | 5 | 1.77 |
| ( -70, -60] | ** | 2 | 0.71 |
| ( -80, -70] | *** | 3 | 1.06 |
| ( -90, -80] | * | 1 | 0.35 |
| ( -100, -90] | ****** | 6 | 2.13 |
| ( -200, -100] | ************* | 13 | 4.61 |
| ( -300, -200] | ********* | 9 | 3.19 |
| ( -400, -300] | ****** | 6 | 2.13 |
| ( -500, -400] | **** | 4 | 1.42 |
| ( -750, -500] | ** | 2 | 0.71 |
| (-1000, -750] | ** | 2 | 0.71 |
| (-2000, -1000] | **** | 4 | 1.42 |

5 10 15 20 25 30 35 40 45

FREQUENCY

**Appendix E.** Reinterview Survey frequency of unexpanded acreage biases. Zero biases not included.

Table 7. 1989 Cropland (Six States Combined).

| Acres bias interval | | Obs. | Percent |
|---|---|---|---|
| (1,000, 2,000] | ** | 3 | 0.84 |
| ( 750, 1,000] | * | 2 | 0.56 |
| ( 500, 750] | **** | 8 | 2.23 |
| ( 400, 500] | * | 2 | 0.56 |
| ( 300, 400] | ** | 4 | 1.12 |
| ( 200, 300] | ***** | 10 | 2.79 |
| ( 100, 200] | ********** | 22 | 6.15 |
| ( 90, 100] | | 0 | 0.00 |
| ( 80, 90] | *** | 5 | 1.40 |
| ( 70, 80] | *** | 5 | 1.40 |
| ( 60, 70] | ** | 3 | 0.84 |
| ( 50, 60] | *** | 5 | 1.40 |
| ( 40, 50] | **** | 8 | 2.23 |
| ( 30, 40] | ******* | 13 | 3.63 |
| ( 20, 30] | ********** | 22 | 6.15 |
| ( 10, 20] | ********** | 21 | 5.87 |
| ( 0, 10] | ********** | 33 | 9.22 |
| ( -10, 0) | ********** | 70 | 19.55 |
| ( -20, -10] | ********** | 20 | 5.59 |
| ( -30, -20] | ******* | 13 | 3.63 |
| ( -40, -30] | ***** | 10 | 2.79 |
| ( -50, -40] | ******** | 16 | 4.47 |
| ( -60, -50] | ***** | 9 | 2.51 |
| ( -70, -60] | * | 2 | 0.56 |
| ( -80, -70] | *** | 6 | 1.68 |
| ( -90, -80] | ** | 3 | 0.84 |
| ( -100, -90] | **** | 8 | 2.23 |
| ( -200, -100] | ********** | 19 | 5.31 |
| ( -300, -200] | *** | 5 | 1.40 |
| ( -400, -300] | ** | 4 | 1.12 |
| ( -500, -400] | * | 2 | 0.56 |
| ( -750, -500] | * | 2 | 0.56 |
| (-1000, -750] | * | 1 | 0.28 |
| (-2000, -1000] | * | 2 | 0.56 |

10 20 30 40 50 60 70

FREQUENCY

**Appendix E.** Reinterview Survey frequency of unexpanded acreage biases. Zero biases not included.

Table 8. 1989 Winter wheat seeded (Six States Combined).

| Acres bias interval | | Obs. | Percent |
|---|---|---|---|
| ( 500, 750] | | 0 | 0.00 |
| ( 400, 500] | | 0 | 0.00 |
| ( 300, 400] | ** | 2 | 2.06 |
| ( 200, 300] | | 0 | 0.00 |
| ( 100, 200] | * | 1 | 1.03 |
| ( 80, 90] | * | 1 | 1.03 |
| ( 80, 70] | | 0 | 0.00 |
| ( 60, 70] | * | 1 | 1.03 |
| ( 50, 60] | ** | 2 | 2.06 |
| ( 40, 50] | | 0 | 0.00 |
| ( 30, 40] | * | 1 | 1.03 |
| ( 20, 30] | *** | 3 | 3.09 |
| ( 10, 20] | ********* | 9 | 9.28 |
| ( 0, 10] | *************** | 15 | 15.46 |
| ( -10, 0) | ********************************** | 35 | 36.08 |
| ( -20, -10] | ******** | 8 | 8.25 |
| ( -30, -20] | ***** | 5 | 5.15 |
| ( -40, -30] | | 0 | 0.00 |
| ( -50, -40] | *** | 3 | 3.09 |
| ( -60, -50] | ** | 2 | 2.06 |
| ( -70, -60] | * | 1 | 1.03 |
| ( -80, -70] | | 0 | 0.00 |
| ( -90, -80] | * | 1 | 1.03 |
| ( -100, -90] | ** | 2 | 2.06 |
| ( -200, -100] | *** | 3 | 3.09 |
| ( -300, -200] | | 0 | 0.00 |
| ( -400, -300] | * | 1 | 1.03 |
| ( -500, -400] | | 0 | 0.00 |
| ( -750, -500] | * | 1 | 1.03 |

5 10 15 20 25 30 35

FREQUENCY

**Appendix E.** Reinterview Survey frequency of unexpanded acreage biases. Zero biases not included.

Table 9. 1989 Corn planted (Six States Combined).

| Acres bias interval | | | Obs. | Percent |
|---|---|---|---|---|
| ( 500, | 750] | * | 1 | 0.44 |
| ( 400, | 500] | * | 1 | 0.44 |
| ( 300, | 400] | ** | 3 | 1.32 |
| ( 200, | 300] | ** | 3 | 1.32 |
| ( 100, | 200] | **** | 8 | 3.51 |
| ( 90, | 100] | * | 2 | 0.88 |
| ( 80, | 90] | * | 1 | 0.44 |
| ( 70, | 80] | * | 2 | 0.88 |
| ( 60, | 70] | * | 1 | 0.44 |
| ( 50, | 60] | **** | 7 | 3.07 |
| ( 40, | 50] | * | 2 | 0.88 |
| ( 30, | 40] | *** | 5 | 2.19 |
| ( 20, | 30] | ***** | 9 | 3.95 |
| ( 10, | 20] | ********* | 17 | 7.46 |
| ( 0, | 10] | ************************ | 48 | 21.05 |
| ( -10, | 0) | ********************************** | 65 | 28.51 |
| ( -20, | -10] | ********* | 18 | 7.89 |
| ( -30, | -20] | **** | 8 | 3.51 |
| ( -40, | -30] | ** | 4 | 1.75 |
| ( -50, | -40] | **** | 8 | 3.51 |
| ( -60, | -50] | ** | 3 | 1.32 |
| ( -70, | -60] | ** | 3 | 1.32 |
| ( -80, | -70] | | 0 | 0.00 |
| ( -90, | -80] | * | 1 | 0.44 |
| ( -100, | -90] | * | 1 | 0.44 |
| ( -200, | -100] | *** | 6 | 2.63 |
| ( -300, | -200] | | 0 | 0.00 |
| ( -400, | -300] | | 0 | 0.00 |
| ( -500, | -400] | | 0 | 0.00 |
| ( -750, | -500] | * | 1 | 0.44 |

10 20 30 40 50 60

FREQUENCY

**Appendix E.** Reinterview Survey frequency of unexpanded acreage biases. Zero biases not included.

Table 10. 1989 Soybeans planted (Six States Combined).

| Acres bias interval | | Obs. | Percent |
|---|---|---|---|
| ( 750, 1,000] | | 0 | 0.00 |
| ( 500, 750] | * | 2 | 1.02 |
| ( 400, 500] | | 0 | 0.00 |
| ( 300, 400] | * | 1 | 0.51 |
| ( 200, 300] | * | 1 | 0.51 |
| ( 100, 200] | ***** | 9 | 4.59 |
| ( 90, 100] | * | 2 | 1.02 |
| ( 80, 90] | * | 2 | 1.02 |
| ( 70, 80] | | 0 | 0.00 |
| ( 60, 70] | * | 2 | 1.02 |
| ( 50, 60] | *** | 6 | 3.06 |
| ( 40, 50] | ****** | 11 | 5.61 |
| ( 30, 40] | *** | 5 | 2.55 |
| ( 20, 30] | *** | 6 | 3.06 |
| ( 10, 20] | ******* | 14 | 7.14 |
| ( 0, 10] | ********** | 45 | 22.96 |
| ( -10, 0) | ********** | 50 | 25.51 |
| ( -20, -10] | *** | 6 | 3.06 |
| ( -30, -20] | ***** | 9 | 4.59 |
| ( -40, -30] | *** | 5 | 2.55 |
| ( -50, -40] | ** | 4 | 2.04 |
| ( -60, -50] | ** | 4 | 2.04 |
| ( -70, -60] | * | 2 | 1.02 |
| ( -80, -70] | * | 2 | 1.02 |
| ( -90, -80] | | 0 | 0.00 |
| ( -100, -90] | ** | 3 | 1.53 |
| ( -200, -100] | ** | 3 | 1.53 |
| ( -300, -200] | * | 1 | 0.51 |
| ( -400, -300] | | 0 | 0.00 |
| ( -500, -400] | | 0 | 0.00 |
| ( -750, -500] | | 0 | 0.00 |
| (-1000, -750] | * | 1 | 0.51 |

10 20 30 40 50

FREQUENCY

**Appendix F.** Bias estimates for harvested acreage and production.

| Crop | 1988 Actual Bias | 1988 % Bias | 1989 Actual Bias | 1989 % Bias |
|---|---|---|---|---|
| **Corn Harvested** | (acres) | | (acres) | |
| Indiana | -90,817 | -1.7 | 196,083 | 3.9 |
| Iowa | 60,543 | 1.1 | 163,824 | 2.6 |
| Minnesota | -65,649 | -1.7 | -82,756 | -1.9 |
| Nebraska | 4,685 | 0.1 | 110,713 | 1.9 |
| Ohio | -21,451 | -0.7 | 96,157 | 3.7 |
| Pennsylvania | -37,010 | -7.2 | 3,795 | 0.5 |
| Total | -149,698 | -0.6 | 487,816 | 2.0 |
| **Soybeans Harvested** | | | | |
| Indiana | -54,143 | -1.3 | 248,617 | 5.5 |
| Iowa | -4,791 | -0.1 | 62,648 | 1.5 |
| Minnesota | -117,530 | -3.2 | -60,028 | -1.5 |
| Nebraska | -12,079 | -0.6 | 50,729 | 2.5 |
| Ohio | 110,631 | 3.1 | 59,300 | 1.7 |
| Pennsylvania | -22,651 | -10.4 | -1,145 | -0.5 |
| Total | -100,573 | -0.6 | 360,120 | 2.0 |
| **Corn Production** | (bushels) | | (bushels) | |
| Indiana | -12,746,620 | -2.8 | 61,453,967 | 9.1 |
| Iowa | 2,384,778 | 0.5 | 22,164,575 | 3.2 |
| Minnesota | -12,993,243 | -5.3 | -4,737,026 | -0.9 |
| Nebraska | 11,401,035 | 1.6 | 18,536,177 | 2.9 |
| Ohio | -3,408,086 | -1.5 | 13,828,117 | 4.5 |
| Pennsylvania | -2,228,676 | -5.9 | 1,855,214 | 2.7 |
| Total | -17,590,811 | -0.8 | 113,101,023 | 3.8 |
| **Soybean Production** | | | | |
| Indiana | 1,467,079 | 1.3 | 7,817,026 | 5.1 |
| Iowa | 1,550,415 | 1.2 | 3,259,311 | 2.2 |
| Minnesota | -4,516,003 | -5.1 | -2,965,092 | -2.2 |
| Nebraska | -715,861 | -1.1 | 462,916 | 0.7 |
| Ohio | 3,397,644 | 3.4 | 3,371,541 | 3.2 |
| Pennsylvania | -919,327 | -12.5 | 569,624 | 7.9 |
| Total | 263,947 | 0.1 | 12,515,326 | 2.0 |