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MODIFICATION OF FCRS NONRESPONSE ADJUSTMENT PROCEDURES

Kay Turner

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ABSTRACT

The Farm Costs and Returns Survey (FCRS) estimates of total expenses, livestock expenses, and labor expenses are biased downward by about 10% in comparison with Pseudo Board numbers; while number of farms and land in farms are biased downward by about 20% from Board numbers. Pseudo Board values are the FCRS estimates adjusted for undercoverage of farms. Part of this bias is due to unit nonresponse. A modified nonresponse adjustment factor was examined for the list frame using 1990 FCRS data. This factor is based on the FCRS assumption that all nonrespondents are operating farms (i.e., positive records). Application of the list frame modified nonresponse adjustment factor by stratum increased the list frame estimates about 10%. Application of the factor by weighting cells based on type of farm and economic size for list and area nonoverlap (NOL) records was also examined. The purpose of the cells is to provide homogeneous groupings with regard to probability of response and value of the survey item(s). The use of type/size cells within State increased the list frame estimates an additional 1% to 7%. There was negligible effect on the area NOL. The multiple frame (MF) estimates of the three expense items ranged from -3.7% to 1.3% of the Pseudo Board values over the 48 States. Analysis of 1990 data indicated the adjustment should be made using type/size weighting classes within State for the list frame records. Since the stratification has changed from 1990 to 1991, it is recommended that analysis be conducted on the 1991 FCRS data to determine if type/size weighting classes are needed, or if the list frame strata are adequate weighting classes. Continued emphasis in manuals and instructions should be given to classifying only known positives as refusals and inaccessibles. Those nonrespondents that have no indication of being in business should be coded as out of business. Final recommendations should be implemented for the 1992 FCRS.

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SUMMARY

The FCRS estimates of total expenses, livestock expenses, and labor expenses are biased downward by about 10% in comparison with Pseudo Board numbers; while number of farms and land in farms are biased downward by about 20% from Board numbers. Part of this bias is due to unit nonresponse.

According to the 1990 FCRS Supervising and Editing Manual, each nonrespondent should operate a farm and qualify for an interview. That is, each nonrespondent record is considered a positive record. The area frame nonresponse adjustment factor uses only positive records, and it implies that the nonrespondents are similar to positive respondents. Currently, the list frame nonresponse adjustment factor implies that the nonrespondents are similar to respondents, which consist of positives and zeros. Including zero records in the list frame nonresponse adjustment factor underestimates the nonrespondents, if in fact they are all positives. The first objective of this project was to examine a modified nonresponse adjustment factor for the list frame using 1990 FCRS data. The modified nonresponse adjustment factor makes the list and area nonresponse adjustment factors equivalent, with one exception: the list frame nonresponse adjustment factor is calculated at the stratum level and the area frame nonresponse adjustment factor is calculated at the State level. The modified nonresponse adjustment factor increases estimates 8.8 to 10.4 percentage points in the five variables for the list frame (Table 10).

This study also examined the application of the modified nonresponse adjustment factor by weighting cells based on farm type and economic size. The purpose is to provide homogeneous groups with regard to probability of response and value of the survey item(s). The second objective of this project was to evaluate the use of weighting cells for the list frame sample, while the third was to extend the evaluation to the area frame NOL records. A requirement of 20 records per cell was set. First, size cells were created <u>within stratum</u> for the list frame. Only 20% of the strata were subdivided into size cells, due to the goal of 20 records per cell. This method did not produce results much different than calculating the modified nonresponse adjustment factor by stratum (Table 11). Second, type/size cells were created <u>within each State</u>. When compared to expansions produced using the modified nonresponse adjustment factor by stratum (Table 10), the use of type/size cells within each State increased expense items by 4 to 7 percentage points; land in farms by 1 percentage point; and number of farms by 2 percentage points for the list frame (Table 12). On the area side, the use of type/size cells within each State had marginal effects on the expansions (Table 14).

At the MF level, the bias in total expenses, livestock expenses, labor expenses, and land in farms is decreased 8 to 11 percentage points when type/size cells within each State are used (Table 15). The bias in number of farms is decreased by only 4 percentage

points. The area NOL records contribute approximately 58% to the number of farms MF indication; whereas the area NOL records contribute only about 23% for the other four items (Tables 9 and 13). Type/size cells within each State did not have much effect on the area NOL records, and thus the bias in number of farms is not decreased as much as the other items. Although type/size cells within each State account for 8 percentage points of the bias in land in farms, its expansion is still 13% below the Board estimate. This is due in part to the underreporting of total farm acres (McClung, 1988).

Application of a nonresponse adjustment for FCRS consistent with the survey assumption that all nonrespondents have operating farms is necessary in order to reduce the downward bias of most survey estimates. Analysis of 1990 data indicated the adjustment should be made using type/size weighting classes within each State for the list frame records. It is recommended that analysis be conducted on the 1991 FCRS data to determine if type/size weighting classes within each State are needed, or if the list frame strata are adequate weighting classes. The creation of type/size classes within each State adds complexity to the summary process. Design strata are an alternative for 1991 and future years since a different stratification strategy is being used. If the new design strata show a similar degree of "homogeneity within and heterogeneity across" as the type/size cells within each State, they should be used as weighting classes. Another possibility is to collapse the 1991 design strata to reach the goal of at least 20 positive respondent records per cell. Analysis should also examine the use of a post-stratification adjustment, similar to that recommended by Fetter (1992) for the Agricultural Surveys. That adjustment assures that sample weights within a weighting class sum to the weighting class population, controlling any potential imbalance in weights across classes. The application of type/size cells within State for the area NOL nonresponse adjustment is optional, since the impact is negligible. The current application at the State level is adequate. Since the nonresponse adjustment is based on the assumption that all nonrespondents have operating farms, survey training materials and instructions should continue to emphasize that refusal and inaccessible sampling units must be farm operators. Those nonrespondents that have no indication of being in business should be coded as out of business. Nonresponse adjustments for the list frame should be implemented for the 1992 FCRS.

MODIFICATION OF FCRS NONRESPONSE ADJUSTMENT PROCEDURES

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INTRODUCTION

The Farm Costs and Returns Survey (FCRS) was instituted in 1985 when the Farm Production Expenditure Survey and the Cost of Production Surveys were combined. The FCRS is an annual survey that takes place in February and March of each year. The data are collected in the 48 contiguous States from farm operators/managers for the preceding year via personal interviews. Detailed and aggregate expenditure, income, and cost of production data are collected. The data from the FCRS are used to ascertain the financial status of the agriculture sector by supplying information such as: farmers' net income, costs of producing commodities, financial situation of farm operators, debt held by farm operators, and importance of production expense items. Farm organizations, agribusinesses, Congress, the Department of Agriculture, farmers, and ranchers are some of the groups that utilize FCRS data (NASS, 1989b). Although different versions of the FCRS questionnaire exist, all versions collect income, asset, and liability data. Each year a sample is drawn for the FCRS using both list and area frames. The list frame includes mainly large and specialty operations. The area frame includes small operations not on the list frame (NASS, 1991a).

OBJECTIVES

Nonresponse exists because all sampled farm operators do not respond to the survey. The two types of nonrespondents are refusals and inaccessibles. The farm operator who declines the interview is classified as a refusal and the farm operator who cannot be contacted is classified as an inaccessible. Kalton and Maligalig (1991) note,

> "When total nonresponse occurs, the survey analyses may simply be carried out on the data provided by the responding elements. However, since responding and nonresponding elements may differ systematically in their survey characteristics, there is a risk with this approach that the survey estimators will be biased. It is therefore a common practice to attempt to compensate for the missing data arising from total nonresponse by some form of weighting adjustment".

The FCRS is conducted under the following assumption.

Assumption •a: All nonrespondents would qualify for an interview and would have some positive responses to the survey.

"In fact, the FCRS Supervising and Editing Manual instructs survey statisticians not to code questionnaires as refusals or inaccessibles unless there was positive data to report" (Dillard, 1991a). The nonresponse adjustment factor is supposed to compensate for nonrespondents, who are assumed to be positives for the FCRS. The underlying assumption of the current list frame nonresponse adjustment factor conflicts with Assumption •a; it is based on positive and zero records. In other words, the current list frame nonresponse adjustment factor adjusts for nonrespondents by assuming they are similar to all respondents which include both positive and zero records. The current area frame nonoverlap (NOL) nonresponse adjustment factor is based solely on positive records at the State level and is consistent with Assumption •a. The current area frame nonresponse adjustment factor adjusts for nonrespondents who are assumed to be positives and is based only on positive records.

The first objective of this study is to:

> 1) evaluate the application of a modified nonresponse adjustment factor for list frame records at the stratum level, which is consistent with Assumption •a.

With one exception, Objective 1 would make the list and current area frame nonresponse adjustment factors consistent with each other. The exception is that the list frame nonresponse adjustment factor is applied by stratum and the area frame nonresponse adjustment factor is applied by State.

There is evidence that farms of similar type and economic size have similar characteristics regarding probability of response and value of the survey item(s). Consequently, it would be beneficial to group nonrespondents and positive respondents with similar farm type and economic size together. Design strata serve this function to some degree. Nevertheless, other groupings or weighting classes based strictly on type and size may be more effective. By creating homogeneous type/size cells, the estimates produced should be more accurate since the variables of positive responding farms will be weighted for the nonresponding records of similar type and economic size within a type/size cell. All positive responding records belonging to the same type/size cell will have the same nonresponse adjustment factor. Type/size cells can be created for the list and area NOL records. This leads to the second and third objectives:

> 2) evaluate the application of a modified nonresponse adjustment factor for list frame records at the farm type and economic size cell level; and
>
> 3) evaluate the application of the current nonresponse adjustment factor for area frame NOL records at the farm type and economic size cell level.

JUSTIFICATION

Dillard (1987) enumerates FCRS list frame response rates by type of farm. Farms with control data for potatoes had a response rate of 51, while farms with tobacco control data had a response rate of 85. In a later report, Dillard (1991b) asserts, "[t]here is some evidence that nonrespondents are larger than respondents in economic size. FCRS response rates are usually lowest in the strata of largest producers." Rutz and Cadwallader (1991, Table 6) shows that large operations have smaller response rates than medium operations and that operations classified on common commodities have smaller response rates than operations classified on uncommon commodities. This indicates that the response of an operation is affected by its type and size. Since respondents and nonrespondents appear to differ by farm type and economic size, weighting classes (or cells) need to be created based on farm type and economic size control data. Using control data allows the nonrespondents, who do not have survey data, to be placed into appropriate type/size cells. These cells should be homogeneous internally and heterogeneous externally. Calculating the nonresponse adjustment factor by type/size cell should produce less biased estimates with lower coefficients of variation (CV's). Cox (1991) states, "[w]eighting class adjustment is based upon the assumption that the sample can be partitioned into groups in such a manner that within each group the responses for nonrespondents (had they been obtained) would be similar to those of respondents."

If a nonresponse adjustment factor is used that assumes that refusals and inaccessibles are similar to the responding units, both positive and zero, then the expansions will be underestimated if the nonrespondents consist entirely of positive units. "Response counts can help estimate the proportion of valid zero reports on the list and show how the current list frame adjustment procedure distorts this proportion" (Dillard, 1991b). The following example is patterned after the example given in Dillard (1991b), but it uses 1990 FCRS data instead of 1989 FCRS data. On the 1990 FCRS, there are 10,612 positive records, 6,133 refusals and inaccessibles, and 3,206 valid zero records. These zero records represent 16% of the original sample. After deleting refusals and inaccessibles, the zero records represent 23% of the remaining sample. "The overall effect of the unit nonresponse adjustment procedures is to introduce a downward bias into the estimates. The size of this bias probably varies depending on the type of farm, and may even disappear or become positive for certain types of farm with relatively high response rates" (Dillard, 1991b).

To illustrate the downward bias of the FCRS expansions, the FCRS expansions for number of farms and land in farms are compared with the Agricultural Statistics Board expansions. The FCRS expansions are based on FCRS data. The Board numbers that are used in the following tables are based on June Agricultural Survey (JAS) data. The Board numbers are calculated as follows. "National, Regional,

and State data are reviewed for reasonableness and consistency. Each State Statistical Office submits their analysis of the current situation to the Agricultural Statistics Board (ASB). Farm numbers and land in farm estimates are based on survey indications and the historical relationship of official estimates to survey indications" (NASS, 1991b). The Board numbers are considered to be truth. The following tables compare FCRS expansions with ASB estimates for number of farms and land in farms, and FCRS expansions with Pseudo Board estimates (see below) for total expenses, labor expenses, and livestock expenses. Adjustments were made to make the FCRS expansions comparable to the Board numbers. The references used to create these tables are NASS (1987-1990), NASS (1989a), NASS (1990), NASS (1991b), and Bureau of the Census (1989).

Table 1: FCRS Expansions for Number of Farms and Land in Farms Compared with ASB Estimates at 48 State Level.

YEAR	Board Number of Farms (Thousands)	FCRS Number of Farms % of Board	Board Land in Farms (Millions)	FCRS Land in Farms % of Board
1987	2,207.7	76.0%	996.2	75.6%
1988	2,191.9	80.7%	991.8	83.6%
1989	2,165.3	80.1%	988.4	80.4%
1990	2,135.2	82.1%	984.7	78.8%

Since Board numbers were not available for total expenses, livestock expenses, or labor expenses, a "Pseudo Board" value was calculated. The FCRS expansion was divided by FCRS number of farms then multiplied by Board number of farms. This was done separately for each of the three economic sales classes with respect to annual total gross value of sales: 1) \$1,000 to \$9,999; 2) \$10,000 to \$99,999; 3) \$100,000 and over. This calculation adjusts somewhat for the FCRS undercoverage of farms. Mathematically, Pseudo Board number =

$$\sum_{i=1}^{3} \frac{(FCRS\ Variable\ Expansion_i)}{(FCRS\ Expanded\ Number\ of\ Farms_i)} * (Board\ Number\ of\ Farms_i) \qquad (1)$$

where i = 1, 2, 3 with respect to the three economic sales classes.

Although the undercoverage of farms is a major source of bias for the FCRS, it is not the only source. Dillard (1991b) points out that the major sources of bias in the FCRS are unit nonresponse adjustment procedures, missed farms, and outlier adjustment procedures; the net effect on the summary expansions of the biases is downward. Consequently, the true expense totals are expected to be larger than the Pseudo Board values. That is, the Pseudo Board values represent a minimum level for truth.

Table 2: FCRS Expansions for Total Expenses and Livestock Expenses Compared with Pseudo Board Estimates at 48 State Level.

YEAR	Pseudo Board Total Expenses (Millions)	FCRS Total Expenses % of Pseudo	Pseudo Board Livestock Expenses (Millions)	FCRS Livestock Expenses % of Pseudo
1987	123,348.6	89.3%	11,779.8	90.7%
1988	131,214.2	90.2%	14,907.8	91.3%
1989	142,161.3	87.6%	15,725.3	89.2%
1990	150,269.2	87.9%	16,863.9	88.9%

Table 2b: FCRS Expansions for Labor Expenses Compared with Pseudo Board Estimates at 48 State Level.

YEAR	Pseudo Board Labor Expenses (Millions)	FCRS Labor Expenses % of Pseudo
1987	10,829.7	92.4%
1988	10,994.4	93.0%
1989	13,097.4	90.2%
1990	14,828.4	90.1%

The mean percentage biases for these five items are summarized in Table 3. The three expense items have smaller downward mean percentage biases than number of farms and land in farms. This is understandable due to undercoverage of smaller farms and the fact that larger farms, which have better coverage, have more expenses. To address this undercoverage, Musser (1992) suggests that the National Agricultural Statistics Service (NASS) consider subsampling non-agricultural tracts with potential agriculture

since, "[t]his would increase the coverage of the FCRS, and might reduce any negative undercoverage bias, in particular, that for number of farms". Nevertheless, it is surprising that land in farms is biased by 20%, since large farms account for more land and have better coverage than smaller farms. This relatively large bias for land in farms may be partly due to the tendency by farmers to underreport total farm acreage documented in previous weighted estimator research (McClung, 1988). In addition to undercoverage of farms and underreporting of total land in farms, part of the biases may be attributable to unit nonresponse. The alternative nonresponse adjustment procedures may help to correct the downward bias due to the current unit nonresponse adjustment procedure.

Table 3: Mean Percentage Biases of Five Selected FCRS Items (1987-1990).

Item	Mean Percentage Bias
Total Expenses	-11%
Livestock Expenses	-10%
Labor Expenses	- 9%
Land in Farms	-20%
Number of Farms	-20%

BACKGROUND

Define an agricultural operation to be an operation that: 1) has crops, livestock, or poultry; 2) stores crops on its total acres operated; 3) sells agricultural products; or 4) receives government agricultural payments. All agricultural operations qualify for an FCRS interview. The definition of a farm is "any establishment from which $1,000 or more of agricultural products were sold or would normally be sold during the year" (NASS, 1991b). All farms are agricultural operations, but only some agricultural operations (i.e., those on which "$1,000 or more of agricultural products were sold or would normally be sold during the year") are considered to be farms for FCRS purposes. If the total gross value of sales is less than $1,000, then a point farm calculation is performed. This is done to determine if any of these agricultural operations whose total gross value of sales is less than $1,000 would have normally sold $1,000 during the year. If the value of the point farm calculation is greater or equal to 1,000 then that record is classified as a farm. The data of those records that qualify as farms and provide completed interviews are used to calculate expansions. If the point farm calculation is less than 1,000, then the record is not classified as a farm and its data are

not expanded.

Completion Codes

A list of completion codes and their definitions follow (NASS, 1991a, Section 6):

code 1 - completed interview, list and area NOL;
code 2 - refusal, list and area NOL;
code 3 - inaccessible or incomplete, list and area NOL;
code 4 - non-farm screen out, list and area;
code 5 - completed interview, area overlap;
code 6 - duplication between strata, list;
code 7 - duplication within a stratum, list;
code 11 - questionnaire pre-determined to be overlap to list and no interview conducted, area overlap; and
code 99 - segments with no tracts, area.

Completion codes 1, 2, 3, and 7 include all point farms - those qualified and those not qualified as farms. The completion codes used for the modified list frame nonresponse adjustment factor and the current area frame nonresponse adjustment factor are 1, 2, 3, and 7. Table 4 classifies the completion codes by type of record.

Table 4: List and Area Frame Completion Codes Listed by Type of Record.

FCR8 Completion Codes		
Type of Record	**List Frame**	**Area Frame**
Positive Records	1, 2, 3, 7	1, 2, 3
Positive Respondent	1, 7	1
Pos. Nonrespondent	2, 3	2, 3
Zero Records	4, 6	4, 5, 11, 99
Zero Respondent	4, 6	4, 5, 11, 99
Zero Nonrespondent	———	———
All Respondent	1, 4, 6, 7	1, 4, 5, 11, 99
All Nonrespondent	2, 3	2, 3
All Records	1, 2, 3, 4, 6, 7	1, 2, 3, 4, 5, 11, 99

Notation

The area frame sampling unit is a segment of land, usually about one square mile in area, within a land use stratum. Area frame reporting units are residents of the sampled segments who reported agricultural activity on the previous JAS, and who are NOL with respect to the FCRS list. The list frame sampling unit is a name on the list sampling frame (LSF) with sample code 182, the code used to identify names eligible for FCRS sampling. The reporting units are all operating arrangements associated with the sampled names.

In the following notation, let

h denote a sampling stratum,

c denote a type/size weighting cell within a State, and

s denote a State.

Furthermore, let

N(t) = number of sampling units in the population denoted by t,
n(t) = number of sampling units sampled from the population denoted by t,
g(t) = number of positive respondent reporting units in t,
f(t) = number of zero respondent reporting units in t,
r(t) = g(t) + f(t) = number of respondent reporting units in t,
e(t) = number of positive nonrespondent reporting units in t,
j(t) = number of zero nonrespondent reporting units in t, and
m(t) = e(t) + j(t) = number of nonrespondent reporting units in t.

Finally, let

$r^*(t)$ = the number of respondent sampling units in t, and
$m^*(t)$ = the number of nonrespondent sampling units in t.

For a sampling unit of the area frame to be classified as nonrespondent, the interviews of all qualifying residents in a land segment must be coded as refusals and inaccessibles. For the list frame, there is usually one reporting unit per sampling unit. If the reporting unit refuses or is inaccessible, then it is a nonrespondent sampling unit. When there is more than one reporting unit associated with a list frame sampling unit, these operating arrangements are referred to as multiple operations. A nonrespondent sampling unit exists in the case of multiple operations when all of the questionnaires corresponding to the sampled name are classified as refusals and inaccessibles.

FCRS Assumption

As stated earlier in the objectives section, the FCRS procedure is to code a questionnaire as a refusal or inaccessible only if the operator would have qualified for an interview. To qualify for an interview, the operator must have an agricultural operation, but the operation does not have to qualify as a farm. If the operation or person(s) did not operate at all during the previous year, never existed, or moved to another State before the previous year, then the questionnaire is coded as a non-farm (NASS, 1991a). A questionnaire coded as a non-farm represents a zero reporting unit. This procedure requires all refusal and inaccessible reporting units to be positive, i.e. an agricultural operation. This implies that nonrespondent zero reporting units do not exist. Assumption •a (page 1), which corresponds to the stated FCRS procedure, can be restated in terms of the above notation as

Assumption •a: $j(h) = 0$ and $e(h) = m(h)$.

O'Connor (1991) gives the frequencies of reasons for operators being classified as refusals and inaccessibles in six States during the 1990 FCRS. Some of the reasons given for classifying an operator as inaccessible indicate a valid zero, rather than a positive. "The address on the label is vacant / burned out / no structure exists" is an example where a record would be assumed to be positive because it is a nonrespondent, but in fact may be a valid zero record. Since all FCRS interviews are face to face, it is assumed that each record can be classified as an agricultural operation or out of business. FCRS manuals and FCRS schools clearly state to code a questionnaire as a refusal or an inaccessible only when it appears that the operator would qualify for an interview. Although it is acknowledged that not all records classified as refusals and inaccessibles are positives, only about 2.5% of the reasons identified as refusals and inaccessibles from O'Connor's report appear to be valid zeros. Identifying these reasons will enable enumerators to improve classification of cases where no farm appears to exist as a valid zero. Continued emphasis should be given to classifying only positives as refusals and inaccessibles. Those nonrespondents that have no indication of being in business should be coded as out of business.

EXPANSION FACTORS

The FCRS summary currently has two methods for adjusting the list and area frames for nonresponse due to refusals and inaccessibles. Both procedures are described below. Each sampled unit is initially assigned an original expansion factor that would be applicable if there were no nonresponse, that is, if a usable report was obtained from each reporting unit. For both the area

and list frames, the original expansion factor is

$$EF = \frac{N(h)}{n(h)} \quad . \tag{2}$$

The corresponding assumption of this expansion factor is the following.

Assumption •b The n(h) sampled units in stratum h are a simple random sample of sampling units from the N(h) population units in the stratum.

This assumption is clearly true. Since all reporting units do not respond, the original expansion factor, Equation (2), is multiplied by an adjustment factor to account for the nonrespondent reporting units. The current list frame expansion factor is

$$EF = \frac{N(h)}{n(h)} * \frac{n(h)}{r^*(h)} \quad . \tag{3}$$

The second term of Equation (3) is based on the following assumption.

Assumption •c The $r^*(h)$ respondent sampling units in stratum h are a simple random sample from the n(h) sampled units.

If Assumption •c were true, then the $m^*(h)$ nonrespondent sampling units would also be a simple random sample of the n(h) sampled units in stratum h. This contradicts Assumption •a (page 1), where all nonrespondents are assumed to be positive.

The modified list frame expansion factor for Objective 1 (page 2) is

$$EF = \frac{N(h)}{n(h)} * \frac{g(h) + e(h)}{g(h)} \quad . \tag{4}$$

The modified list frame expansion factor for Objective 2 (page 2) is

$$EF = \frac{N(h)}{n(h)} * \frac{g(c) + e(c)}{g(c)} \quad . \qquad (5)$$

The second terms of Equations (4) and (5) are based on the following assumption.

Assumption •d The positive respondent reporting units {g(h), g(c)} are a simple random sample from the positive reporting units in the stratum or weighting cell.

The nonresponse adjustment factors -- the second terms of Equations (4) and (5) -- will be applied at the list frame stratum level for Objective 1 (page 2) and at the list frame type/size cell level for Objective 2 (page 2). The above nonresponse adjustment factors are consistent with FCRS Assumption •a (i.e. all nonrespondents are positive) since they are based entirely on positive records.

The current area frame expansion factor is

$$EF = \frac{N(h)}{r^*(h)} * \frac{r^*(s)}{n(s)} * \frac{g(s) + e(s)}{g(s)} \quad . \qquad (6)$$

The first two terms of Equation (6) are an approximation for N(h) / n(h). Using N(h) / n(h) directly, the revised current area frame expansion factor is

$$EF = \frac{N(h)}{n(h)} * \frac{g(s) + e(s)}{g(s)} \quad . \qquad (7)$$

The area frame expansion factor for Objective 3 (page 2) is

$$EF = \frac{N(h)}{n(h)} * \frac{g(c) + e(c)}{g(c)} \quad . \qquad (8)$$

The second terms of Equations (7) and (8) are nonresponse

adjustment factors. Both of these nonresponse adjustment factors are based on Assumption •d above. The nonresponse adjustment factor of Equation (7) is applied at the area frame State level and the nonresponse adjustment factor of Equation (8) is applied at the area frame type/size cell level for Objective 3 (page 2).

The data that are expanded belong to those records that are completed interviews and qualify as farms (including those point farms that qualify as farms). These records are a subset of the positive respondents. The positive respondents are comprised of records that qualify as farms, and those point farms that do not qualify as farms. The nonresponse adjustment factors of Equations (3) through (8) are based on all positive respondents not just those that qualify as farms. The assumption used by the FCRS is that all refusals and inaccessibles would have qualified for an interview (i.e. they are agricultural operations). This does not mean that all refusals and inaccessibles would qualify as farms. That is, some of the refusals and inaccessibles could be records that are point farms that would not qualify as farms. Thus basing the nonresponse adjustment factors of Equations (3) through (8) on all positive respondents, not just those that qualify as farms, is consistent with Assumption •a (page 1).

METHODS

Data Sets

For this project, 1990 FCRS data are used. This study includes all versions of the FCRS. A list of the FCRS versions and what each version specifically collects follows: 1) expenditure collects detailed expenditure data; 2) farm operator resource (FOR) collects aggregate expenditures and farm demographic data; and 3) several cost of production (COP) versions collect aggregate expenditures and detailed cost of production data. Income, asset, and liability data are collected on all versions of the FCRS (NASS, 1991a).

Most States currently have LSFs that use an operation dominant approach to list maintenance, where the list sampling unit is an operation name. NASS is in the process of converting to an operator dominant approach to list maintenance. The list sampling unit of the operator dominant approach is an individual operator name (NASS, 1991c). The 1990 FCRS had nine operator dominant States and 39 operation dominant States. The nine operator dominant States were Arizona, Colorado, Georgia, Illinois, Kansas, Montana, New York, North Carolina, and Wisconsin. The control data for size was missing on the 1991 list frame for these nine States. This was due to the size variable being overlaid because of special processing for the operator dominant States. This will not be a problem in future years, since the control data for size will be saved. These nine States could not be included when type/size cells were created for the list frame.

Control information on farm type and economic size is needed to

assign records to type/size cells. For NOL records, this information is collected on the JAS. For list records, the control information is not typically kept on the survey data file but will be kept on a regular basis starting with the 1991 FCRS. A convenient method to obtain the farm type and economic size information for the 1990 list frame records at the time of this analysis was to match the entire 1990 FCRS list data set against the 1991 list frame, which has farm type and economic size control data. The 1991 list frame control data are assumed to be comparable to the 1990 list frame control data. Because the list frame is updated, some of the records in the 1990 FCRS data set were no longer on the 1991 list frame. For those records, the type and size control data were unattainable. There are 15,543 FCRS list frame sample records in the 39 operation dominant States. Approximately 13% of the operation dominant list frame 1990 FCRS records for the 39 States were missing from the 1991 list frame. The needed control information for the unmatched records is unknown.

Table 5 shows that the records with and without control data are very different in nature. The records without control data cannot be assumed to be a random sample of the total sample. About 72% of these records were "zero records", while only about 9% of the records with control data were zeros (see Appendix A, Table A1). If they were a random sample they could be ignored and the expansion could just be based on the records with control data. But this is not the case. Consequently, these records were placed in a separate "other cell" for each State when calculating the nonresponse adjustment factor. Since these records without control data will not be grouped by type and size of farm, but grouped together into a single cell for each State, the nonresponse adjustment may not be very accurate for "other cells". Nevertheless, this adjustment only affects positive records without control data, which make up only 2.6% of the total sample at the 39 State level. Based on these findings, it is assumed that the effect of not having control data for these records on analysis results is negligible.

Table 5: Number and Column Percentages of Records With and Without Control Data by Type of Record.

39 Operation Dominant States List Frame All Records						
Type of Record	**With Control Data**		**Without Control Data**		**Row Totals**	
Positive Respondents	7,871	58%	321	16%	8,192	53%
Zero Respondents	1,152	9%	1,462	72%	2,614	17%
Positive Nonrespondents	4,489	33%	248	12%	4,737	30%
	13,512		2,031		15,543	

Variables

The variables that are examined in the analysis are

1. total expenses,
2. livestock expenses,
3. labor expenses,
4. land in farms, and
5. number of farms.

Standard Errors

Standard errors were obtained via the SUrvey DAta ANalysis (SUDAAN) software for multi-stage sample designs by Research Triangle Institute. This procedure uses the nonresponse adjustment factors from the weighting cells under the assumption of a stratified simple random design. It provides a reasonable approximation if the variance of the adjustment factors is fairly small within design strata and the respondent counts are reasonably high. To verify the SUDAAN standard errors for the list and area frames, standard errors for the operational method were calculated by SUDAAN and compared with FCRS standard errors. The list frame SUDAAN standard errors equaled the FCRS standard errors almost exactly, while the area frame SUDAAN standard errors were no more than 0.3% smaller than the FCRS standard errors.

ANALYSIS
List Frame

The control variables type and size were obtained from the 1991 list frame for most records. Reported type and size data from the FCRS is unknown for the refusals and inaccessibles. Therefore, the control variables type and size are used so that the refusals and inaccessibles can also be placed in type/size cells. The control variable type can have a value from one to ten, which indicates type of farm. The ten type categories are mutually exclusive, even though a farm may produce several commodities. Codes one through six were collapsed together to form the crops category and codes seven through ten were collapsed together to form the livestock category. The control variable size contains a dollar value. These values were collapsed into the 20 categories listed on the FCRS questionnaire, where a code indicates the range into which the value falls. As alluded to before, control variable size was missing for the nine operator dominant States, so only the 39 operation dominant States were included in this analysis.

Variance inflation can result when adjustment factors are not based upon adequate sample sizes. "A rule of thumb commonly used by the U.S. Bureau of the Census is that weighting classes should contain more than 20 respondents and the adjustment factor should not exceed 2..." (Cox, 1991). A goal of at least 20 positive respondent records with control data per weighting class was set. The reason the minimum number of records per cell is with respect to positive respondent records instead of positive and zero respondent records is because the refusals and inaccessibles are assumed to be positive records. Therefore the zero records are not placed into type/size cells. The zero records are not included in the type/size cells for the modified list nonresponse adjustment factor or for the current area nonresponse adjustment factor.

Current Nonresponse Adjustment Factor at Stratum Level

The current nonresponse adjustment factor -- the second term of Equation (3) -- was applied by stratum for the 39 operation dominant States. There are 281 strata in the 39 operation dominant States. These 281 strata can be thought of as 281 cells. These estimates were used as the basis for comparison of the modified nonresponse adjustment factor applied at the stratum and cell levels.

Modified Nonresponse Adjustment Factor at Stratum Level

The modified nonresponse adjustment factor -- the second term of Equation (4) -- was applied by stratum for the 39 operation dominant States. This method also has 281 strata (cells). Evaluation of this application addresses Objective 1 (page 2).

Modified Nonresponse Adjustment Factor at Cell Level

Two different options for creating type/size cells were evaluated to address Objective 2 (page 2).

a. Size Cells Within Stratum

In order for a stratum to be considered for division into cells, it must have at least 40 positive respondent records given the target goal of at least 20 positive respondent records per cell. The following table shows how many strata there are for specified ranges of positive respondent records prior to division into size cells.

Table 6: Given Specified Ranges of Positive Respondent Records, the Number and Percentage of Strata per Range at 39 State Level Prior to Division into Size Cells.

Range of Positive Respondent Records With Type and Size Control Data	Number and Percentage of Strata that Fall Within Given Ranges	
Less than 20	152	54%
Between 20 and 39 Inclusive	69	25%
Between 40 and 79 Inclusive	43	15%
80 or more	17	6%

Sixty of the 281 strata (21%) have at least 40 positive respondents. As previously stated, the control variable type was collapsed into the two categories crops and livestock and the control variable size was collapsed into the 20 size categories listed on the FCRS questionnaire. Since only 17 (which come from ranges 40 through 79 and 80+ of Table 6) of the 281 (6%) strata could be divided by type and still have at least 20 positive respondents per weighting class, it was decided to use only the variable size to create weighting classes within stratum. Fifty-five of the 281 (20%) strata were divided into two weighting classes based on size. Each of the 55 strata that were divided into two size cells had its own size break. The size break for each stratum could occur between any of the 20 size categories. The size break for a stratum was chosen to divide the stratum's records in half. The remaining 226 strata were not divided into weighting classes, but were left as they were. The modified nonresponse adjustment factor -- term two of Equation (5) -- was applied within each size cell and within each unchanged stratum. The 55 strata that were subdivided into size cells occurred within 26 States. Any positive records with missing control data in the

55 strata were put into an "other cell" for each State. If, however, there were no positive respondent records with missing type or size control data, then there was no data to expand, and the "other cell" was not used. One of the 26 possible "other cells" did not have any positive respondent records and therefore was not used. Any refusals or inaccessibles that fell into an other cell without positive respondent records were not weighted for. Fifty-five strata had two size cells, 226 strata consisted of one cell, and 25 States had "other cells" giving a total of 361 cells.

b. Type/Size Cells Within State

Developing type/size cells within a State is based on a prescribed logic that would make sure the cells are created uniformly from State to State. Each cell should have, if possible, at least 20 positive respondent records with control data per cell. If a State is divided into two or more cells, then an "other cell" is created for those positive records without control data. The type categories are collapsed into the two classes: crops and livestock. The following five size cells were chosen with respect to annual total gross value of sales:

1) 1 to 9,999,
2) 10,000 to 39,999,
3) 40,000 to 99,999,
4) 100,000 to 249,999, and
5) 250,000 plus.

To divide the positive respondent records with control data of a State or type category into size cells, use the *Priority Scheme* provided in Figure 1. Given the number of positive respondent records with control data, enter the *Priority Scheme* at the step designated:

100 or more records, start at step 1),
80 to 99 records, start at step 2),
60 to 79 records, start at step 5), and
40 to 59 records, start at step 8).

Figure 1: *Priority Scheme* for Size Cell Combinations.

(1) Use the following five size cells:
1) 1 to 9,999,
2) 10,000 to 39,999,
3) 40,000 to 99,999,
4) 100,000 to 249,999, and
5) 250,000 plus.
(2) Collapse size categories 1) & 2);
(3) Collapse size categories 4) & 5);
(4) Collapse size categories 2) & 3);
(5) Collapse size categories 1) & 2) together, and 4) & 5) together;
(6) Collapse size categories 1) through 3);
(7) Collapse size categories 2) & 3) together, and 4) & 5) together;
(8) Collapse size categories 1) through 3) together, and 4) & 5) together;
(9) Collapse size categories 1) & 2) together, and 3) through 5) together;
(10) Collapse size categories 1) through 4); and
(11) Collapse size categories 2) through 5).

When all of the resulting size cells of a *Priority Scheme* step have at least 20 positive respondent records with control data, then exit the *Priority Scheme* and let the size cells remain as they are. If even one of the resulting size cells has less than 20 positive respondent records with control data, then proceed to the next step of the *Priority Scheme*. If step (11) is reached and still at least one size cell has less than the needed 20 records, then size cells cannot be formed for this State or type category. A logic flowchart that corresponds to Figure 1 is presented in Appendix B. See Appendix C for a complete *Priority Scheme* in which all cell combinations are listed. The complete *Priority Scheme* in Appendix C was not used here, but could be used to include all possible cell combinations, and thus produce more cells.

Using the logic illustrated in the flowchart of Appendix B, type/size cells were created for the list frame records of the 39 operation dominant States. The modified nonresponse adjustment factor -- term two of Equation (5) -- was used to expand the data for the cells. This method resulted in seven States with one cell per State; one State with only type cells; three States with only size cells; seven States with one type category as a cell and the remaining type category subdivided into size cells; and 21 States with both type categories subdivided into size cells. There are 32 possible "other cells" which are created to contain those positive records without control data in those States with two or more cells. If however, an "other cell" does not have any positive respondent records then the "other cell" does not exist. Two of

the 32 possible other cells do not exist. Any refusals or inaccessibles that fell into an other cell without positive respondent records were not weighted for. There are 182 type, size, or type-size cells, and 30 other cells, resulting in 212 total cells. Table 7 below outlines the cell structure resulting from this method.

Table 7: Structure of Type/Size Cells Across Strata Within State, by State Group at 39 State Level.

State Group	No. of States	Type/Size Cell Structure
1.	7	One cell per State
2.	1	Type cells only
3.	3	Size cells only
4.	7	One type category divided into two or more size cells (type-size cells) and one type category undivided (type cell)
5.	21	Both type categories divided into two or more size cells (type-size cells)

Area Frame

Survey responses, from the 1990 JAS, for type and size were used to classify records by type and size. Control data for type and size is needed since the refusals and inaccessibles do not have reported type and size data. The JAS size variable consists of 12 possible codes representing dollar ranges for the total gross value of sales. The JAS type variable consists of ten type codes, which represent the category (type of farm description) with the largest portion of the gross income from the operation. Codes one through six of the JAS type variable were collapsed to form the crops category and codes seven through ten were collapsed to form the livestock category. All 48 States were included for the area frame analysis, since the problem affecting the nine operator dominant States pertains to list frame records only.

Revised Current Nonresponse Adjustment Factor at State Level

The modified nonresponse adjustment factor is essentially already in effect operationally for the area frame. Thus we will not see an increase in the total expansions due to a change in the nonresponse adjustment factor like we did for the list frame. The current weighting classes consist of one cell per State. The

nonresponse adjustment factor -- term two of Equation (7) -- was applied for each State cell. This method has 48 cells.

Revised Current Nonresponse Adjustment Factor at Cell Level

Since the modified nonresponse adjustment approach is currently being applied for the area frame NOL at the State level, this study evaluated the impact of this approach at the type/size cell level (Objective 3, page 2). Records were assigned to area frame NOL type/size cells within State using the same logic used for the list frame records. Using this logic, type/size cells were created for all 48 States. The modified nonresponse adjustment factor -- term two of Equation (8) -- was used to expand the data for the cells. This method resulted in 31 States with one cell per State (which is the current method); 11 States with only type cells; three States with only size cells; and three States with one type category as a cell and the remaining type category subdivided into size cells. There is one "other cell" for two records with undefined type. There are 67 type, size, or type-size cells, and one other cell, resulting in 68 total cells. Table 8 below outlines the cell structure resulting from this method.

Table 8: Structure of Type/Size Cells Within State, by State Group at 48 State Level.

State Group	No. of States	Type/Size Cell Structure
1.	31	One cell per State
2.	11	Type cells only
3.	3	Size cells only
4.	3	One type category divided into two size cells (type-size cells) and one type category undivided (type cell)

RESULTS
List Frame

Table 9 shows the 39 operation dominant State level expansions and CV's obtained for five variables using the current list frame nonresponse adjustment factor, term two of Equation (3). The alternative methods' expansions will be compared to these current expansions. As a rule of thumb, nonresponse adjustment factors should not be over two. The current list method has 11.7% of the strata with nonresponse adjustment factors over two.

Table 9: Current List Frame Estimates.

Summary Statistics	Variable	Estimate (mil.)	CV
39 States 281 Strata Mean* = 29.2 Median* = 18 Minimum* = 1 Maximum* = 226	Total Expenses	77,249	2.57
	Livestock Expenses	8,204	8.19
	Labor Expenses	8,951	6.84
	Land in Farms	638	4.34
	Number of Farms	0.6521	0.83

*Number of positive respondent records per stratum.

Table 10 shows the expansions obtained using the modified nonresponse adjustment factor -- term two of Equation (4) -- as a percent of the current expansions. The modified nonresponse adjustment factor by stratum produces expansions approximately 9% to 10% higher than the current expansions. The statistics: mean, median, minimum, and maximum remain unchanged because the modified nonresponse adjustment factor was applied by stratum and the number of positive respondent records per stratum did not change. Four of the CV's are slightly greater than those in Table 9 (current method) and one CV is the same. Nonresponse adjustment factors over two occur in 18.1% of the strata.

Table 10: List Frame Estimates With Modified Nonresponse Adjustment By Stratum, as Percent of Current List Frame Expansions.

Summary Statistics	Variable	Estimate (% of Current)	CV
39 States 281 Strata Mean* = 29.2 Median* = 18 Minimum* = 1 Maximum* = 226	Total Expenses	109.8%	2.60
	Livestock Expenses	109.8%	8.19
	Labor Expenses	110.4%	7.01
	Land in Farms	108.8%	4.45
	Number of Farms	109.7%	0.86

*Number of positive respondent records per stratum.

The results of Table 11 used the nonresponse adjustment factor of Equation (5) by stratum size cells. Only 55 of the 281 strata were divided into size cells, so most size cells are actually strata. These estimates, shown as a percent of the current estimates, are

approximately 9% to 11% higher than the current list frame estimates. The percentages in this table are higher than those of Table 10 (modified method) but not by more than 1.6%. Creating size cells within stratum with a goal of at least 20 positive respondent records with control data, does not provide cell counts much different from just using the original strata. The mean and maximum of this table are less than those in Table 9 (current method) and Table 10 (modified method) because 55 of the 281 strata were subdivided into two size cells. The CV's are very comparable to those in Tables 9 and 10. Of these cells, 17.5% have nonresponse adjustment factors greater than two.

Table 11: List Frame Estimates With Modified Nonresponse Adjustment by Size Cell Within Stratum, as Percent of Current List Frame Expansions.

Summary Statistics	Variable	Estimate (% of Current)	CV
39 States 361 Cells Mean* = 22.7 Median* = 21 Minimum* = 1 Maximum* = 113	Total Expenses	110.7%	2.61
	Livestock Expenses	111.4%	8.31
	Labor Expenses	110.8%	6.93
	Land in Farms	109.2%	4.39
	Number of Farms	109.9%	0.87

*Number of positive respondent records per cell.

The Table 12 estimates are based on the modified nonresponse adjustment factor applied by type/size cell within State, with a goal of at least 20 records per cell. These estimates are 10% to 17% greater than the current estimates. The mean and median number of positive respondent records per cell in this table are greater than those in Tables 9 through 11. This method disregards strata, and thus there is more flexibility in creating cells. Disregarding the strata allows the number of records per cell to be increased. The CV's tend to be slightly larger than those for the unadjusted expansions (Table 9) or for adjusted expansions at the stratum level (Tables 10 and 11). This method produces cells where 12.7% of them have nonresponse adjustment factors over two.

Table 12: List Frame Estimates With Modified Nonresponse Adjustment by Type/Size Cell Across Strata Within State, as Percent of Current List Frame Expansions.

Summary Statistics	Variable	Estimate (% of Current)	CV
39 States 212 Cells Mean* = 38.6 Median* = 35 Minimum* = 1 Maximum* = 136	Total Expenses	114.2%	2.76
	Livestock Expenses	114.4%	8.59
	Labor Expenses	117.1%	7.43
	Land in Farms	110.0%	4.28
	Number of Farms	112.0%	0.88

*Number of positive respondent records per cell.

Area Frame

The expansions and CV's in Table 13 were obtained by using Equation (7). The current method uses one cell per State. The alternative method will be compared to the revised current method. Out of these 48 cells, 2.1% have nonresponse adjustment factors greater than two.

Table 13: Revised Current Area Frame NOL Estimates.

Summary Statistics	Variable	Estimate (mil.)	CV
48 States 48 Cells Mean* = 53.1 Median* = 39 Minimum* = 5 Maximum* = 206	Total Expenses	27,350	5.49
	Livestock Expenses	2,294	11.81
	Labor Expenses	2,303	16.46
	Land in Farms	190	8.54
	Number of Farms	0.9147	3.29

*Number of positive respondent records per State.

Table 14 estimates are based on the type/size cells within State designed with a goal of at least 20 records per cell. The cell statistics of this table are all less than those of the current method, because cells are created within State. The estimates are very near the current NOL estimates in Table 13. Three of the CV's in this table are less than those of the current method and two are greater. Of these cells, 1.4% have nonresponse adjustment factors

over two. Since the percentage change in the estimates is small for Table 14, these results indicate that application of the nonresponse adjustment for the area frame NOL within cells has negligible effect.

Table 14: Area Frame NOL Estimates With Nonresponse Adjustment By Type/Size Cell Within State, as Percent of Revised Current Area Frame Expansions.

Summary Statistics	Variable	Estimate (% of Current)	CV
48 States 69 Cells Mean* = 37.0 Median* = 31 Minimum* = 2 Maximum* = 151	Total Expenses	100.7%	5.47
	Livestock Expenses	99.3%	11.65
	Labor Expenses	99.7%	16.35
	Land in Farms	101.6%	8.66
	Number of Farms	100.1%	3.35

*Number of positive respondent records per cell.

Multiple Frame

Nonresponse adjusted multiple frame (MF) estimates were calculated at the 48 State level using type/size cells within State for both the list and area NOL indications. The list data for the nine operator dominant States were expanded by stratum using the modified nonresponse adjustment factor, since size control data were not available to create type/size cells. It is expected, from comparison of Tables 10 and 12, that the expansions for these nine States would be smaller than their expansions using type/size cells within State. The probable effect of using the modified nonresponse adjustment by stratum for the nine operator dominant States on the 48 State MF indications, instead using the modified nonresponse adjustment by type/size cell within each State, is to bring the indications downward. These nonresponse adjusted MF estimates as well as the current MF estimates are compared to the Board and Pseudo Board estimates in Table 15. The nonresponse adjusted MF estimates for the expense items closely match their Pseudo Board values, ranging from 3.7% below to 1.3% above. Since the Pseudo Board values are adjusted for undercoverage of farms, these results indicate the nonresponse adjustment procedure compensates for most of the bias due to undercoverage. Land in farms adjusted for nonresponse is still biased downward by about 13%. However, this bias is about 8 percentage points smaller than the current MF bias of 21%. This reduction in bias, represented by the last column in Table 15, for land in farms is comparable to the

reduction for the expense items, indicating the nonresponse adjustment using type/size cells has about an 8 to 11 percentage point effect on the MF estimates for these items. One important characteristic of these four items is that approximately 23% of the MF estimates are from the area NOL (Tables 9 and 13). The reduction in bias for number of farms is only about 4 percentage points, but approximately 58% of the MF estimate is from the area NOL. Since the nonresponse adjustment has negligible effect on the area NOL, the bias reduction for the MF estimate is also small.

Table 15: 1990 Current MF Estimates and Nonresponse Adjusted MF Estimates Using Type/Size Cells Within State at 48 State Level Compared to 1990 Board and Pseudo Board Estimates.

Item	1990 Board & Pseudo Board Estimates (mil.)	Current MF		Nonresponse Adjusted Type/Size Cells MF		Nonresp. Adjusted % of Board Minus Current MF % of Board
		% of Board	% of Board - 100%	% of Board	% of Board - 100%	
Total Expenses	150,269	87.9%	-12.1%	96.3%	-3.7%	8.4%
Livestock Expenses	16,864	88.9%	-11.1%	97.1%	-2.9%	8.2%
Labor Expenses	14,828	90.1%	-9.9%	101.3%	+1.3%	11.2%
Land in Farms	985	78.8%	-21.2%	86.6%	-13.4%	7.8%
No. of Farms	2.1352	82.1%	-17.9%	85.8%	-14.2%	3.7%

CONCLUSIONS

FCRS estimates of major expense items have a minimum downward bias of approximately 10%. Land in farms and number of farms are biased downward about 20% (Table 3). A major source of the bias is the lack of an appropriate nonresponse adjustment for the list frame portion of the MF estimate. A simple adjustment based on the FCRS assumption that all nonrespondents have operating farms was applied in this study to list frame sample records using the following weighting classes:

1) the design strata,

2) size cells within design stratum, and
3) type/size cells over strata.

A nonresponse adjustment, which assumes that all nonrespondents have operating farms, is currently being applied to area NOL records at the State level. This study examined the effect of applying the adjustment at a type/size cell level. Weighting classes or cells based on farm type and economic size are intended to provide more homogeneity within weighting classes and heterogeneity across weighting classes than the current classes (strata for the list and States for the area NOL) provide. If the weighting classes are effective in capturing this homogeneity within and heterogeneity across classes with respect to response probabilities, they will help reduce nonresponse bias.

Results indicated that the largest bias reduction for the list frame portion of the estimate occurred using type/size cells over strata. Evidently, these cells do a more effective job of grouping homogeneous records together than the current design strata. There was little effect, however, from using type/size cells for area NOL records primarily because cells could only be created in 17 of the 48 States because of the goal of at least 20 records per cell. The MF nonresponse adjusted estimates using type/size cells compared closely to the Pseudo Board values for the three expense items over all 48 States for 1990. The biases ranged from -3.7% to +1.3%. Since Pseudo Board values are only adjusted for undercoverage of farms, they represent a minimum level for truth. Consequently, the MF nonresponse adjusted estimates of the expense items would be expected to have a negative bias of at least 3 to 4%. The land in farms estimate was still biased downward by about 13%, as compared to 21% for the current estimator. This bias is probably due in part to the tendency of farm operators to underreport total farm acreage (McClung, 1988). The number of farms estimate was still biased downward by about 14% as compared to 18% for the current estimator. The MF number of farms estimate is 58% area NOL, and the nonresponse adjustments have little effect on the area NOL estimate, which explains why the adjustments for number of farms had only a small effect. A major factor to the remaining downward bias on all five items is the undercoverage of farms by FCRS. The CV's based on the SUDAAN approximation of the nonresponse adjusted estimates increased slightly as compared to the current CV's. This probably reflects more the failure of the variance estimation procedure than the nonresponse adjustment procedures.

RECOMMENDATIONS

Application of a nonresponse adjustment for FCRS consistent with the survey assumption that all nonrespondents have operating farms is necessary in order to reduce the downward bias of most survey estimates. Analysis of 1990 data indicated the adjustment should be made using type/size weighting classes within each State for the list frame records. It is recommended that analysis be conducted on the 1991 FCRS data to determine if type/size weighting classes

within each State are needed, or if the list frame strata are adequate weighting classes. The creation of type/size classes within each State adds complexity to the summary process. Design strata are an alternative for 1991 and future years since a different stratification strategy is being used. If the new design strata show a similar degree of "homogeneity within and heterogeneity across" as the type/size cells within each State, they should be used as weighting classes. Another possibility is to collapse the 1991 design strata to reach the goal of at least 20 positive respondent records per cell. Analysis should also examine the use of a post-stratification adjustment, similar to that recommended by Fetter (1992) for the Agricultural Surveys. That adjustment assures that sample weights within a weighting class sum to the weighting class population, controlling any potential imbalance in weights across classes. The application of type/size cells within State for the area NOL nonresponse adjustment is optional, since the impact is negligible. The current application at the State level is adequate. Since the nonresponse adjustment is based on the assumption that all nonrespondents have operating farms, survey training materials and instructions should continue to emphasize that refusal and inaccessible sampling units must be farm operators. Those nonrespondents that have no indication of being in business should be coded as out of business. Nonresponse adjustments for the list frame should be implemented for the 1992 FCRS.

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APPENDIX A

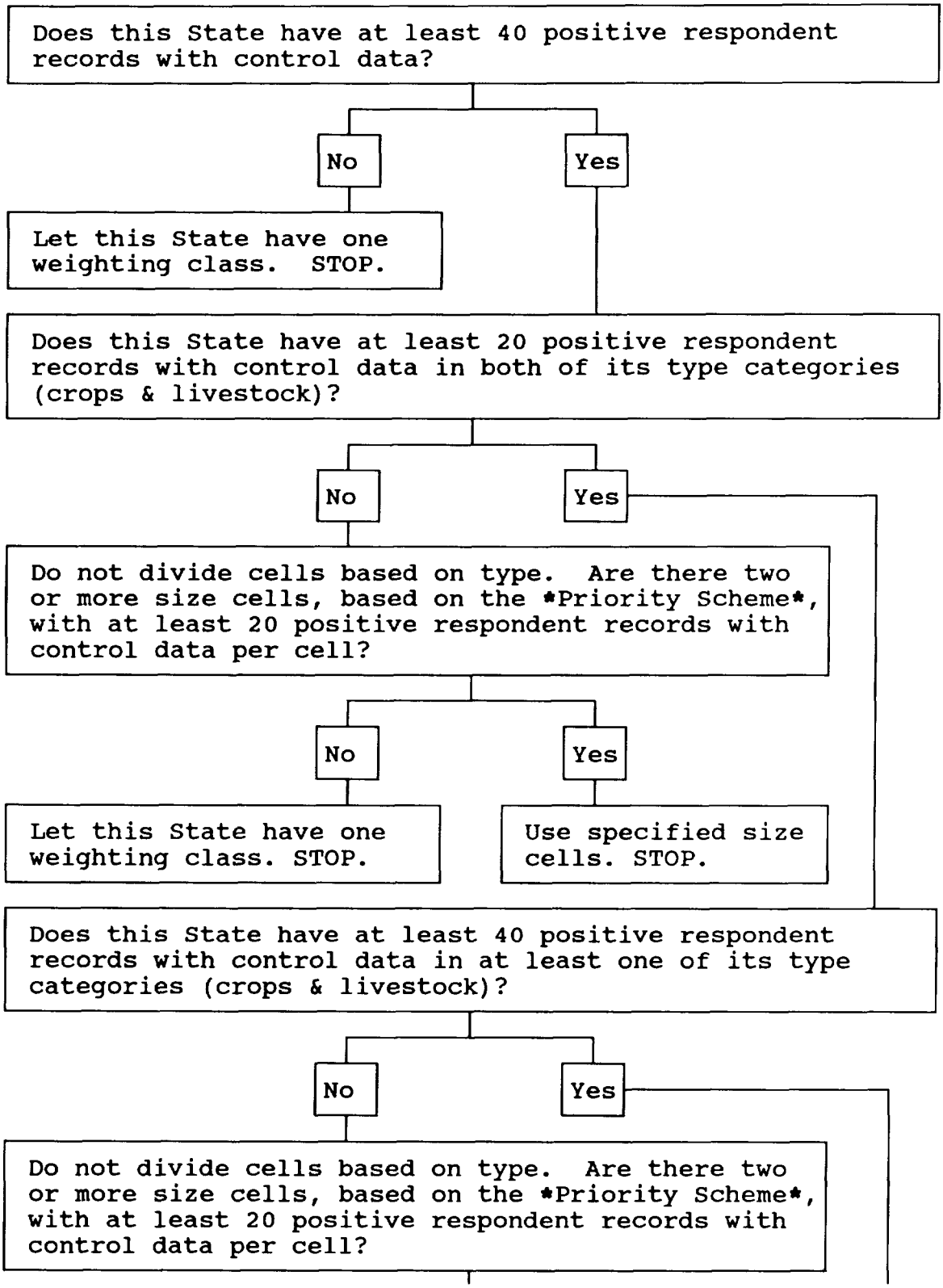
Table A1: Number and Column Percentages of Records With and Without Control Data by Completion Code.

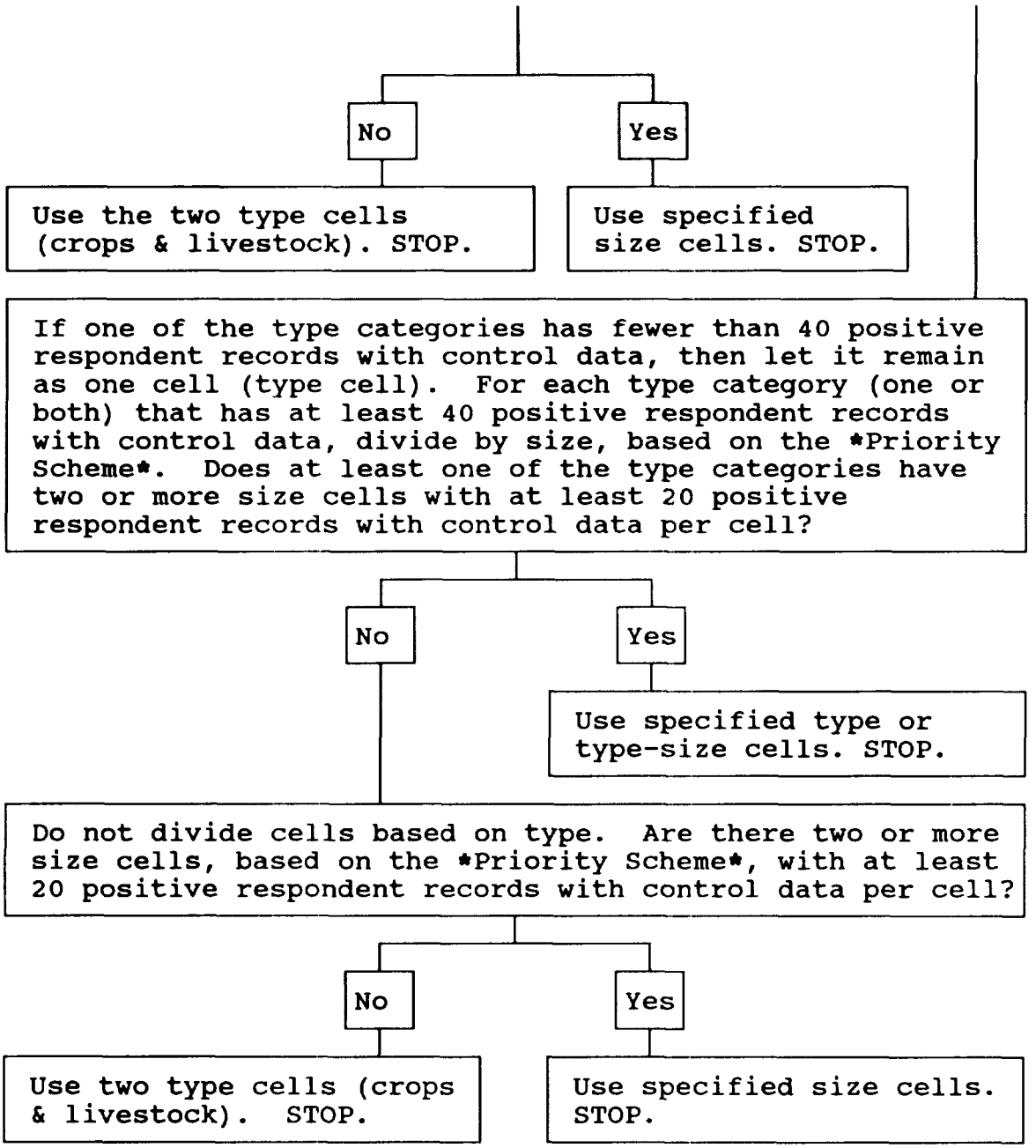
39 Operation Dominant States List Frame All Records						
Completion Code	**With Control Data**		**Without Control Data**		**Row Totals**	
1	7858	58.2%	316	15.6%	8,174	52.6%
2	3462	25.6%	147	7.2%	3,609	23.2%
3	1027	7.6%	101	5.0%	1,128	7.3%
4	1143	8.5%	1453	71.5%	2,596	16.7%
6	9	0.1%	9	0.4%	18	0.1%
7	13	0.1%	5	0.2%	18	0.1%
	13,512		2,031		15,543	

*Note, the percentages may not add to 100% due to rounding.

APPENDIX B

Figure B1: Logic Flowchart for Creating Type/Size Cells Within State.




No
Yes
Use the two type cells (crops & livestock). STOP.
Use specified size cells. STOP.
If one of the type categories has fewer than 40 positive respondent records with control data, then let it remain as one cell (type cell). For each type category (one or both) that has at least 40 positive respondent records with control data, divide by size, based on the *Priority Scheme*. Does at least one of the type categories have two or more size cells with at least 20 positive respondent records with control data per cell?
No
Yes
Use specified type or type-size cells. STOP.
Do not divide cells based on type. Are there two or more size cells, based on the *Priority Scheme*, with at least 20 positive respondent records with control data per cell?
No
Yes
Use two type cells (crops & livestock). STOP.
Use specified size cells. STOP.

APPENDIX C

Figure C1: Complete *Priority Scheme* for Size Cell Combinations.

(1) Use the following five size cells:
 1) 1 to 9,999,
 2) 10,000 to 39,999,
 3) 40,000 to 99,999,
 4) 100,000 to 249,999, and
 5) 250,000 plus.
(2) Collapse size categories 1) & 2);
(3) Collapse size categories 4) & 5);
(4) Collapse size categories 2) & 3);
(5) Collapse size categories 3) & 4);
(6) Collapse size categories 1) & 2) together, and 4) & 5) together;
(7) Collapse size categories 1) through 3);
(8) Collapse size categories 2) & 3) together, and 4) & 5) together;
(9) Collapse size categories 1) & 2) together, and 3) & 4) together;
(10) Collapse size categories 3) through 5);
(11) Collapse size categories 2) through 4);
(12) Collapse size categories 1) through 3) together, and 4) & 5) together;
(13) Collapse size categories 1) & 2) together, and 3) through 5) together;
(14) Collapse size categories 1) through 4); and
(15) Collapse size categories 2) through 5).

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