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**REDRAWING THE 1993 FARM
COSTS AND RETURNS SURVEY
LIST FRAME SAMPLE TO
REDUCE ITS OVERLAP WITH
THE 1992 FCRS AND THREE
OTHER MAJOR 1993 SURVEYS**

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REDRAWING THE 1993 FARM COSTS AND RETURNS SURVEY LIST FRAME SAMPLE TO REDUCE ITS OVERLAP WITH THE 1992 FCRS AND THREE OTHER MAJOR 1993 SURVEYS, by Charles R. Perry, Jameson C. Burt, and William C. Iwig, Sampling and Estimation Research Section, Survey Research Branch, Research Division, National Agricultural Statistics Service, U.S. Department of Agriculture, Washington, D.C. 20250, October, 1994, Report No. SRB 94-10.

ABSTRACT

This report describes the Two Stage Algorithm used by the National Agricultural Statistics Service (NASS) to redraw the 1993 Farm Costs and Returns Survey (FCRS) list frame sample. This algorithm was devised to reduce the number of farm and ranch operators in the FCRS sample that are also in other major surveys' samples. It decreased the number of operators in the 1993 FCRS sample that were also in one or more of the four other major surveys from 4,561 to 1,966 (a decrease of 57 percent). It decreased the number of operators in the 1993 FCRS sample that were also in the previous year's FCRS sample from 469 to 29 (a decrease of 94 percent). It increased the number of operators in the 1993 FCRS sample that were not in any of the four other major surveys from 6,617 to 9,212 (an increase of 39 percent). It is recommended that a five stage algorithm be used to redraw the 1994 FCRS sample.

KEYWORDS

Respondent Burden, Multiple Selection, Cross-classification, Sample Coordination.

<p>This report was prepared for distribution to the research community outside the U.S. Department of Agriculture. The views expressed herein are not necessarily those of NASS or USDA.</p>
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SUMMARY

This report describes a sampling algorithm implemented by the National Agricultural Statistics Service (NASS) to reduce substantially the number of farmers selected for the 1993 Farm Costs and Returns Survey (FCRS) who were also selected for one or more of NASS's three other major 1993 surveys or for the 1992 FCRS. To accomplish this, NASS employed a two stage process:

- 1) Redraw the 1993 FCRS sample in order to reduce overlap between the 1993 FCRS sample and the 1993 Quarterly Agricultural Survey (QAS), Agricultural Labor Survey (ALS), and Cattle and Sheep Survey (CSS) samples; then,
- 2) Redraw the sample resulting from the first stage in order to reduce overlap between the 1993 FCRS sample and the 1992 FCRS sample.

The report begins with a description of the two stage algorithm. It proceeds with theoretical and empirical justification for the algorithm, including tables showing that the estimated totals for eight control variables are very similar for the original and redrawn samples. Next, results are given. Tables are presented showing counts for different sample configurations of:

- 1) Records initially selected for the 1993 FCRS,
- 2) Records selected at the end of the first stage of the algorithm, and
- 3) Records selected for the final redrawn sample.

Following the results, conclusions are given. Among other encouraging findings, redrawing the 1993 FCRS sample:

- 1) Decreased the number of 1993 FCRS sample units that were in one or more of the other four surveys from 4,561 to 1,966 (a decrease of 57 percent),
- 2) Decreased the number of 1993 FCRS sample units that were also in the previous year's FCRS sample from 469 to 29 (a decrease of 94 percent), and
- 3) Increased the number of 1993 FCRS sample units that were not in any of the other four surveys from 6,617 to 9,212 (an increase of 39 percent).

It should be noted that the redrawn sample was based on stratification and sample select information from the 1992 and 1993 list frame spring classify and sample select. The analysis does not reflect reclassification and resampling (after spring classify and sample select) of some records in 1992 in certain states' Cost of Production specialty strata (California (rice), Michigan (sugar beets), Ohio (sugar beets), and Florida (sugar cane)). It should also be noted that the records selected in Illinois, Iowa, and Minnesota for the 1993 CUFFS were excluded from the redrawing process and analysis.

The potential for bias resulting from the second stage of the algorithm in 1993 is discussed. It is concluded that any such bias will be much less than one percent of the 1993 FCRS estimates, hence undetectable in light of the coefficients of variation associated with the estimates.

It is recommended that a five stage algorithm, which is an extension of the two stage algorithm used in 1993, be used to redraw the 1994 FCRS sample. The two stage algorithm would increase the potential for bias in the 1994 estimates. By using the five stage algorithm, the potential for bias in the 1994 FCRS estimates will be only slightly greater than in 1993, while the reduction in burden will remain essentially the same.

Redrawing the 1993 Farm Costs and Returns Survey List Frame Sample to Reduce its Overlap with the 1992 FCRS and Three other Major 1993 Surveys

Charles R. Perry, Jameson C. Burt, William C. Iwig

INTRODUCTION

Because of the length of the Farm Costs and Returns Survey (FCRS) questionnaire, the detail of the information required to answer many FCRS questions, and the intrusive nature of the information asked for in many FCRS questions, there exists a general agreement among National Agricultural Statistics Service (NASS) statisticians and interviewers that the FCRS causes more burden on a respondent than any other NASS survey.

In the last few years, as the number of public and private surveys has increased, statisticians and other government officials have become increasingly concerned about the burden these surveys place on individual respondents. The widely held belief is that the burden experienced by individual respondents tends to increase nonlinearly as they are asked to participate in multiple surveys over a short time period. This means that the burden placed on the population can be reduced by minimizing the number of times any one individual is contacted. For example, burden is reduced by contacting two individuals for one survey each instead of contacting one individual for two surveys.

In addition to reducing burden, there are two other reasons for spreading the burden over the population to the extent possible. First, responding to surveys is one of the

costs of providing agricultural statistics. To the extent that these statistics benefit farmers, it is more equitable that their costs be shared equally among farmers. Second, at some level of burden, farmers may refuse to participate in surveys. By spreading the burden to more farmers, the number of refusals should be reduced.

The points above lead most NASS statisticians to conclude that the FCRS sample should be selected using a method that minimizes the overlap within survey cycles between the FCRS sample and other major survey samples and minimizes the overlap across survey cycles between FCRS samples. The general assumption is that decreasing the number of times NASS contacts individual farm and ranch operators (farmers) should decrease the burden placed on the farm population. This should not only improve the overall response rates and quality of NASS surveys, but it should also improve the cooperation farmers give to NASS and other survey organizations.

In "Methods of Selecting Samples In Multiple Surveys To Reduce Respondent Burden," Perry, Burt, and Iwig (1993) presented two new methods of drawing samples in multiple surveys that minimize the burden on the individual population units sampled. These new methods work by spreading the burden from multiple surveys as uniformly as possible over the

population without changing the selection probabilities for any survey.

This report describes how a special case of the Second-Method presented by Perry, Burt, and Iwig (1993) was first used to redraw the 1993 FCRS list frame sample so that its overlap with the 1993 Quarterly Agricultural Survey (QAS), Agricultural Labor Survey (ALS), and Cattle and Sheep Survey (CSS) is minimized and then used again to randomly shift the redrawn sample where necessary so that its overlap with the 1992 FCRS is minimized.

In the remainder of this report, the qualifying phrase list frame is dropped from terms such as list frame sample. Since this report deals exclusively with the list frame part of NASS surveys, these abbreviations should cause no ambiguity.

The first section of this report describes the two stage algorithm used to redraw the 1993 FCRS sample. Within groups of farmers having the same multivariate stratification for the four major 1993 surveys (that is to say, farmers A and B are in the same group when farmer A is in the same stratum as farmer B for all four surveys), the first stage of the algorithm randomly shifts the 1993 FCRS sample, where possible, to another sample of farmers having lower burden for the four 1993 surveys. Within groups of farmers having the same multivariate stratification for the 1992 and 1993 FCRS surveys, the second stage of the algorithm randomly shifts the part of first stage sample that overlaps with the 1992 FCRS sample, where possible, to another sample of farmers who were not in the 1992 FCRS sample.

The second section describes the results of redrawing the 1993 FCRS sample. Tables

are given that show a detailed breakdown of the burden associated with the initial, first stage, and final redrawn samples along with the burden reduction achieved by redrawing the sample. Also, tables are given that show, for eight population control variables, the estimated totals and coefficients of variation that are associated with the initial, first stage, and redrawn samples.

The third section discusses any possible bias that may be introduced into the estimates by the algorithm. Particularly, the bias that could result from the second stage of the algorithm is examined. In addition, the potential for bias that arises when the algorithm is applied in two consecutive years is examined. Finally, four stage and five stage algorithms are introduced and examined which limit the potential for bias that arises when the algorithm is applied in two consecutive years.

The fourth and fifth sections respectively give conclusions and recommendations for redrawing the 1994 FCRS that result from what has been learned in the course of redrawing the 1993 FCRS sample.

ALGORITHM

There are three steps to the Second-Method described by Perry, Burt, and Iwig (1993) for drawing multiple surveys samples that minimize the burden on the individual units sampled:

- Step 1. Use an equal probability of selection procedure within each stratum to select independent stratified samples for each survey.

- Step 2. Cross-classify the population by the stratifications used in the individual surveys.
- Step 3. Within each substratum, randomly reassign the samples associated with sampling units having excess burden to population units having less burden. Repeat the process until the burden on individual units sampled is minimized.

A two stage algorithm is given below that first redraws the 1993 FCRS sample to reduce its overlap with the 1993 QAS, ALS, and CSS samples and then redraws the redrawn sample to reduce its overlap with the 1992 FCRS sample. The first stage of the algorithm randomly shifts the 1993 FCRS sample within groups of farmers having the same multivariate stratification for the four 1993 surveys, where possible, to another sample of farmers having lower burden for the four 1993 surveys. The second stage of the algorithm randomly shifts the part of first stage sample that overlaps with the 1992 FCRS sample within groups of farmers having the same multivariate stratification for the 1992 and 1993 FCRS surveys, where possible, to other farmers who were not in the 1992 FCRS sample.

It will be shown that the first stage of the algorithm is a special case of the Second-Method. Thus, the FCRS estimates that are based on the first stage sample have the same expected values as those based on the original FCRS sample. Under the assumption that no sample data from the 1992 FCRS is used to update the 1993 frame, it will be shown that the second stage of the algorithm is also a special case of the Second-Method. It then

follows that the FCRS estimates that are based on the second stage sample have the same expected values as those based on the original FCRS sample. It will be shown that less than four percent of the sample is redrawn by the second stage of the algorithm. Consequently, the two stage algorithm used to redraw the 1993 FCRS has only a limited potential to introduce bias into the 1993 FCRS estimates even if some 1992 sample data were used to update the 1993 FCRS frame.

First Stage: Redrawing the 1993 FCRS to Reduce “Overlap” with Three Other Major 1993 Surveys

The sampling procedures used with the 1993 FCRS, QAS, ALS, and CSS satisfy the condition of Step 1 of the Second-Method. The cross-classification of the population required in Step 2 of the Second-Method is produced by sequentially sorting the population records by the individual 1993 FCRS, QAS, ALS, and CSS stratifications.

Throughout the first stage of the algorithm, all of the 1993 samples, except the 1993 FCRS, are assumed to be fixed and hence cannot be reassigned. Thus, the reassignment required in Step 3 of the Second-Method is produced by Steps B through F of the algorithm below. Steps B-F randomly reassign the 1993 FCRS sample so that the total burden from all four 1993 surveys on the farmers in the 1993 FCRS sample is minimized.

Step A: Merge the stratification and sample selection information from the 1992 FCRS frame onto the 1993 FCRS frame.

Note: The first stage of the algorithm is totally independent of the 1992 FCRS. Nevertheless, the 1992 FCRS stratification and sample information is merged onto the 1993 FCRS frame at this point so that it can be made clear how the first stage of the algorithm interacts with the 1992 FCRS sample. This information will be used in the second stage of the algorithm to minimize the overlap of the 1993 FCRS sample with the 1992 FCRS sample.

Step B: Within each of the 1993 FCRS list frame strata, sequentially sort the records by:

1. The 1993 QAS strata,
2. The 1993 ALS strata, and
3. The 1993 CSS strata.

This step puts the 1993 FCRS list frame records into substrata such that within each substratum all records have the same multivariate stratification and selection probabilities with respect to all four 1993 surveys.

Step C: For each record on the 1993 FCRS frame, compute the burden that comes from its being sampled in the 1993 QAS, ALS, or CSS.

Step D: Within each substratum, sequentially sort the records:

1. In ascending order of the total burden from the other three 1993 surveys (the records are now ordered by ascending value of the burden from all 1993 surveys except the 1993 FCRS),

2. In descending order of a zero-one indicator variable, with one indicating selection for the initial 1993 FCRS sample (this places the records initially selected for the 1993 FCRS sample first within the burden groups formed by step D.1, thus ensuring that records are redrawn only when it reduces burden), and
3. In ascending order of a random number (this randomly orders the records within each of the subgroups formed by steps D.1 and D.2).

Step E: Redraw the 1993 FCRS sample by reassigning within each substratum the initial 1993 FCRS sample to the first elements of the substratum.

The next step permits a larger sample to be drawn initially than will actually be required. The initial sample can be reduced later to the required size (which may not be known initially) by dropping the larger replicates while still minimizing the burden on the sample.

Step F: Sort the replicate numbers associated with the substratum sample in ascending order and reassign them to the first elements of the substratum. This assigns the smaller replicate numbers to the records with the smaller total burden for the other three 1993 surveys.

The sequence of implications given in the next paragraph proves the following

three assertions, which in turn imply the conditions of Step 3 of the Second-Method are satisfied (see page 3).

1. The redrawn FCRS sample for this year has exactly the same selection probabilities (and hence same expansion factors) as the initial sample.
2. Within each substratum, the records are put in random order by the sequential sort described in Step D above, which means that within each substratum the redrawn FCRS sample is a simple random sample.
3. Within each substratum the redrawn FCRS sample minimizes the total burden on individual farmers.

Since the samples are drawn independently for each individual survey using an equal probability of selection mechanism within each stratum and since within each substratum all farmers have exactly the same stratification on individual surveys, the farmers within each substratum all have the same set of multivariate selection probabilities. Since within each substratum all records have exactly the same probability of experiencing a specified burden level, it follows that they are left in simple random order when they are sorted by ascending (non-decreasing) burden in Step D of the algorithm. Since within each substratum the total burden on any individual farmer from the other three 1993 surveys is a non-decreasing function of the final sort order, shifting the 1993 FCRS sample to the first elements of the substratum selects a simple random sample that minimizes the total burden on the individual farmers from all four 1993 surveys. Since the redrawn FCRS

sample is selected as a simple random sample within substrata, it has the same expansion factors as the initial FCRS sample.

Thus, the first stage of the algorithm can not bias the sample. That is, the FCRS estimates based on the first stage sample have the same expected values as those based on the original FCRS sample.

Example 1:

Applying The First Stage Of The Algorithm To Reduce The “Overlap” Of The 1993 FCRS With Other Major 1993 Surveys

Table 1 displays the relevant sample and burden information for the records in the Kansas substratum formed by intersecting 1993 FCRS stratum 92, 1993 QAS stratum 72, 1993 ALS stratum 95, and 1993 CSS stratum 20. The burdens assigned in this substratum for the FCRS, QAS, ALS, and CSS are respectively 60, 45, 40, and 25. (To the extent information was available, burdens were assigned to reflect the approximate time required for all expected survey contacts.)

Columns 1 and 2 of Table 1 contain the sample configurations for the initial and redrawn samples respectively. The configurations indicate whether the record was sampled (1) or not (0) for the 1993 FCRS, 1992 FCRS, 1993 QAS, 1993 ALS, and 1993 CSS respectively. For example, the sample configurations for the tenth record of the table are respectively 10101 and 00101, which indicate that initially this record was selected for the 1993 FCRS, QAS, and CSS but after the 1993 FCRS was redrawn the tenth record was selected only for the 1993 QAS and CSS. (We note once again

Table 1. Example of the Method Used to Redraw the 1993 FCRS in Substrata to Reduce the Burden from the Overlap with Other 1993 Surveys.

Initial Sample Configuration (1)	Redrawn Sample Configuration (2)	Burden Other 1993 Surveys (3)	Initial 1993 FCRS Sample (4)	Uniform Random Number Attached (5)	Redrawn 1993 FCRS Sample (6)	Burden		Rep Code		Burden	
						Initial 1993 Samples (7)	Redrawn 1993 Samples (8)	Initial FCRS Sample (9)	Redrawn FCRS Sample (10)	Initial All Samples (11)	Redrawn All Samples (12)
01000	11000	0	0	0.46313	1	0	60	0	11	60	120
10001	10001	25	1	0.13284	1	85	85	11	25	85	85
00001	10001	25	0	0.05881	1	25	85	0	72	25	85
00001	00001	25	0	0.28983	0	25	25	0	0	25	25
01001	01001	25	0	0.36130	0	25	25	0	0	85	85
00001	00001	25	0	0.47441	0	25	25	0	0	25	25
00001	00001	25	0	0.93427	0	25	25	0	0	25	25
00100	00100	45	0	0.22914	0	45	45	0	0	45	45
00100	00100	45	0	0.86787	0	45	45	0	0	45	45
10101	00101	70	1	0.07412	0	130	70	25	0	130	70
10101	00101	70	1	0.32697	0	130	70	72	0	130	70
00101	00101	70	0	0.61579	0	70	70	0	0	70	70
00101	00101	70	0	0.69437	0	70	70	0	0	70	70
00101	00101	70	0	0.77151	0	70	70	0	0	70	70
00101	00101	70	0	0.93982	0	70	70	0	0	70	70

that the 1992 FCRS Survey is not involved in this stage of the algorithm.)

Column 3 of Table 1 shows the total burden placed on the individual farmers by the three other 1993 surveys. The entries of this column are computed from the individual survey burdens and last three digits of either the initial or redrawn sample configurations. For example, the total burden from the other three 1993 surveys for tenth record is given by $1 * 45 + 0 * 40 + 1 * 25 = 70$.

Columns 3, 4, and 5 of Table 1 show that the records are sorted by the conditions of Step D above. That is, the records have been sequentially ordered: first, by ascending order of the total burden from three other 1993 surveys (see column 3); second, by the ones initially selected for the 1993 FCRS sample followed by those not initially selected (see column 4); third, by a uniformly distributed random number (see column 5).

Column 6 of Table 1 shows the redrawn 1993 FCRS sample, which is obtained by shifting the 1993 FCRS sample to the first elements of the table. A comparison of columns 3, 7, and 8 will confirm that since the records have been ordered in ascending order of the burden from the other three 1993 surveys, shifting the 1993 sample to the first three records yields a sample that places minimum burden on the sampled farmers. That is, the total burden placed on the farmers in the redrawn sample by the four surveys cannot be reduced, either individually or collectively, by exchanging a farmer in the redrawn sample for a farmer not in the redrawn sample.

Column 10 of Table 1 shows the replicate numbers attached to the redrawn sample, which are obtained by sorting the set of positive replicate numbers from column 9 in ascending order and then attaching them to the first records of Table 1—the records in the redrawn sample. Notice

that, if any set of records with the larger replicate numbers are dropped from the redrawn sample, the remainder of the redrawn sample is such that no other sample of the same size in this substratum places lower burden on the sampled farmers.

Since this stage of the algorithm is independent of the 1992 FCRS sample, some records that are initially in both 1992 and 1993 FCRS samples will end up being only in the 1992 FCRS sample and some records that are initially in only the 1992 FCRS sample will end up being in both the 1992 and 1993 FCRS samples. The first record of Table 1 demonstrates the later case. The second stage of the algorithm reduces the overlap of the 1993 FCRS sample with the 1992 FCRS sample. To help clarify the situation, the total burden from the 1992 FCRS and the four major 1993 surveys is given for the initial and redrawn samples in columns 11 and 12, respectively.

Second Stage: Redrawing the 1993 FCRS to Reduce “Overlap” with the 1992 FCRS

The sampling procedures used with the 1992 FCRS and 1993 FCRS satisfy the conditions of Step 1 of the Second-Method, provided no information from the 1992 FCRS sample is used to update the 1993 FCRS frame. The cross-classification of the population and sample required in Step 2 of the Second-Method is produced by sequentially sorting the population records by the 1993 FCRS and 1992 FCRS stratifications.

In this stage of the algorithm, the 1992 FCRS sample is predetermined.

Thus, the reassignment required in Step 3 of the Second-Method is produced by Steps G through K of the algorithm below. These steps randomly reassign the 1993 FCRS sample redrawn at the end of the first stage of the algorithm so that the total burden from the 1992 and 1993 FCRS on the farmers in the 1993 FCRS sample is minimized.

Step G: Within each of the 1993 FCRS list frame strata, sort the records by the 1992 FCRS strata. This step puts the 1993 FCRS list frame records into substrata such that within each substratum all records have the same multivariate stratification and selection probabilities with respect to the 1992 FCRS and the 1993 FCRS surveys.

Step H: For each record on the 1993 FCRS frame, compute the burden that comes from its being sampled in the 1992 FCRS.

Step I: Within each substratum, sequentially sort the records:

1. In ascending order of the burden from the 1992 FCRS (this puts the record not sampled in the 1992 FCRS first followed by those that were sampled in the 1992 FCRS), and
2. In descending order of a zero-one indicator variable, with one indicating selection for the redrawn 1993 FCRS sample at the end of the first stage of the algorithm (this places the records that were selected at the end of the first stage of the

algorithm first within each of the two burden groups formed by step I.1, thus ensuring that records are redrawn only when redrawing reduces burden), and

3. In ascending order of a random number (this randomly orders the records within each of the subgroups formed by steps I.1 and I.2).

Step J: Redraw the 1993 FCRS sample that was selected at the end of the first stage of the algorithm by reassigning it within each substratum to the first elements of the substratum.

Step K: Reassign the replicate numbers associated with the substratum sample that was redrawn at the end of first stage of the algorithm to the first elements of the substratum in their original order. Except for those few records that are also in the 1992 FCRS sample, this leaves the replicate numbers that were assigned in the first stage of the algorithm assigned to exactly the same sample record. The result is that the minimal overlap of the 1993 FCRS sample with three other major 1993 survey samples achieved at the end of the first stage of the algorithm is increased by less than four percent in the final redrawn 1993 FCRS U.S. sample.

If no information from the 1992 FCRS sample is used to update the 1993 FCRS frame, then it is clear that the sequence

of logical implications given in the two paragraphs following Step F applies to the second stage of the algorithm. It then follows that within each substratum the second stage redrawn sample is a simple random sample with the same expansion factors as the initial FCRS sample.

Thus, if no information from the 1992 FCRS is used to update the 1993 FCRS frame, then the second stage of the algorithm can not bias the estimates. This result, along with the unconditional unbiasedness of the first stage which was established earlier, shows that the FCRS estimates based on the second stage sample have the same expected values as those based on the original FCRS sample, provided no information from the 1992 FCRS is used to update the 1993 FCRS frame (see later discussion of bias).

Example 2:

Applying The Second Stage Of The Algorithm To Reduce The “Overlap” Of The 1993 FCRS With The 1992 FCRS Table 2 displays the relevant sample and burden information for the records in the Iowa substratum formed by intersecting the 1993 FCRS stratum 92 with 1992 FCRS stratum 92. The burdens assigned the FCRS and ALS in all strata are respectively 60 and 40. The burden assigned the QAS in QAS strata 95 through 98 is 85. In other QAS strata the QAS is assigned a burden of 45. The burden assigned the CSS in CSS strata 35 through 39 is 30. In other CSS strata the CSS is assigned a burden of 25. (Higher stratum numbers denote larger farm operations.)

Columns 1 and 2 of Table 2 contain the sample configurations for the first stage

Table 2. Example of the Method Used to Redraw the 1993 FCRS in Substrata to Reduce the Burden from Overlap with the 1992 FCRS Sample.

First Stage Sample Configuration (1)	Final Redrawn Sample Configuration (2)	Burden 1992 FCRS Survey (3)	Sampled Stage 1 1993 FCRS (4)	Uniform Random Number Attached (5)	Sampled Redrawn 1993 FCRS (6)	Burden		Rep Code		Burden	
						Stage 1 92 & 93 FCRS (7)	Redrawn 92 & 93 FCRS (8)	Stage 1 FCRS Sample (9)	Redrawn FCRS Sample (10)	Stage 1 All Samples (11)	Redrawn All Samples (12)
10001	10001	0	1	0.12824	1	60	60	5	5	90	90
10001	10001	0	1	0.61343	1	60	60	7	7	90	90
10101	10101	0	1	0.89720	1	60	60	13	13	135	135
00001	10001	0	0	0.37579	1	0	60	0	2	30	90
00001	00001	0	0	0.59949	0	0	0	0	0	30	30
11001	01001	60	1	0.06257	0	120	60	2	0	145	85

redrawn and the final redrawn samples respectively. The configurations indicate whether the record was sampled (1) or not (0) for the 1993 FCRS, 1992 FCRS, 1993 QAS, 1993 ALS, and 1993 CSS respectively. For example, the sample configurations for the sixth record of the table are respectively 11001 and 01001, which indicates that after the first stage of the algorithm this record was selected for the 1993 FCRS, 1992 FCRS, and 1993 CSS but after the second stage of the algorithm the record was selected only for the 1992 FCRS and 1993 CSS.

In the remainder of this report: (1) the first stage redrawn sample or simply first stage sample will refer to the redrawn sample that is obtained by applying the first stage of the algorithm to the initial 1993 FCRS sample and (2) the final redrawn sample or simply final sample will refer to the redrawn sample that is obtained by applying the second stage of the algorithm to the first stage redrawn 1993 FCRS.

Column 3 of Table 2 shows the burden placed on the individual farmers by the 1992 FCRS. Only the last record in

this substratum was selected for the 1992 FCRS.

Columns 3, 4, and 5 of Table 2 show that the records are sorted by the conditions of Step I above. That is, the records have been sequentially ordered: first, by whether they were or were not selected for the 1992 FCRS sample (see column 3); second, by whether they were or were not selected for the 1993 FCRS sample at the end of the first stage of the algorithm (see column 4); third, by a uniformly distributed random number (see column 5).

Column 6 of Table 2 shows the final redrawn 1993 FCRS sample, which is obtained by shifting the 1993 FCRS sample selected at the end of the first stage of the algorithm to the first elements of the table. A comparison of columns 3, 7, and 8 will confirm that since the records have been ordered in ascending order of the burden from the 1992 FCRS, shifting the 1993 sample to the first four records yields a sample that has minimum overlap with the 1992 FCRS sample.

Column 10 of Table 2 shows the replicate numbers attached to the final redrawn

1993 FCRS sample. They are obtained by reassigning the positive replicate numbers in column 9, in their original order, to the first records of Table 2.

Since the redrawing process in this stage of the algorithm is independent of the other three 1993 survey samples, some of the reduction of overlap between 1993 FCRS sample and the other three 1993 survey samples that was achieved in the first stage of the algorithm will be lost. However, since only about four percent of the 1993 FCRS sample that was selected at the end of the first stage of the algorithm overlaps with the 1992 FCRS, which are the records being redrawn in this stage of the algorithm, the loss of overlap reduction with respect to the other 1993 survey samples will be small.

Reasons for Using a Two Stage Algorithm Instead of a Single Stage Algorithm to Redraw the 1993 FCRS

The first stage of the two stage algorithm can be converted to a one stage algorithm that minimizes the “overlap” of the 1993 FCRS sample with the 1993 QAS, ALS, and CSS samples and the 1992 FCRS sample by including a sequential sort by the 1992 FCRS strata in Step B and adding the burden from the 1992 FCRS to the burden computed in Step C. So, why choose a two stage algorithm? The use of the two stage algorithm limits the potential for introducing bias into the FCRS estimates. Also, the two stage algorithm provides considerably more burden reduction than the one stage algorithm.

The primary reason the two stage algorithm was used instead of a single stage

algorithm to redraw the 1993 FCRS was to minimize the potential for introducing bias into the FCRS estimates. Since the first stage of the two stage algorithm is unconditionally unbiased, bias can only be introduced in the second stage of the two stage algorithm. Potential for bias will exist if the 1992 FCRS data have been used to update the 1993 FCRS frame. This will be discussed in the Bias Considerations section.

In the second stage of the two stage algorithm, the only part of the sample that is redrawn is the part that overlaps with the 1992 FCRS sample. Since this part of the sample amounts to only about four percent of the sample, it follows that when the two stage algorithm is used only about four percent of the redrawn sample has any potential for biasing the 1993 FCRS estimates.

In contrast, when the one stage algorithm is used every element in the redrawn sample is drawn conditional on the 1992 FCRS sample. Thus, with the one stage algorithm, every element of the redrawn sample has a potential for biasing the 1993 FCRS estimates.

In summary, unless it can be shown that no information from the 1992 FCRS sample is used to update the 1993 FCRS frame, both the single and two stage algorithms have potential for biasing the 1993 FCRS estimates. With the single stage algorithm, every element is redrawn conditional on the 1992 FCRS sample; but, with the two stage algorithm only about four percent of the sample is redrawn conditional on the 1992 FCRS sample. Thus it follows that there is much less potential for biasing the 1993 FCRS estimates with the two stage

algorithm than there is with the single stage algorithm.

In addition to the greatly reduced potential for biasing the 1993 FCRS estimates, the two stage algorithm provides considerably more burden reduction than the single stage algorithm.

In Appendix A, tables are given that show the burden reduction that would have been obtained had the single stage algorithm been used to redraw the 1993 FCRS sample. Tables 3A, 3B, and 3C, which are given in the results section, show the burden reduction that was obtained by using the two stage algorithm to redraw the 1993 FCRS sample. A comparison of these two sets of tables, which should be made after reading the first results section below will show that the two stage algorithm does a much better job of reducing the burden that comes from the overlap of the 1993 FCRS sample with either the 1992 FCRS sample or the other 1993 samples.

RESULTS

The sample of 11,178 farmers surveyed in the 1993 FCRS was redrawn with the two step procedure to reduce the number of farmers sampled in the 1993 FCRS that were also contacted in the 1992 FCRS or the other major 1993 surveys. The redrawing process was based on stratification and sample select information from the 1992 and 1993 list frame spring classify and sample select. This means that the analysis does not reflect reclassification and resampling (after spring classify and sample select) of some records in 1992 in certain states' Cost of Production specialty

strata (California (rice), Michigan (sugar beets), Ohio (sugar beets), and Florida (sugar cane)). The records that were selected in Illinois, Iowa, and Minnesota for the 1993 CUFFS were excluded from the redrawing process and analysis.

The first section below discusses the reduction in burden achieved by redrawing the sample. Tables are given that show a detailed breakdown of the burden reduction achieved by redrawing the sample along with the burden associated with the initial, first stage, and redrawn samples.

The second section below discusses the similarity of the redrawn sample to the initial sample by examining the associated population control values. Tables are given that show for each of eight population control values the estimated totals and coefficients of variation that are associated with the initial, first stage, and redrawn samples.

U.S. Level Burden Reduction

Recall that the reason for redrawing the 1993 FCRS sample was to reduce the burden on the individual farmers selected by replacing the initial FCRS sample of 11,178 farmers with another sample of 11,178 farmers which places less burden on the individuals selected. Also, recall that the first stage of the algorithm used to redraw the sample reduced the overlap of the 1993 FCRS sample with the other 1993 surveys' samples and that the second stage reduced the overlap of the 1993 FCRS sample with the 1992 FCRS sample.

Consequently, the burden reduction achieved by redrawing the 1993 FCRS can be summarized by the changes (or percentage changes) that occurred from the initial to the redrawn sample in the number of farmers selected for none, one, two, three, and four of the other surveys (1992 FCRS, 1993 QAS, ALS, and CSS). The next three paragraphs summarize the burden reduction achieved by the algorithm for the complete 1993 FCRS sample, the part of the sample in strata 90 and above, and the part of the sample in strata 89 and below, respectively.

Redrawing the 1993 FCRS sample of 11,178 farmers:

1. Increased the number of 1993 FCRS samples that were not selected for any of the other four surveys from 6,617 to 9,212 (an increase of 39 percent),
2. Decreased the number of 1993 FCRS samples that were selected for only one of the other four surveys from 3,603 to 1,598 (a decrease of 56 percent),
3. Decreased the number of 1993 FCRS samples that were selected for exactly two of the other four surveys from 843 to 325 (a decrease of 61 percent),
4. Decreased the number of 1993 FCRS samples that were selected for exactly three of the other four surveys from 107 to 41 (a decrease of 62 percent),
5. Decreased the number of 1993 FCRS samples that were selected for all of the other four surveys from 8 to 2 (a decrease of 75 percent), and
6. Decreased the number of 1993 FCRS samples that were also in the previous year's FCRS sample from 469 to 29 (a decrease of 94 percent).

Redrawing the strata 90 and above FCRS sample of 3,795 farmers (the strata containing farms with sales of \$500,000 or more):

1. Increased the number of 1993 FCRS samples that were not selected for any of the other four surveys from 1,361 to 2,317 (an increase of 70 percent),
2. Decreased the number of 1993 FCRS samples that were selected for only one of the other four surveys from 1,760 to 1,177 (a decrease of 33 percent),
3. Decreased the number of 1993 FCRS samples that were selected for exactly two of the other four surveys from 586 to 266 (a decrease of 55 percent),
4. Decreased the number of 1993 FCRS samples that were selected for exactly three of the other four surveys from 82 to 34 (a decrease of 59 percent),
5. Decreased the number of 1993 FCRS samples that were selected for all of the other four surveys from 6 to 1 (a decrease of 83 percent), and
6. Decreased the number of 1993 FCRS samples that were also in the previous year's FCRS sample from 300 to 13 (a decrease of 96 percent).

Redrawing the strata 89 and below FCRS sample of 7,383 farmers (the strata containing the farms with sales less than \$500,000):

1. Increased the number of 1993 FCRS samples that were not selected for any of the other four surveys from 5,256 to 6,895 (an increase of 31 percent),

2. Decreased the number of 1993 FCRS samples that were selected for only one of the other four surveys from 1,843 to 421 (a decrease of 77 percent),
3. Decreased the number of 1993 FCRS samples that were selected for exactly two of the other four surveys from 257 to 59 (a decrease of 77 percent),
4. Decreased the number of 1993 FCRS samples that were selected for exactly three of the other four surveys from 25 to 7 (a decrease of 72 percent),
5. Decreased the number of 1993 FCRS samples that were selected for all of the other four surveys from 2 to 1 (a decrease of 50 percent), and
6. Decreased the number of 1993 FCRS samples that were also in the previous year's FCRS sample from 169 to 16 (a decrease of 91 percent).

In summary, redrawing the 1993 FCRS sample decreased the number of times the 1993 FCRS sample overlapped with one or more of the other four survey samples:

1. From 4,561 to 1,966 for the 1993 FCRS sample of 11,178 farmers (a decrease of 57 percent),
2. From 2,434 to 1,478 for the part of the sample in strata 90 and above (a decrease of 39 percent), and
3. From 2,127 to 488 for the part of the sample in strata 89 and below (a decrease of 77 percent).

These statistics show the effectiveness of the two stage algorithm.

Tables 3A, 3B, and 3C provide detailed summary statistics by sampling stage for the initial, first stage, and redrawn sample. In Table 3A, the 11,178 farmers in each sample are first broken down according to the number of times they were selected for other surveys. Then the farmers in each sample are further broken down according to the specific combination of surveys for which they were selected. In Table 3B, similar breakdowns are given for the 3,795 farmers of each sample that are in strata 90 and above. And, in Table 3C, breakdowns are given for the 7,383 farmers of each sample that are in strata 89 and below.

In each table, column 1 shows the number of other surveys that the 1993 FCRS is combined with. Column 2 shows the specific combination of surveys that the 1993 FCRS is combined with. Columns 3, 4, and 5 show the number of records in each category for the initial, first stage, and redrawn samples, respectively. Columns 6, 7, and 8 show the percentages of farmers in each category for the initial, first stage, and redrawn samples, respectively. Columns 9 and 10 show the change in the number of farmers in the category from the initial sample to the first stage and redrawn samples, respectively. Columns 11 and 12 show the percentage change in the number of farmers in the category from the initial sample to the first stage and redrawn samples, respectively.

State Level Burden Reduction

Tables 4A, 4B, and 4C show for each state the number of 1993 FCRS samples that were in the 1992 FCRS at each stage of the algorithm. Column two,

Table 3A. For All Strata, U.S.: The Number of FCRS Samples and Percent of Total FCRS Sample by Sampling Configuration for the Initial, First Stage Redrawn, and Final Redrawn 1993 FCRS Samples.

Combination of Surveys (1)	Sampling Configuration [†] (2)	Count			Percent			Change					
		Initial	Stage 1	Redrawn	Initial	Stage 1	Redrawn	Initial to Stage 1		Stage 1 to Redrawn		Initial to Redrawn	
		(#)	(#)	(#)	(%)	(%)	(%)	Count	Percent	Count	Percent	Count	Percent
	9 9 3 2 9 9 9 F F 3 3 3 C C Q A C R R A L S S S S S S	(#)	(#)	(#)	(%)	(%)	(%)	(#)	(%)	(#)	(%)	(#)	(%)
		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
93 FCRS alone	1 0 0 0 0	6617	9095	9212	59.2	81.4	82.4	+2478	+37%	+117	+1%	+2595	+39%
	Total	6617	9095	9212	59.2	81.4	82.4	+2478	+37%	+117	+1%	+2595	+39%
93 FCRS plus one other survey	1 0 0 0 1	1110	597	662	9.9	5.3	5.9	-513	-46%	+65	+11%	-448	-40%
	1 0 0 1 0	336	74	93	3.0	0.7	0.8	-262	-78%	+19	+26%	-243	-72%
	1 0 1 0 0	1966	668	836	17.6	6.0	7.5	-1298	-66%	+168	+25%	-1130	-57%
	1 1 0 0 0	191	305	7	1.7	2.7	0.1	+114	+60%	-298	-98%	-184	-96%
	Total	3603	1644	1598	32.2	14.7	14.3	-1959	-54%	-46	-3%	-2005	-56%
93 FCRS plus two other surveys	1 0 0 1 1	74	24	30	0.7	0.2	0.3	-50	-68%	+6	+25%	-44	-59%
	1 0 1 0 1	414	189	225	3.7	1.7	2.0	-225	-54%	+36	+19%	-189	-46%
	1 0 1 1 0	147	39	60	1.3	0.3	0.5	-108	-73%	+21	+54%	-87	-59%
	1 1 0 0 1	59	44	4	0.5	0.4	0.0	-15	-25%	-40	-91%	-55	-93%
	1 1 0 1 0	12	6	1	0.1	0.1	0.0	-6	-50%	-5	-83%	-11	-92%
	1 1 1 0 0	137	73	5	1.2	0.7	0.0	-64	-47%	-68	-93%	-132	-96%
	Total	843	375	325	7.5	3.4	2.9	-468	-56%	-50	-13%	-518	-61%
93 FCRS plus three other surveys	1 0 1 1 1	45	26	31	0.4	0.2	0.3	-19	-42%	+5	+19%	-14	-31%
	1 1 0 1 1	6	2	0	0.1	0.0	0	-4	-67%	-2	-100%	-6	-100%
	1 1 1 0 1	33	21	6	0.3	0.2	0.1	-12	-36%	-15	-71%	-27	-82%
	1 1 1 1 0	23	9	4	0.2	0.1	0.0	-14	-61%	-5	-56%	-19	-83%
	Total	107	58	41	1.0	0.5	0.4	-49	-46%	-17	-29%	-66	-62%
93 FCRS plus four other surveys	1 1 1 1 1	8	6	2	0.1	0.1	0.0	-2	-25%	-4	-67%	-6	-75%
	Total	8	6	2	0.1	0.1	0.0	-2	-25%	-4	-67%	-6	-75%
Total		11,178	11,178	11,178	100.0	100.0	100.0	0	0%	0	0%	0	0%

[†] Note: The **Sampling Configuration** indicates the sampling pattern for the 93FCRS, 92FCRS, 93QAS, 93ALS and 93CSS (Cattle and Sheep). For example, a 10001 indicates sample units selected for only the 93FCRS and 93CSS.

Table 3B. For Strata 90 and Above, U.S.: The Number of FCRS Samples and Percent of Total FCRS Sample by Sampling Configuration for the Initial, First Stage Redrawn, and Final Redrawn 1993 FCRS Samples.

Combination of Surveys (1)	Sampling Configuration † (2)	Count			Percent			Change					
		Initial	Stage 1	Redrawn	Initial	Stage 1	Redrawn	Initial to Stage 1		Stage 1 to Redrawn		Initial to Redrawn	
		(#)	(#)	(#)	(%)	(%)	(%)	Count	Percent	Count	Percent	Count	Percent
93 FCRS alone	9 9 3 2 9 9 9 F F 3 3 3 C C Q A C R R A L S S S S S S	1361	2260	2317	35.9	59.5	61.0	+899	+66%	+57	+3%	+956	+70%
	Total	1361	2260	2317	35.9	59.5	61.0	+899	+66%	+57	+3%	+956	+70%
93 FCRS plus one other survey	1 0 0 0 1	517	459	508	13.6	12.1	13.4	-58	-11%	+49	+11%	-9	-2%
	1 0 0 1 0	159	42	54	4.2	1.1	1.4	-117	-74%	+12	+29%	-105	-66%
	1 0 1 0 0	986	499	613	26.0	13.2	16.1	-487	-49%	+114	+23%	-373	-38%
	1 1 0 0 0	98	175	2	2.6	4.6	0.1	+77	+79%	-173	-99%	-96	-98%
	Total	1760	1175	1177	46.4	31.0	31.0	-585	-33%	+2	+0%	-583	-33%
93 FCRS plus two other surveys	1 0 0 1 1	52	22	28	1.4	0.6	0.7	-30	-58%	+6	+27%	-24	-46%
	1 0 1 0 1	293	158	189	7.7	4.2	5.0	-135	-46%	+31	+20%	-104	-35%
	1 0 1 1 0	91	27	45	2.4	0.7	1.2	-64	-70%	+18	+67%	-46	-51%
	1 1 0 0 1	47	39	2	1.2	1.0	0.1	-8	-17%	-37	-95%	-45	-96%
	1 1 0 1 0	11	5	1	0.3	0.1	0.0	-6	-55%	-4	-80%	-10	-91%
	1 1 1 0 0	92	59	1	2.4	1.6	0.0	-33	-36%	-58	-98%	-91	-99%
	Total	586	310	266	15.4	8.2	7.0	-276	-47%	-44	-14%	-320	-55%
93 FCRS plus three other surveys	1 0 1 1 1	36	23	28	0.9	0.6	0.7	-13	-36%	+5	+22%	-8	-22%
	1 1 0 1 1	4	1	0	0.1	0.0	0	-3	-75%	-1	-100%	-4	-100%
	1 1 1 0 1	25	16	5	0.7	0.4	0.1	-9	-36%	-11	-69%	-20	-80%
	1 1 1 1 0	17	6	1	0.5	0.2	0.0	-11	-65%	-5	-83%	-16	-94%
	Total	82	46	34	2.2	1.2	0.9	-36	-44%	-12	-26%	-48	-59%
93 FCRS plus four other surveys	1 1 1 1 1	6	4	1	0.2	0.1	0.0	-2	-33%	-3	-75%	-5	-83%
	Total	6	4	1	0.2	0.1	0.0	-2	-33%	-3	-75%	-5	-83%
Total		3795	3795	3795	100.0	100.0	100.0	0	0%	0	0%	0	0%

† Note: The **Sampling Configuration** indicates the sampling pattern for the 93FCRS, 92FCRS, 93QAS, 93ALS and 93CSS (Cattle and Sheep). For example, a 10001 indicates sample units selected for only the 93FCRS and 93CSS.

Table 3C. For Strata 89 and Below, U.S.: The Number of FCRS Samples and Percent of Total FCRS Sample by Sampling Configuration for the Initial, First Stage Redrawn, and Final Redrawn 1993 FCRS Samples.

Combination of Surveys (1)	Sampling Configuration [†] (2)	Count			Percent			Change					
		Initial	Stage 1	Redrawn	Initial	Stage 1	Redrawn	Initial to Stage 1		Stage 1 to Redrawn		Initial to Redrawn	
		(#)	(#)	(#)	(%)	(%)	(%)	Count	Percent	Count	Percent	Count	Percent
		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
93 FCRS alone	1 0 0 0 0	5256	6835	6895	71.2	92.6	93.4	+1579	+30%	+60	+1%	+1639	+31%
	Total	5256	6835	6895	71.2	92.6	93.4	+1579	+30%	+60	+1%	+1639	+31%
93 FCRS plus one other survey	1 0 0 0 1	593	138	154	8.0	1.9	2.1	-455	-77%	+16	+12%	-439	-74%
	1 0 0 1 0	177	32	39	2.4	0.4	0.5	-145	-82%	+7	+22%	-138	-78%
	1 0 1 0 0	980	169	223	13.3	2.3	3.0	-811	-83%	+54	+32%	-757	-77%
	1 1 0 0 0	93	130	5	1.3	1.8	0.1	+37	+40%	-125	-96%	-88	-95%
	Total	1843	469	421	25.0	6.3	5.7	-1374	-75%	-48	-10%	-1422	-77%
93 FCRS plus two other surveys	1 0 0 1 1	22	2	2	0.3	0.0	0.0	-20	-91%	0	0%	-20	-91%
	1 0 1 0 1	121	31	36	1.6	0.4	0.5	-90	-74%	+5	+16%	-85	-70%
	1 0 1 1 0	56	12	15	0.8	0.2	0.2	-44	-79%	+3	+25%	-41	-73%
	1 1 0 0 1	12	5	2	0.2	0.1	0.0	-7	-58%	-3	-60%	-10	-83%
	1 1 0 1 0	1	1	0	0.0	0.0	0	0	0%	-1	-100%	-1	-100%
	1 1 1 0 0	45	14	4	0.6	0.2	0.1	-31	-69%	-10	-71%	-41	-91%
	Total	257	65	59	3.5	0.9	0.8	-192	-75%	-6	-9%	-198	-77%
93 FCRS plus three other surveys	1 0 1 1 1	9	3	3	0.1	0.0	0.0	-6	-67%	0	0%	-6	-67%
	1 1 0 1 1	2	1	0	0.0	0.0	0	-1	-50%	-1	-100%	-2	-100%
	1 1 1 0 1	8	5	1	0.1	0.1	0.0	-3	-38%	-4	-80%	-7	-88%
	1 1 1 1 0	6	3	3	0.1	0.0	0.0	-3	-50%	0	0%	-3	-50%
	Total	25	12	7	0.3	0.2	0.1	-13	-52%	-5	-42%	-18	-72%
93 FCRS plus four other surveys	1 1 1 1 1	2	2	1	0.0	0.0	0.0	0	0%	-1	-50%	-1	-50%
	Total	2	2	1	0.0	0.0	0.0	0	0%	-1	-50%	-1	-50%
Total		7383	7383	7383	100.0	100.0	100.0	0	0%	0	0%	0	0%

[†] Note: The **Sampling Configuration** indicates the sampling pattern for the 93FCRS, 92FCRS, 93QAS, 93ALS and 93CSS (Cattle and Sheep). For example, a 10001 indicates sample units selected for only the 93FCRS and 93CSS.

three, and four of each table, which are based on the data from the 1992 and 1993 list frame spring classify and sample select, show respectively the overlap for the initial, first stage redrawn, and final redrawn 1993 FCRS samples. Column five shows the additional overlap that is not accounted for in columns two, three, and four. The added overlap resulted from (1) adjustments made to the 1992 FCRS Cost of Production Specialty Strata samples in California, Michigan, Ohio, and Florida after the spring classify and sample select and (2) one added overlap that occurred in Nevada. From Column four of Table 4A it can be seen that three states—Arizona (10), New Hampshire (6), and Rhodes Island (7)—accounted for almost 80 percent of the overlap remaining in the final redrawn sample.

U.S. Level Control Variable Estimates

This section discusses the similarity of the redrawn sample to the initial sample by examining associated population control values. The tables below show for each of eight population control values the estimated totals and coefficients of variation that are associated with the initial, first stage, and redrawn samples.

Table 5A gives the U.S. level estimates, which are derived from the 11,178 farmers in each of the three samples. Table 5B gives the U.S. level estimates for strata 90 and above, which are derived from the 3,795 strata 90 and above farmers in each of the three samples. And, Table 5C gives the U.S. level estimates for strata 89 and below, which are derived from the 7,383 strata 89 and below farmers in each of the three samples.

In each table, column 1 shows the names of control items. Column 2 shows the 1993 population totals for the control items. Columns 3 and 4 show, respectively, the lower and upper bounds for a 90 percent confidence interval centered on the true total for the estimated totals. Columns 5, 6, and 7 show the estimated totals using the initial, first stage, and redrawn sample, respectively. Column 8 shows the coefficients of variation for the estimated totals. Columns 9, 10, and 11 show the estimated coefficients of variation using the initial, first stage, and redrawn sample, respectively.

These tables show that the three samples are very similar with respect to the estimates derived from them. The three estimates tend to fall at almost the same place in the respective confidence intervals. The same is true for the estimated coefficients of variation. If the estimated coefficient of variation for an item is small (large) relative to the true coefficient of variation for one sample then it is also small (large) for the other two samples.

BIAS CONSIDERATIONS

Recall that the first stage of the two stage algorithm cannot bias the FCRS estimates. The next section discusses the potential for bias that arises at the second stage of the algorithm in 1993. The second section discusses the potential for bias that will arise at the second stage of the algorithm in 1994 and beyond. The third section presents a four stage algorithm that should help limit the potential for bias that results from reapplication of the algorithm in subsequent years. The fourth section

Table 4A. For All Strata: The Number of 1993 FCRS Samples in each State that were in the 1992 FCRS Sample for the Initial, First Stage Redrawn, and Final Redrawn 1993 FCRS Samples, along with the Added Overlap Caused by Changes Made to the Sample in the Specialty Strata.

State	Overlap			
	Initial	Stage 1	Redrawn	Added
01: Alabama	6	4	1	
04: Arizona	30	29	10	
05: Arkansas	9	14		
06: California	26	21		2
08: Colorado	16	17		
09: Connecticut	5	1		
10: Delaware	3	2		
12: Florida	11	10	1	2
13: Georgia	5	4		
16: Idaho	15	14		
17: Illinois	15	12		
18: Indiana	6	13		
19: Iowa	23	22		
20: Kansas	18	19		
21: Kentucky	7	6		
22: Louisiana	12	15		
23: Maine	3	2		
24: Maryland	6	5		
25: Massachusetts	2	3		
26: Michigan	11	14		3
27: Minnesota	21	18	1	
28: Mississippi	13	12	1	
29: Missouri	8	7		
30: Montana	2	7		
31: Nebraska	16	16		
32: Nevada	6	4		1
33: New Hampshire	9	7	6	
34: New Jersey	2	3		
36: New York	2	4		
37: North Carolina	12	14		
38: North Dakota	17	17		
39: Ohio	9	9		1
40: Oklahoma	1	1		
41: Oregon	8	7		
42: Pennsylvania	9	6		
44: Rhode Island	12	11	7	
45: South Carolina	9	12		
46: South Dakota	18	19		
47: Tennessee	4	5		
48: Texas	19	17	1	
49: Utah	3	4		
50: Vermont	8	9		
51: Virginia	4	4		
53: Washington	7	8		
54: West Virginia	4	3		
55: Wisconsin	2	3	1	
56: Wyoming	15	12		
Total	469	466	29	9
Cumulative Percent Reduction		0.6%	93.8%	

Table 4B. For Stratum 90 and Above: The Number of 1993 FCRS Samples in each State that were in the 1992 FCRS Sample for the Initial, First Stage Redrawn, and Final Redrawn 1993 FCRS Samples, along with the Added Overlap Caused by Changes Made to the Sample in the Specialty Strata.

State	Overlap			
	Initial	Stage 1	Redrawn	Added
01: Alabama	2	2		
04: Arizona	17	18	4	
05: Arkansas	7	10		
06: California	23	18		2
08: Colorado	8	9		
09: Connecticut	1	0		
10: Delaware	2	1		
12: Florida	8	4	1	
13: Georgia	4	4		
16: Idaho	6	7		
17: Illinois	12	10		
18: Indiana	3	8		
19: Iowa	18	16		
20: Kansas	16	18		
21: Kentucky	4	4		
22: Louisiana	7	8		
23: Maine	2	2		
24: Maryland	5	4		
25: Massachusetts	2	3		
26: Michigan	6	6		
27: Minnesota	13	13	1	
28: Mississippi	8	8		
29: Missouri	0	1		
30: Montana	0	2		
31: Nebraska	13	12		
32: Nevada	4	3		1
33: New Hampshire	7	7	6	
34: New Jersey	2	3		
36: New York	2	4		
37: North Carolina	10	11		
38: North Dakota	13	12		
39: Ohio	5	6		
40: Oklahoma	1	1		
41: Oregon	4	4		
44: Rhode Island				
42: Pennsylvania	7	4		
45: South Carolina	7	9		
46: South Dakota	14	14		
47: Tennessee	1	2		
48: Texas	17	16	1	
49: Utah	0	1		
50: Vermont	2	4		
51: Virginia	2	3		
53: Washington	5	4		
54: West Virginia	3	2		
55: Wisconsin	0	1		
56: Wyoming	7	6		
Total	300	305	13	3
Cumulative Percent Reduction		-1.7%	95.7%	

Table 4C. For Stratum 89 and Below: The Number of 1993 FCRS Samples in Each State that were in the 1992 FCRS Sample for the Initial, First Stage Redrawn, and Final Redrawn 1993 FCRS Samples, along with the Added Overlap Caused by Changes Made to the Sample in the Specialty Strata.

State	Overlap			
	Initial	Stage 1	Redrawn	Added
01: Alabama	4	2	1	
04: Arizona	13	11	6	
05: Arkansas	2	4		
06: California	3	3		
08: Colorado	8	8		
09: Connecticut	4	1		
10: Delaware	1	1		
12: Florida	3	6		2
13: Georgia	1	0		
16: Idaho	9	7		
17: Illinois	3	2		
18: Indiana	3	5		
19: Iowa	5	6		
20: Kansas	2	1		
21: Kentucky	3	2		
22: Louisiana	5	7		
23: Maine	1	0		
24: Maryland	1	1		
26: Michigan	5	8		3
27: Minnesota	8	5		
28: Mississippi	5	4	1	
29: Missouri	8	6		
30: Montana	2	5		
31: Nebraska	3	4		
32: Nevada	2	1		
33: New Hampshire	2			
37: North Carolina	2	3		
38: North Dakota	4	5		
39: Ohio	4	3		1
41: Oregon	4	3		
42: Pennsylvania	2	2		
44: Rhode Island	12	11	7	
45: South Carolina	2	3		
46: South Dakota	4	5		
47: Tennessee	3	3		
48: Texas	2	1		
49: Utah	3	3		
50: Vermont	6	5		
51: Virginia	2	1		
53: Washington	2	4		
54: West Virginia	1	1		
55: Wisconsin	2	2	1	
56: Wyoming	8	6		
Total	169	161	16	6
Cumulative Percent Reduction		4.7%	90.5%	

Table 5A. For All Strata, U.S.: The Estimated 1993 Population Control Variable Totals for the Initial, First Stage Redrawn, and Final Redrawn 1993 FCRS Sample.

Control Variable [†] (1)	Population Total (#) (2)	90% Lower Bound (#) (3)	90% Upper Bound (#) (4)	Estimated Total			Exact CV of Estimated Total (%) (8)	Estimated CV		
				Initial Sample (#) (5)	Stage 1 Sample (#) (6)	Redrawn Sample (#) (7)		Initial Sample (%) (9)	Stage 1 Sample (%) (10)	Redrawn Sample (%) (11)
Total Land in Farm	862.52	47.04	1678.01	791.28	798.17	790.29	57.30	2.31	2.46	2.43
Farm Value of Sales	150.53	148.44	152.62	151.96	151.93	151.76	0.84	0.86	0.85	0.84
Total Cropland	363.62	327.21	400.03	363.54	365.83	364.74	6.07	1.11	1.07	1.06
On-Farm Grain Storage	947.58	902.34	992.81	992.67	990.91	997.68	2.89	2.98	2.88	2.99
All Cattle & Calves	850.13	811.07	889.19	821.80	829.07	840.22	2.78	3.05	3.21	3.61
Total Hogs & Pigs	547.15	457.17	637.12	588.76	576.22	585.09	9.97	5.33	4.08	4.29
All Sheep	114.96	88.60	141.32	106.15	103.90	103.23	13.90	13.02	13.13	13.20
Farm Workers Hired	127.21	58.80	195.61	102.40	102.54	102.05	32.59	5.22	5.31	5.33

[†] All missing control values were set to zero before any computations were performed. The units of measure for the population totals and their estimates are:

1,000,000 acres for Total Land; \$1,000,000,000 for Farm Value Of Sales;
 1,000,000 acres for Total Cropland; 10,000,000 bushels for On-Farm Grain Storage;
 100,000 head for Cattle & Calves, Hogs & Pigs, and Sheep; 10,000 workers Farm Workers Hired.

Table 5B. For Strata 90 and Above, U.S.: The Estimated 1993 Population Control Variable Totals for the Initial, First Stage Redrawn, and Final Redrawn 1993 FCRS Sample.

Control Variable [†] (1)	Population Total (#) (2)	90% Lower Bound (#) (3)	90% Upper Bound (#) (4)	Estimated Total			Exact CV of Estimated Total (%) (8)	Estimated CV		
				Initial Sample (#) (5)	Stage 1 Sample (#) (6)	Redrawn Sample (#) (7)		Initial Sample (%) (9)	Stage 1 Sample (%) (10)	Redrawn Sample (%) (11)
Total Land in Farm	200.12	160.57	239.67	196.58	192.54	187.86	11.98	5.19	5.16	5.13
Farm Value of Sales	50.00	48.26	51.73	50.77	50.74	50.52	2.10	2.14	2.13	2.12
Total Cropland	87.84	53.34	122.33	81.81	82.47	81.91	23.80	1.94	1.93	1.90
On-Farm Grain Storage	209.98	198.54	221.41	220.22	221.58	221.84	3.30	3.96	3.93	3.99
All Cattle & Calves	285.97	251.17	320.77	286.42	295.52	307.11	7.38	7.93	8.30	9.29
Total Hogs & Pigs	198.78	113.57	283.98	196.45	177.03	181.23	25.98	12.75	7.47	8.62
All Sheep	32.95	18.40	47.50	32.10	33.26	32.28	26.76	25.68	25.10	25.57
Farm Workers Hired	45.00	25.34	64.64	37.16	36.63	35.48	26.47	8.02	8.04	8.16

[†] All missing control values were set to zero before any computations were performed. The units of measure for the population totals and their estimates are:

1,000,000 acres for Total Land; \$1,000,000,000 for Farm Value Of Sales;
 1,000,000 acres for Total Cropland; 10,000,000 bushels for On-Farm Grain Storage;
 100,000 head for Cattle & Calves, Hogs & Pigs, and Sheep; 10,000 workers Farm Workers Hired.

Table 5C. For Strata 89 and Below, U.S.: The Estimated 1993 Population Control Variable Totals for the Initial, First Stage Redrawn, and Final Redrawn 1993 FCRS Sample.

Control Variable [†] (1)	Population Total (#) (2)	90% Lower Bound (#) (3)	90% Upper Bound (#) (4)	Estimated Total			Exact CV of Estimated Total (%) (8)	Estimated CV		
				Initial Sample (#) (5)	Stage 1 Sample (#) (6)	Redrawn Sample (#) (7)		Initial Sample (%) (9)	Stage 1 Sample (%) (10)	Redrawn Sample (%) (11)
				Total Land in Farm	662.40	-152.13		1476.92	594.70	605.63
Value of Sales	100.53	99.36	101.71	101.19	101.19	101.24	0.71	0.70	0.68	0.68
Total Cropland	275.78	264.14	287.43	281.73	283.36	282.83	2.56	1.32	1.26	1.25
On-Farm Grain Storage	737.60	693.84	781.37	772.45	769.32	775.84	3.60	3.66	3.53	3.68
All Cattle & Calves	564.16	546.42	581.89	535.38	533.56	533.11	1.91	1.97	1.93	1.93
Total Hogs & Pigs	348.37	319.46	377.28	392.31	399.19	403.85	5.03	4.82	4.86	4.86
All Sheep	82.01	60.02	103.99	74.05	70.65	70.95	16.25	14.98	15.28	15.29
Farm Workers Hired	82.22	16.70	147.74	65.24	65.91	66.57	48.30	6.80	6.94	6.91

[†] All missing control values were set to zero before any computations were performed. The units of measure for the population totals and their estimates are:

1,000,000 acres for Total Land;	\$1,000,000,000 for Farm Value Of Sales;
1,000,000 acres for Total Cropland;	10,000,000 bushels for On-Farm Grain Storage;
100,000 head for Cattle & Calves, Hogs & Pigs, and Sheep;	10,000 workers Farm Workers Hired.

presents a five stage algorithm that should further limit the potential for bias that results from reapplication of the algorithm in subsequent years.

For the 1993 FCRS Estimates

With respect to any bias that might be caused by redrawing the 1993 FCRS sample with the two stage algorithm, the earlier discussions of this report can be summarized as follows:

1. The first stage of the algorithm has no potential to introduce bias into the FCRS estimates;
2. Only when the information from the 1992 FCRS is used to update the 1993 FCRS frame, does the second stage of the algorithm have a potential to introduce bias into the FCRS estimates; and

3. Only about four percent of the 1993 FCRS sample (444 out of 11,178 sampled records or 3.97 percent) were redrawn in the second stage of the two stage algorithm. The expanded control data associated with the 444 records ranged from 3.4 to 5.9 percent of respective control data totals.

Thus, only about four percent of the redrawn 1993 FCRS sample has any potential to introduce bias into the 1993 FCRS estimates. And, only those records in the four percent that have had their control data updated from 1992 FCRS sample data can introduce any bias into the estimates.

The small impact of any possible bias that might be introduced by the use of 1992 FCRS sample data to update the 1993 FCRS frame on the 1993 FCRS estimates can be seen as follows. Assume that 1992 FCRS sample data are used to update the 1993 FCRS frame and that the two stage algorithm discussed in this report is used to redraw the sample. The records redrawn in the second stage will then tend to have older control data than the ones they replaced. If the difference in the age of the control data associated with the records that are redrawn at the second stage is related to the data collected from the records then bias will be introduced into the FCRS estimates.

To show that the effect of this potential bias on the 1993 FCRS estimates is small, consider a (highly unlikely) worst-case example. Suppose that the change in age of the control data causes the data collected from the part of the sample that is redrawn in the second stage to be consistently 20 percent smaller (or

larger) than the data that would have been collected had the elements not been redrawn. Note that this much bias in the four percent of the sample redrawn at the second stage seems highly unlikely, since there is little reason to believe that any significant amount of information from the 1992 FCRS sample is used to update control data prior to the 1993 FCRS frame stratification. Further, it is unlikely that slightly older or newer control data would produce such a large difference in the relationship between the control data and observations.

From the discussion above, the expanded control data of the four percent of the sample that was redrawn in the second stage ranged from 3.4 to 5.9 percent of respective totals. Making a worst case assumption, assume that the expanded data of the part of the sample redrawn in the second stage represents five percent of the estimate. Even under these extreme assumptions, redrawing the sample at the second stage would cause only a one percent change ($0.20 * 0.05 = 0.01$) in the 1993 estimates. This change would be undetectable in light of the coefficients of variation associated with the FCRS estimates. Thus, even though the second stage of the algorithm cannot be guaranteed to be unbiased, it is highly unlikely that any detectable bias will result from redrawing the 1993 FCRS sample.

For the 1994 FCRS Estimates, If the Same Two Stage Algorithm is Used

If the same two stage algorithm is used sequentially in two years, then the second stage of the algorithm potentially can introduce bias into the FCRS estimates,

even when no information from the previous year's FCRS sample is used to update the current FCRS frame. With respect to redrawing the 1994 FCRS, the situation can be summarized as follows:

1. The first stage of the algorithm has no potential to introduce bias into the FCRS estimates;
2. The second stage of the algorithm has a potential to introduce bias into the FCRS estimates if any sample data from the 1993 FCRS, QAS, ALS, or CSS samples is used to update the 1994 FCRS frame; however,
3. In 1994, less than three percent of the FCRS sample will be redrawn at the second stage of the two stage algorithm. This assumes that the 1994 FCRS has the same sample size as the 1993 FCRS and that the percentage redrawn in any year is proportional to the expected overlap with the previous year's sample, which is approximately proportional for small sampling fractions to the product of the sample sizes in consecutive years ($3.97\% * (11,178 * 11,178)/(11,178 * 16,600) = 2.67\% < 3\%$).

The use of 1993 FCRS sample data to update the 1994 FCRS frame opens the 1994 FCRS estimates to potential bias just as it did in 1993. For the same reasons that were sighted for the 1993 FCRS, it is unlikely that any detectable bias will result in 1994 from this source of potential bias.

However, in 1994 the use of 1993 QAS, ALS, and CSS sample data to update the 1994 FCRS frame opens the 1994 FCRS estimates to another potential source of bias. Since the 1993 FCRS sample was

redrawn to reduce its overlap with the other 1993 survey samples, when the part of the first stage 1994 FCRS sample that overlaps with the 1993 FCRS is redrawn in the second stage to reduce its overlap with the 1993 FCRS sample, the resulting sample will be more likely to contain farmers that were in one of the other 1993 surveys—hence more likely to have their control data updated in 1993. Therefore, the part of the 1994 FCRS sample that is redrawn at the second stage is more likely to have updated control data than the frame population, and hence, may not be representative of the population.

Thus, in 1994 and subsequent years, even when no FCRS data from the previous year's FCRS sample has been used to update the FCRS frame, the second stage of the algorithm has a potential to introduce bias into the FCRS estimates, since one cannot guarantee that the farmers in a substratum do not differ by the age of their control data. The next section presents a four stage algorithm that should help to limit this potential source of bias by restricting the later stage of the redrawing process to substrata that incorporate both the original multivariate stratifications and two indicators of a record's control data age.

For the 1994 FCRS Estimates, If a Four Stage Algorithm is Used

The four stage algorithm presented in this section removes at each successive stage more and more of overlap between the 1993 and 1994 FCRS while maintaining at each stage, to the extent possible, the control data age characteristics of the sample. The four stage algorithm is

derived from the components of the two stage algorithm as follows. First, use the first stage of the two stage algorithm to remove, to the extent possible, the overlap of the 1994 FCRS sample with the other 1994 surveys' samples. Then, use the second stage of the two stage algorithm three times with less and less restrictive age dependent substrata to reduce the overlap between the 1993 and 1994 FCRS samples.

The substrata are made to depend on the age of the control values of the records they contain through two age indicators: the last year Total Land In Farm, Total Crop Land, or On-Farm Grain Storage was updated is used as an indicator or proxy for the age of a record's field crop control values; and the last year All Cattle and Calves, Total Hogs and Pigs, or All Sheep was updated is used as an indicator or proxy for the age of a record's livestock control values. The second stage redraws the records of the 1994 FCRS sample that overlap with the 1993 FCRS sample within the substrata formed by cross classifying the records according to the 1994 FCRS, 1993 FCRS, 1994 QAS, 1994 ALS, 1994 CSS strata and the two age indicators. The third stage redraws the records of the 1994 FCRS sample that overlap with the 1993 FCRS sample within the substrata formed by cross classifying the records according to the 1994 FCRS and 1993 FCRS strata and the two age indicators. The fourth stage redraws the records of the 1994 FCRS sample that overlap with the 1993 FCRS sample within the substrata formed by cross classifying the records according to the 1994 FCRS strata and the two age indicators.

In the last three stages of this four stage algorithm, each record that is

redrawn has the same age indicator as the record it replaces, which should limit the potential for bias that might arise because of application of the algorithm in two consecutive years. In addition, at the second stage, the redrawn records have the same stratification with respect to all five surveys, at the third stage the same stratification with respect to the 1993 and 1994 FCRS surveys, and at the fourth stage the same stratification with respect to the 1994 FCRS. The last three stages are progressively less restrictive. Hence, each stage provides progressively more overlap reduction and less protection against potential bias. Thus, we see that at each stage the gains in burden reduction come at the expense of the loss of some protection against bias.

Had this four stage algorithm been used to redraw the FCRS sample in 1993, the overlap between the 1992 and 1993 FCRS samples would have been reduced at the second stage from 466 to 273 (a 41 percent reduction), at the third stage from 273 to 65 (a 44 percent reduction), and at the fourth stage from 65 to 32 (a 7 percent reduction). Tables B1, B2, and B3 of Appendix B show a detailed breakdown of the burden reduction that would have been achieved with the four stage algorithm at each stage of the algorithm.

Tables B4, B5, and B6 of Appendix B show the number of farmers in each state that would have been in the redrawn 1993 FCRS sample at each stage with the four stage algorithm that were also in the 1992 FCRS sample. Tables B7, B8, and B9 of Appendix B show the U.S. level control variable estimates and coefficients of variation derived from the sample at each stage with the four stage algorithm that were also in the 1992 FCRS sample.

The next section presents a five stage algorithm that further restricts the records of each substrata to one FCRS Farm Type. This additional restriction will help ensure that the age indicators are more comparable with substrata, and consequently, that the records of each substratum are more alike with respect to the expected current FCRS data.

For the 1994 FCRS Estimates, If a Five Stage Algorithm is Used

The five stage algorithm presented in this section removes at each successive stage more and more of overlap between the 1993 and 1994 FCRS while maintaining at each stage, to the extent possible, the control data age and farm type characteristics of the sample.

The first stage of the algorithm is the same as the first stage of the four stage algorithm. The second, third, and fourth stages of the algorithm are obtained from the corresponding stages of the four stage algorithm by further restricting the substrata to one FCRS Farm Type. The fifth stage is obtained from the fourth stage by substituting a single age indicator for the two age indicators. The last year Total Land In Farm, Total Crop Land, On-Farm Grain Storage, All Cattle and Calves, Total Hogs and Pigs, or All Sheep was updated is used at the fifth stage as a single age indicator. Restricting the substrata to one farm type should help make sure that the age indicators are more comparable within the substrata. This should further limit the potential for bias that might arise because of application of the algorithm in two consecutive years. A sixth stage is added to the five stage algorithm solely

for the purpose of making comparisons. The sixth stage is obtained from the fifth stage by dropping the age indicators altogether. The last five stages of the algorithm are progressively less restrictive. Hence, each stage provides progressively more overlap reduction and less protection against potential bias. Which means that at each stage the gains in burden reduction come at the expense of the loss of bias protection. Note that, the sixth stage provides no protection against bias arising from differences in the age of the control data.

Had this five (six) stage algorithm been used to redraw the FCRS sample in 1993, the overlap between the 1992 and 1993 FCRS samples would have been reduced at the second stage from 466 to 285 (a 39 percent reduction), at the third stage from 285 to 80 (a 44 percent reduction), at the fourth stage from 80 to 41 (a 8 percent reduction), at the fifth stage from 41 to 32 (a 2 percent reduction), and at the fifth stage from 32 to 23 (a 2 percent reduction). Tables B10, B11, and B12 of Appendix B show a detailed breakdown of the burden reduction that would have been achieved with the five stage algorithm at each stage of the algorithm.

Tables B13, B14, and B15 of Appendix B show the number of farmers in each state that would have been in the redrawn 1993 FCRS sample at each stage with the five stage algorithm that were also in the 1992 FCRS sample. Tables B16, B17, and B18 of Appendix B show the U.S. level control variable estimates and coefficients of variation derived from the sample at each stage with the five stage algorithm that were also in the 1992 FCRS sample.

Theoretically, it would be simple to test the second and latter stage of these algorithms for potential bias by either 1) collecting data from the farmers in the FCRS year-to-year overlap in addition to the data from redrawn farmers or 2) by splitting the FCRS year-to-year overlap and only using half of it. To split the year-to-year FCRS overlap one would divide the records that were redrawn at the second and latter stage into pairs based on all the available information, then randomly choose one record from each pair to be redrawn. The other record from each pair that would be used would be the record selected at the end of the first stage of the algorithm. All tests would need to be based on expanded data, since our interest is in potential for bias with respect to the FCRS estimates. Thus, in practice, neither procedure would likely yield useful information, since at best one would have no more than 400 records, which would be scattered over all strata in all states.

CONCLUSIONS

Redrawing the 1993 FCRS list frame sample of 11,178 farmers reduced the burden on the individual farmer sampled by:

1. Decreasing the number of 1993 FCRS samples that were in one or more of the other samples (1993 QAS, ALS, CSS or 1992 FCRS) from 4,561 to 1,966 (a decrease of 57 percent),
2. Decreasing the number of 1993 FCRS samples that were in the 1992 FCRS sample from 469 to 29 (a decrease of 94 percent), and
3. Increasing the number of 1993 FCRS samples that are not in any of the other four surveys from 6,617 to 9,212 (an increase of 39 percent).

The two stage algorithm used to redraw the 1993 FCRS has very little potential to introduce bias into the 1993 FCRS estimates. In fact, only at the second stage, which involves less than four percent of the sample, does it have any potential of introducing bias. At the second stage, the potential to introduce bias is limited to those samples which have had their 1992 FCRS sample information used to update the 1993 FCRS frame.

The primary reason that a two stage algorithm was chosen over a single stage algorithm for redrawing the 1993 FCRS was to minimize the potential to introduce bias into the FCRS estimates. A secondary reason for the choice was that the two stage algorithm also provides considerably more burden reduction than the single stage algorithm.

If the same two step algorithm is used again next year to redraw the 1994 FCRS, the potential to introduce bias into the FCRS estimates will increase. This increased bias potential results from the use of 1993 QAS, ALS, and CSS sample data to update the 1994 FCRS frame which tends to cause the 1994 FCRS sample to be placed on records that have had their control data updated recently.

A four stage algorithm and a five stage algorithm were discussed that should help limit the potential bias that may result from the use of 1993 sample data to update the 1994 FCRS frame. Since the five stage algorithm places more age

indicator and Farm Type restrictions on the substrata used in the latter stages of the algorithm than either the two or four stage algorithms it should provide the most protection against potential bias. A comparison of the two, four, and five stage algorithms using the 1992 and 1993 frame and sample data shows that they provide similar levels of burden reduction.

Since any potential bias is restricted to the latter stages of the redrawing process with all algorithms, it will affect less than three percent of the sample (assuming that the 1994 FCRS sample is the same size as in 1993). With only three percent of the sample being redrawn in the latter stages it seems that under a worst-case example at most a one percent bias would be expected with either the four or five stage algorithm. Hence, in comparison to the coefficients of variation associated with FCRS items, any bias should be undetectable.

RECOMMENDATIONS

The 1993 FCRS was redrawn using a new two stage algorithm in order to substantially reduce respondent burden. The algorithm was performed by the Research Division in cooperation with Survey Management Division in a joint research and operations staff effort.

For The 1994 FCRS

Redraw the 1994 FCRS sample with the five stage algorithm. The use of the five stage algorithm will limit to the extent possible the potential for bias that results from the use of 1993 sample data to update

the 1994 FCRS frame. Since the potential for bias in 1994 FCRS estimates is only slightly more than it was with 1993 FCRS estimates, the reduction in burden that will be obtained with the 1994 FCRS outweighs the increased potential for bias.

For The 1996 Sample Select

Research Division is evaluating the two methods described by Perry, Burt, and Iwig (1993) for selecting multiple survey samples to reduce burden on the individuals selected in all samples. This work will be completed in 1995 and at that time recommendations will be made for incorporating the results into the 1996 Sample Select.

REFERENCES

Perry, Charles R., Jameson C. Burt, and William C. Iwig; "Methods Of Selecting Samples In Multiple Surveys To Reduce Respondent Burden"; *Proceedings of the International Conference on Establishment Surveys*; ASA; Alexandria, Virginia; June 1993.

Perry, Charles R., Jameson C. Burt, and William C. Iwig; "Redrawing the 1993 Farm Cost and Returns Survey List Sample to Reduce Overlap with Three Other 1993 Surveys and the 1992 FCRS"; *1994 Proceedings of the Section on Survey Research Methods*; ASA; Alexandria, Virginia; 1994.

APPENDIX A: BURDEN REDUCTION FOR A SINGLE STAGE ALGORITHM

The following three tables give a detailed breakdown of the burden reduction that would have been obtained had a single stage algorithm been used to redraw the 1993 FCRS sample. A comparison of these tables with Table 3A, 3B, and 3C, respectively, will show that the two step algorithm does a much better job of reducing the overlap of the 1993 FCRS sample with both the 1992 FCRS sample and the other three 1993 samples. In particular, had the single stage algorithm been used to redraw the 1993 FCRS, there would have been 171 farmers in the 1993 FCRS sample that were also in the 1992 FCRS sample; whereas, with the two stage algorithm, there were only 29 farmers in the 1993 FCRS who were also in the 1992 FCRS sample.

U.S. Level Burden Reduction

Table A1. For All Strata Using a Single Stage Algorithm, U.S.: The Number of FCRS Samples and Percent of Total FCRS Sample by Sampling Configuration for the Initial and Redrawn 1993 FCRS Samples.

Combination of Surveys (1)	Sampling Configuration [†] (2)	Count		Percent		Change	
		Initial (#) (3)	Redrawn (#) (4)	Initial (%) (5)	Redrawn (%) (6)	Count (#) (7)	Percent (%) (8)
93 FCRS alone	1 0 0 0 0	6617	8853	59.2	79.2	+2236	+34%
	Total	6617	8853	59.2	79.2	+2236	+34%
93 FCRS plus one other survey	1 0 0 0 1	1110	695	9.9	6.2	-415	-37%
	1 0 0 1 0	336	113	3.0	1.0	-223	-66%
	1 0 1 0 0	1966	964	17.6	8.6	-1002	-51%
	1 1 0 0 0	191	55	1.7	0.5	-136	-71%
	Total	3603	1827	32.2	16.3	-1776	-49%
93 FCRS plus two other surveys	1 0 0 1 1	74	38	0.7	0.3	-36	-49%
	1 0 1 0 1	414	245	3.7	2.2	-169	-41%
	1 0 1 1 0	147	69	1.3	0.6	-78	-53%
	1 1 0 0 1	59	24	0.5	0.2	-35	-59%
	1 1 0 1 0	12	5	0.1	0.0	-7	-58%
	1 1 1 0 0	137	43	1.2	0.4	-94	-69%
	Total	843	424	7.5	3.8	-419	-50%
93 FCRS plus three other surveys	1 0 1 1 1	45	30	0.4	0.3	-15	-33%
	1 1 0 1 1	6	3	0.1	0.0	-3	-50%
	1 1 1 0 1	33	24	0.3	0.2	-9	-27%
	1 1 1 1 0	23	11	0.2	0.1	-12	-52%
	Total	107	68	1.0	0.6	-39	-36%
93 FCRS plus four other surveys	1 1 1 1 1	8	6	0.1	0.1	-2	-25%
	Total	8	6	0.1	0.1	-2	-25%
Total		11,178	11,178	100.0	100.0	0	0%

[†] Note: The **Sampling Configuration** indicates the sampling pattern for the 93FCRS, 92FCRS, 93QAS, 93ALS and 93CSS (Cattle and Sheep). For example, a 10001 indicates sample units selected for only the 93FCRS and 93CSS.

Table A2. For Strata 90 and Above Using a Single Stage Algorithm, U.S.: The Number of FCRS Samples and Percent of Total FCRS Sample by Sampling Configuration for the Initial and Final Redrawn 1993 FCRS Samples.

Combination of Surveys (1)	Sampling Configuration [†] (2)	Count		Percent		Change	
		Initial (#) (3)	Redrawn (#) (4)	Initial (%) (5)	Redrawn (%) (6)	Count (#) (7)	Percent (%) (8)
93 FCRS alone	1 0 0 0 0	1361	2121	35.9	55.9	+760	+56%
	Total	1361	2121	35.9	55.9	+760	+56%
93 FCRS plus one other survey	1 0 0 0 1	517	502	13.6	13.2	-15	-3%
	1 0 0 1 0	159	71	4.2	1.9	-88	-55%
	1 0 1 0 0	986	667	26.0	17.6	-319	-32%
	1 1 0 0 0	98	39	2.6	1.0	-59	-60%
	Total	1760	1279	46.4	33.7	-481	-27%
93 FCRS plus two other surveys	1 0 0 1 1	52	31	1.4	0.8	-21	-40%
	1 0 1 0 1	293	201	7.7	5.3	-92	-31%
	1 0 1 1 0	91	52	2.4	1.4	-39	-43%
	1 1 0 0 1	47	19	1.2	0.5	-28	-60%
	1 1 0 1 0	11	4	0.3	0.1	-7	-64%
	1 1 1 0 0	92	29	2.4	0.8	-63	-68%
	Total	586	336	15.4	8.8	-250	-43%
93 FCRS plus three other surveys	1 0 1 1 1	36	26	0.9	0.7	-10	-28%
	1 1 0 1 1	4	2	0.1	0.1	-2	-50%
	1 1 1 0 1	25	19	0.7	0.5	-6	-24%
	1 1 1 1 0	17	8	0.5	0.2	-9	-53%
	Total	82	55	2.2	1.4	-27	-33%
93 FCRS plus four other surveys	1 1 1 1 1	6	4	0.2	0.1	-2	-33%
	Total	6	4	0.2	0.1	-2	-33%
Total		3795	3795	100.0	100.0	0	0%

[†] Note: The **Sampling Configuration** indicates the sampling pattern for the 93FCRS, 92FCRS, 93QAS, 93ALS and 93CSS (Cattle and Sheep). For example, a 10001 indicates sample units selected for only the 93FCRS and 93CSS.

Table A3. For Strata 89 and Below Using a Single Stage Algorithm, U.S.: The Number of FCRS Samples and Percent of Total FCRS Sample by Sampling Configuration for the Initial and Final Redrawn 1993 FCRS Samples.

Combination of Surveys (1)	Sampling Configuration [†] (2)	Count		Percent		Change	
		Initial (#) (3)	Redrawn (#) (4)	Initial (%) (5)	Redrawn (%) (6)	Count (#) (7)	Percent (%) (8)
93 FCRS alone	1 0 0 0 0	5256	6732	71.2	91.2	+1476	+28%
	Total	5256	6732	71.2	91.2	+1476	+28%
93 FCRS plus one other survey	1 0 0 0 1	593	193	8.0	2.6	-400	-67%
	1 0 0 1 0	177	42	2.4	0.6	-135	-76%
	1 0 1 0 0	980	297	13.3	4.0	-683	-70%
	1 1 0 0 0	93	16	1.3	0.2	-77	-83%
	Total	1843	548	25.0	7.4	-1295	-70%
93 FCRS plus two other surveys	1 0 0 1 1	22	7	0.3	0.1	-15	-68%
	1 0 1 0 1	121	44	1.6	0.6	-77	-64%
	1 0 1 1 0	56	17	0.8	0.2	-39	-70%
	1 1 0 0 1	12	5	0.2	0.1	-7	-58%
	1 1 0 1 0	1	1	0.0	0.0	0	0%
	1 1 1 0 0	45	14	0.6	0.2	-31	-69%
	Total	257	88	3.5	1.2	-169	-66%
93 FCRS plus three other surveys	1 0 1 1 1	9	4	0.1	0.1	-5	-56%
	1 1 0 1 1	2	1	0.0	0.0	-1	-50%
	1 1 1 0 1	8	5	0.1	0.1	-3	-38%
	1 1 1 1 0	6	3	0.1	0.0	-3	-50%
	Total	25	13	0.3	0.2	-12	-48%
93 FCRS plus four other surveys	1 1 1 1 1	2	2	0.0	0.0	0	0%
	Total	2	2	0.0	0.0	0	0%
Total		7383	7383	100.0	100.0	0	0%

[†] Note: The **Sampling Configuration** indicates the sampling pattern for the 93FCRS, 92FCRS, 93QAS, 93ALS and 93CSS (Cattle and Sheep). For example, a 10001 indicates sample units selected for only the 93FCRS and 93CSS.

APPENDIX B: BURDEN REDUCTION, OVERLAP REDUCTION, AND BIAS FOR THE FOUR STAGE AND FIVE STAGE ALGORITHMS

Tables B1, B2, and B3 show a detailed breakdown of the burden reduction that would have been achieved had the four stage algorithm been used to redraw the 1993 FCRS. The initial 1993 FCRS sample was redrawn at the first stage within the substrata formed by crossing the four 1993 FCRS, QAS, ALS, and CSS stratifications to reduce to the extent possible its overlap with the other three 1993 surveys' samples. The part of the first stage redrawn sample that overlapped with the 1992 FCRS sample was redrawn at the second stage within the substrata formed by crossing the 1992 FCRS strata; the 1993 FCRS, QAS, ALS, and CSS strata; and the two age indicators to reduce to the extent possible its overlap with the 1992 FCRS sample. The part of the second stage redrawn sample that still overlapped with the 1992 FCRS sample was redrawn at the third stage within the substrata formed by crossing the 1992 FCRS strata, the 1993 FCRS strata, and the two age indicators to reduce to the extent possible its overlap with the 1992 FCRS sample. The part of the third stage redrawn sample that still remained overlapped with the 1992 FCRS sample was redrawn at the fourth stage within the substrata formed by crossing the 1993 FCRS strata and the two age indicators to reduce to the extent possible its overlap with the 1992 FCRS sample.

Tables B4, B5, and B6 show the overlap in each state between the 1992 FCRS sample and the 1993 redrawn FCRS sample that

would have remain at each stage had the four stage algorithm been used to redraw the 1993 FCRS. Table B4 shows that the four stage algorithm reduces the overlap at the end of the fourth stage to no more than one in all but three states: Arizona, New Hampshire, and Rhode Island. The overlap in these three states account 72 percent of the remaining overlap at the end of the four stage algorithm.

Tables B7, B8, and B9 show for eight population control values the estimated totals and coefficients of variation that would have been associated with the sample at each stage had the four stage algorithm been used to redraw the 1993 FCRS. The U.S. level estimates are given in Table B7 for all strata; in Table B8 for stratum 90 and above; and in Table B9 for stratum 89 and below. These tables show that the samples are very similar at each stage with respect to the estimates derived from them. The estimates tend to fall at almost the same place in the respective confidence intervals; the same is true for the estimated coefficients of variation.

Tables B10, B11, and B12 show a detailed breakdown of the burden reduction that would have been achieved had the five stage algorithm been used to redraw the 1993 FCRS. The initial 1993 FCRS sample was redrawn at the first stage within the substrata formed by crossing the four 1993 FCRS, QAS, ALS, and CSS stratifications to reduce to the extent possible its overlap with the other three 1993 surveys' samples. The part of the first stage redrawn sample that overlapped with the 1992 FCRS sample was redrawn at the second stage within the substrata formed by crossing the 1992 FCRS strata; the 1993 FCRS, QAS, ALS, and CSS strata;

FCRS Farm Type; and the two age indicators to reduce to the extent possible its overlap with the 1992 FCRS sample. The part of the second stage redrawn sample that still overlapped with the 1992 FCRS sample was redrawn at the third stage within the substrata formed by crossing the 1992 FCRS strata, the 1993 FCRS strata, FCRS Farm Type, and the two age indicators to reduce to the extent possible its overlap with the 1992 FCRS sample. The part of the third stage redrawn sample that still remained overlapped with the 1992 FCRS sample was redrawn at the fourth stage within the substrata formed by crossing the 1993 FCRS strata, FCRS Farm Type, and the two age indicators to reduce to the extent possible its overlap with the 1992 FCRS sample. The part of the fourth stage redrawn sample that still remained overlapped with the 1992 FCRS sample was redrawn at the fifth stage within the substrata formed by crossing the 1993 FCRS strata, FCRS Farm Type, and the single age indicator to reduce to the extent possible its overlap with the 1992 FCRS sample. The part of the fifth stage redrawn sample that still remained overlapped with the 1992 FCRS sample was redrawn at the sixth stage within the substrata formed by crossing the 1993 FCRS strata and the FCRS Farm Type to reduce to the extent possible its overlap with the 1992 FCRS sample. Note that *the sixth stage is not really a part of the five stage algorithm* and that it provides no protection against bias arising from differences in the age of the control data. It is just being carried along to determine the amount of overlap reduction that could be obtained with no age indicator restrictions.

Tables B13, B14, and B15 show the overlap

in each state between the 1992 FCRS sample and the 1993 redrawn FCRS sample that would have remained at each stage (including the extra sixth stage) had the five stage algorithm been used to redraw the 1993 FCRS. Table B13 shows that the five stage algorithm reduces the overlap at the end of the fifth stage to no more than two in all but three states: Arizona, New Hampshire, and Rhode Island. The overlap in these three states account 66 percent of the remaining overlap at the end of the five stage algorithm. Note that, if no age indicator restrictions had been used the FCRS to FCRS overlap would have been reduced only from 32 to 23.

Tables B16, B17, and B18 show for eight population control values the estimated totals and coefficients of variation that would have been associated with the sample at each stage had the five stage algorithm been used to redraw the 1993 FCRS. The U.S. level estimates are given in Table B16 for all strata; in Table B17 for stratum 90 and above; and in Table B18 for stratum 89 and below. These tables show that the samples are very similar at each stage with respect to the estimates derived from them. The estimates tend to fall at almost the same place in the respective confidence intervals; the same is true for the estimated coefficients of variation.

A comparison of Tables B1 through B6 and Tables B10 through B15 with Tables 3A through 4C, respectively, shows that the burden reduction and FCRS to FCRS overlap reduction achieved with the four stage and the five stage algorithms is very similar to that achieved with the two stage algorithm. With the four stage and five stage algorithms, there would have

been 32 farmers in the 1993 FCRS sample that were also in the 1992 FCRS sample. With the two stage algorithm, there were 29 farmers in the 1993 FCRS that were also in the 1992 FCRS sample. With each algorithm the larger remaining FCRS to FCRS overlap tended to be in the same states.

However, the extra restrictions placed on the redrawing process in the second, third, fourth, and fifth stage of the five stage algorithm should cause it to have a lower potential for biasing the 1994 FCRS estimates than the two stage algorithm. This is indirectly confirmed by observing that the estimated totals and coefficients of variations given in Tables B16, B17, and B18 tend to be almost the same for the first, second, third, fourth, and fifth stage from the five stage algorithm.

U.S. Level Burden Reduction Using the Four Stage Algorithm

Table B1. For All Strata, U.S.: The Number of FCRS Samples and Percent of Total FCRS Samples by Sampling Configuration for the Initial, First Stage, Second Stage, Third Stage, Fourth Stage 1993 FCRS Sample.

Combination of Surveys (1)	Sampling Configuration [†] (2)	Count					Percent				
		Initial (#) (3)	Stage 1 (#) (4)	Stage 2 (#) (5)	Stage 3 (#) (6)	Stage 4 (#) (7)	Initial (%) (8)	Stage 1 (%) (9)	Stage 2 (%) (10)	Stage 3 (%) (11)	Stage 4 (%) (12)
93 FCRS alone	1 0 0 0 0	6617	9095	9172	9240	9250	59.2	81.4	82.0	82.7	82.8
	Total	6617	9095	9172	9240	9250	59.2	81.4	82.0	82.7	82.8
93 FCRS plus one other survey	1 0 0 0 1	1110	597	607	636	643	9.9	5.3	5.4	5.7	5.8
	1 0 0 1 0	336	74	79	87	89	3.0	0.7	0.7	0.8	0.8
	1 0 1 0 0	1966	668	737	801	813	17.6	6.0	6.6	7.2	7.3
	1 1 0 0 0	191	305	148	33	11	1.7	2.7	1.3	0.3	0.1
	Total	3603	1644	1571	1557	1556	32.2	14.7	14.1	13.9	13.9
93 FCRS plus two other surveys	1 0 0 1 1	74	24	28	33	34	0.7	0.2	0.2	0.3	0.3
	1 0 1 0 1	414	189	206	224	225	3.7	1.7	1.8	2.0	2.0
	1 0 1 1 0	147	39	50	59	59	1.3	0.3	0.5	0.5	0.5
	1 1 0 0 1	59	44	32	7	4	0.5	0.4	0.3	0.1	0.0
	1 1 0 1 0	12	6	5	1	1	0.1	0.1	0.0	0.0	0.0
	1 1 1 0 0	137	73	51	10	4	1.2	0.7	0.5	0.1	0.0
	Total	843	375	372	334	327	7.5	3.4	3.3	3.0	2.9
93 FCRS plus three other surveys	1 0 1 1 1	45	26	26	33	33	0.4	0.2	0.2	0.3	0.3
	1 1 0 1 1	6	2	2	0	0	0.1	0.0	0.0	0	0
	1 1 1 0 1	33	21	20	8	7	0.3	0.2	0.2	0.1	0.1
	1 1 1 1 0	23	9	9	3	2	0.2	0.1	0.1	0.0	0.0
	Total	107	58	57	44	42	1.0	0.5	0.5	0.4	0.4
93 FCRS plus four other surveys	1 1 1 1 1	8	6	6	3	3	0.1	0.1	0.1	0.0	0.0
	Total	8	6	6	3	3	0.1	0.1	0.1	0.0	0.0
Total		11,178	11,178	11,178	11,178	11,178	100.0	100.0	100.0	100.0	100.0

[†] Note: The **Sampling Configuration** indicates the sampling pattern for the 93FCRS, 92FCRS, 93QAS, 93ALS and 93CSS (Cattle and Sheep). For example, a 10001 indicates sample units selected for only the 93FCRS and 93CSS.

Table B2. For Stratum 90 and Above, U.S.: The Number of FCRS Samples and Percent of Total FCRS Samples by Sampling Configuration for the Initial, First Stage, Second Stage, Third Stage, Fourth Stage 1993 FCRS Samples.

Combination of Surveys (1)	Sampling Configuration [†] (2)	Count					Percent				
		Initial	Stage 1	Stage 2	Stage 3	Stage 4	Initial	Stage 1	Stage 2	Stage 3	Stage 4
	9 9 3 2 9 9 9 F F 3 3 3 C C Q A C R R A L S S S S S S	(#)	(#)	(#)	(#)	(#)	(%)	(%)	(%)	(%)	(%)
		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
93 FCRS alone	1 0 0 0 0	1361	2260	2293	2332	2339	35.9	59.5	60.4	61.5	61.6
	Total	1361	2260	2293	2332	2339	35.9	59.5	60.4	61.5	61.6
93 FCRS plus one other survey	1 0 0 0 1	517	459	465	489	495	13.6	12.1	12.2	12.9	13.0
	1 0 0 1 0	159	42	46	52	54	4.2	1.1	1.2	1.4	1.4
	1 0 1 0 0	986	499	545	589	598	26.0	13.2	14.4	15.5	15.8
	1 1 0 0 0	98	175	92	22	6	2.6	4.6	2.4	0.6	0.2
	Total	1760	1175	1148	1152	1153	46.4	31.0	30.2	30.4	30.4
93 FCRS plus two other surveys	1 0 0 1 1	52	22	25	29	30	1.4	0.6	0.7	0.8	0.8
	1 0 1 0 1	293	158	173	187	188	7.7	4.2	4.6	4.9	5.0
	1 0 1 1 0	91	27	36	44	44	2.4	0.7	0.9	1.2	1.2
	1 1 0 0 1	47	39	27	6	3	1.2	1.0	0.7	0.2	0.1
	1 1 0 1 0	11	5	4	1	1	0.3	0.1	0.1	0.0	0.0
	1 1 1 0 0	92	59	40	7	2	2.4	1.6	1.1	0.2	0.1
	Total	586	310	305	274	268	15.4	8.2	8.0	7.2	7.1
93 FCRS plus three other surveys	1 0 1 1 1	36	23	23	29	29	0.9	0.6	0.6	0.8	0.8
	1 1 0 1 1	4	1	1	0	0	0.1	0.0	0.0	0	0
	1 1 1 0 1	25	16	15	6	5	0.7	0.4	0.4	0.2	0.1
	1 1 1 1 0	17	6	6	1	0	0.5	0.2	0.2	0.0	0
	Total	82	46	45	36	34	2.2	1.2	1.2	0.9	0.9
93 FCRS plus four other surveys	1 1 1 1 1	6	4	4	1	1	0.2	0.1	0.1	0.0	0.0
	Total	6	4	4	1	1	0.2	0.1	0.1	0.0	0.0
Total		3795	3795	3795	3795	3795	100.0	100.0	100.0	100.0	100.0

[†] Note: The **Sampling Configuration** indicates the sampling pattern for the 93FCRS, 92FCRS, 93QAS, 93ALS and 93CSS (Cattle and Sheep). For example, a 10001 indicates sample units selected for only the 93FCRS and 93CSS.

Table B3. For Stratum 89 and Below, U.S.: The Number of FCRS Samples and Percent of Total FCRS Samples by Sampling Configuration for the Initial, First Stage, Second Stage, Third Stage, Fourth Stage 1993 FCRS Samples.

Combination of Surveys (1)	Sampling Configuration [†] (2)	Count					Percent				
		Initial (#) (3)	Stage 1 (#) (4)	Stage 2 (#) (5)	Stage 3 (#) (6)	Stage 4 (#) (7)	Initial (%) (8)	Stage 1 (%) (9)	Stage 2 (%) (10)	Stage 3 (%) (11)	Stage 4 (%) (12)
93 FCRS alone	1 0 0 0 0	5256	6835	6879	6908	6911	71.2	92.6	93.2	93.6	93.6
	Total	5256	6835	6879	6908	6911	71.2	92.6	93.2	93.6	93.6
93 FCRS plus one other survey	1 0 0 0 1	593	138	142	147	148	8.0	1.9	1.9	2.0	2.0
	1 0 0 1 0	177	32	33	35	35	2.4	0.4	0.5	0.5	0.5
	1 0 1 0 0	980	169	192	212	215	13.3	2.3	2.6	2.9	2.9
	1 1 0 0 0	93	130	56	11	5	1.3	1.8	0.8	0.1	0.1
	Total	1843	469	423	405	403	25.0	6.3	5.7	5.5	5.5
93 FCRS plus two other surveys	1 0 0 1 1	22	2	3	4	4	0.3	0.0	0.0	0.1	0.1
	1 0 1 0 1	121	31	33	37	37	1.6	0.4	0.5	0.5	0.5
	1 0 1 1 0	56	12	14	15	15	0.8	0.2	0.2	0.2	0.2
	1 1 0 0 1	12	5	5	1	1	0.2	0.1	0.1	0.0	0.0
	1 1 0 1 0	1	1	1	0	0	0.0	0.0	0.0	0	0
	1 1 1 0 0	45	14	11	3	2	0.6	0.2	0.1	0.0	0.0
	Total	257	65	67	60	59	3.5	0.9	0.9	0.8	0.8
93 FCRS plus three other surveys	1 0 1 1 1	9	3	3	4	4	0.1	0.0	0.0	0.1	0.1
	1 1 0 1 1	2	1	1	0	0	0.0	0.0	0.0	0	0
	1 1 1 0 1	8	5	5	2	2	0.1	0.1	0.1	0.0	0.0
	1 1 1 1 0	6	3	3	2	2	0.1	0.0	0.0	0.0	0.0
	Total	25	12	12	8	8	0.3	0.2	0.2	0.1	0.1
93 FCRS plus four other surveys	1 1 1 1 1	2	2	2	2	2	0.0	0.0	0.0	0.0	0.0
	Total	2	2	2	2	2	0.0	0.0	0.0	0.0	0.0
Total		7383	7383	7383	7383	7383	100.0	100.0	100.0	100.0	100.0

[†] Note: The **Sampling Configuration** indicates the sampling pattern for the 93FCRS, 92FCRS, 93QAS, 93ALS and 93CSS (Cattle and Sheep). For example, a 10001 indicates sample units selected for only the 93FCRS and 93CSS.

Reduction in Overlap between 1992 and 1993 FCRS Using the Four Stage Algorithm

Table B4. For All Strata: The Number of 1993 FCRS Samples by State that were in the 1992 FCRS Sample at Each Stage of the Redrawing Process.

State	Overlap				
	Initial	Stage 1	Stage 2	Stage 3	Stage 4
01: Alabama	6	4	4	2	
04: Arizona	30	29	22	14	11
05: Arkansas	9	14	5	2	
06: California	26	21	13	2	
08: Colorado	16	17	13	4	1
09: Connecticut	5	1	1		
10: Delaware	3	2	1		
12: Florida	11	10	5	2	2
13: Georgia	5	4	4	1	
16: Idaho	15	14	10	1	
17: Illinois	15	12	4	1	
18: Indiana	6	13	4		
19: Iowa	23	22	13	1	
20: Kansas	18	19	11		
21: Kentucky	7	6	5		
22: Louisiana	12	15	7	2	1
23: Maine	3	2			
24: Maryland	6	5	4	1	
25: Massachusetts	2	3	2		
26: Michigan	11	14	4	1	
27: Minnesota	21	18	13	2	
28: Mississippi	13	12	4	1	
29: Missouri	8	7	2	1	1
30: Montana	2	7	5		
31: Nebraska	16	16	10	2	
32: Nevada	6	4	1		
33: New Hampshire	9	7	7	6	6
34: New Jersey	2	3	3		
36: New York	2	4	2		
37: North Carolina	12	14	10	1	
38: North Dakota	17	17	7		
39: Ohio	9	9	1	1	1
40: Oklahoma	1	1			
41: Oregon	8	7	4	1	1
42: Pennsylvania	9	6	3		
44: Rhode Island	12	11	9	6	6
45: South Carolina	9	12	7		
46: South Dakota	18	19	13	2	
47: Tennessee	4	5	2		
48: Texas	19	17	10	2	
49: Utah	3	4	2		
50: Vermont	8	9	4	1	1
51: Virginia	4	4	3	2	
53: Washington	7	8	4	1	1
54: West Virginia	4	3	3		
55: Wisconsin	2	3	1	1	
56: Wyoming	15	12	11	1	
Total	469	466	273	65	32
Cumulative Percent Reduction		0.6%	41.8%	86.1%	93.2%

Table B5. For Stratum 90 and Above: The Number of 1993 FCRS Samples by State that were in the 1992 FCRS Sample at each Stage of the Redrawing Process.

State	Overlap				
	Initial	Stage 1	Stage 2	Stage 3	Stage 4
01: Alabama	2	2	2	1	
04: Arizona	17	18	14	7	5
05: Arkansas	7	10	5	2	
06: California	23	18	11	2	
08: Colorado	8	9	8	2	1
09: Connecticut	1				
10: Delaware	2	1	1		
12: Florida	8	4	2	1	1
13: Georgia	4	4	4	1	
16: Idaho	6	7	6	1	
17: Illinois	12	10	4	1	
18: Indiana	3	8	1		
19: Iowa	18	16	11	1	
20: Kansas	16	18	11		
21: Kentucky	4	4	3		
22: Louisiana	7	8	4	2	1
23: Maine	2	2			
24: Maryland	5	4	4	1	
25: Massachusetts	2	3	2		
26: Michigan	6	6	3	1	
27: Minnesota	13	13	10	2	
28: Mississippi	8	8	1		
29: Missouri		1			
30: Montana		2	1		
31: Nebraska	13	12	9	2	
32: Nevada	4	3	1		
33: New Hampshire	7	7	7	6	6
34: New Jersey	2	3	3		
36: New York	2	4	2		
37: North Carolina	10	11	8	1	
38: North Dakota	13	12	5		
39: Ohio	5	6	1	1	1
40: Oklahoma	1	1			
41: Oregon	4	4	2	1	1
42: Pennsylvania	7	4	2		
45: South Carolina	7	9	6		
46: South Dakota	14	14	9	2	
47: Tennessee	1	2	1		
48: Texas	17	16	9	2	
49: Utah		1	1		
50: Vermont	2	4	2	1	1
51: Virginia	2	3	2	1	
53: Washington	5	4	3	1	1
54: West Virginia	3	2	2		
55: Wisconsin		1			
56: Wyoming	7	6	6	1	
Total	300	305	189	44	18
Cumulative Percent Reduction		1.7%	37.0%	85.3%	94.0%

Table B6. For Stratum 89 and Below: The Number of 1993 FCRS Samples by State that were in the 1992 FCRS Sample at each Stage of the Redrawing Process.

State	Overlap				
	Initial	Stage 1	Stage 2	Stage 3	Stage 4
01: Alabama	4	2	2	1	
04: Arizona	13	11	8	7	6
05: Arkansas	2	4			
06: California	3	3	2		
08: Colorado	8	8	5	2	
09: Connecticut	4	1	1		
10: Delaware	1	1			
12: Florida	3	6	3	1	1
13: Georgia	1				
16: Idaho	9	7	4		
17: Illinois	3	2			
18: Indiana	3	5	3		
19: Iowa	5	6	2		
20: Kansas	2	1			
21: Kentucky	3	2	2		
22: Louisiana	5	7	3		
23: Maine	1				
24: Maryland	1	1			
26: Michigan	5	8	1		
27: Minnesota	8	5	3		
28: Mississippi	5	4	3	1	
29: Missouri	8	6	2	1	1
30: Montana	2	5	4		
31: Nebraska	3	4	1		
32: Nevada	2	1			
33: New Hampshire	2				
37: North Carolina	2	3	2		
38: North Dakota	4	5	2		
39: Ohio	4	3			
41: Oregon	4	3	2		
42: Pennsylvania	2	2	1		
44: Rhode Island	12	11	9	6	6
45: South Carolina	2	3	1		
46: South Dakota	4	5	4		
47: Tennessee	3	3	1		
48: Texas	2	1	1		
49: Utah	3	3	1		
50: Vermont	6	5	2		
51: Virginia	2	1	1	1	
53: Washington	2	4	1		
54: West Virginia	1	1	1		
55: Wisconsin	2	2	1	1	
56: Wyoming	8	6	5		
Total	169	161	84	21	14
Cumulative Percent Reduction		4.7%	50.3%	87.6%	91.7%

U.S. Level Control Value Estimates Using the Four Stage Algorithm

Table B7. For All Strata, U.S.: The Estimated 1993 Population Control Variable Totals for the Initial, First Stage, Second Stage, Third Stage, and Fourth Stage 1993 FCRS Samples.

Control Variable† (1)	Pop. Total (#) (2)	90% Lower Bound (#) (3)	90% Upper Bound (#) (4)	Estimated Total					Exact CV of Estimated Total (%) (10)	Estimated CV				
				Initial Sample (#) (5)	Stage 1 Sample (#) (6)	Stage 2 Sample (#) (7)	Stage 3 Sample (#) (8)	Stage 4 Sample (#) (9)		Initial Sample (%) (11)	Stage 1 Sample (%) (12)	Stage 2 Sample (%) (13)	Stage 3 Sample (%) (14)	Stage 4 Sample (%) (15)
Total Land in Farm	862.52	47.04	1678.01	791.28	798.17	794.39	789.44	788.83	57.30	2.31	2.46	2.45	2.43	2.44
Farm Value of Sales	150.53	148.44	152.62	151.96	151.93	152.07	152.28	152.13	0.84	0.86	0.85	0.88	0.88	0.88
Total Cropland	363.62	327.21	400.03	363.54	365.83	365.65	365.74	365.34	6.07	1.11	1.07	1.07	1.06	1.06
On-Farm Grain Storage	947.58	902.34	992.81	992.67	990.91	990.02	987.42	985.70	2.89	2.98	2.88	2.88	2.88	2.88
All Cattle & Calves	850.13	811.07	889.19	821.80	829.07	828.11	825.19	824.34	2.78	3.05	3.21	3.21	3.19	3.18
Total Hogs & Pigs	547.15	457.17	637.12	588.76	576.22	572.97	573.24	571.79	9.97	5.33	4.08	4.08	4.08	4.09
All Sheep	114.96	88.60	141.32	106.15	103.90	104.12	102.14	102.14	13.90	13.02	13.13	13.11	13.30	13.30
Farm Workers Hired	127.21	58.80	195.61	102.40	102.54	103.66	105.11	104.65	32.59	5.22	5.31	5.43	5.41	5.43

† All missing control values were set to zero before any computations were performed. The units of measure for the population totals and their estimates are:

- 1,000,000 acres for Total Land; \$1,000,000,000 for Farm Value Of Sales;
- 1,000,000 acres for Total Cropland; 10,000,000 bushels for On-Farm Grain Storage;
- 100,000 head for Cattle & Calves, Hogs & Pigs, and Sheep; 10,000 workers Farm Workers Hired.

Table B8. For Stratum 90 and Above, U.S.: The Estimated 1993 Population Control Variable Totals for the Initial, First Stage, Second Stage, Third Stage, and Fourth Stage 1993 FCRS Samples.

Control Variable† (1)	Pop. Total (#) (2)	90% Lower Bound (#) (3)	90% Upper Bound (#) (4)	Estimated Total					Exact CV of Estimated Total (%) (10)	Estimated CV				
				Initial Sample (#) (5)	Stage 1 Sample (#) (6)	Stage 2 Sample (#) (7)	Stage 3 Sample (#) (8)	Stage 4 Sample (#) (9)		Initial Sample (%) (11)	Stage 1 Sample (%) (12)	Stage 2 Sample (%) (13)	Stage 3 Sample (%) (14)	Stage 4 Sample (%) (15)
Total Land in Farm	200.12	160.57	239.67	196.58	192.54	191.38	186.91	186.52	11.98	5.19	5.16	5.14	5.13	5.14
Farm Value of Sales	50.00	48.26	51.73	50.77	50.74	50.95	51.05	50.90	2.10	2.14	2.13	2.26	2.26	2.26
Total Cropland	87.84	53.34	122.33	81.81	82.47	82.35	82.37	82.12	23.80	1.94	1.93	1.92	1.92	1.91
On-Farm Grain Storage	209.98	198.54	221.41	220.22	221.58	222.99	222.68	222.82	3.30	3.96	3.93	3.93	3.98	3.98
All Cattle & Calves	285.97	251.17	320.77	286.42	295.52	295.02	291.71	290.60	7.38	7.93	8.30	8.31	8.30	8.30
Total Hogs & Pigs	198.78	113.57	283.98	196.45	177.03	175.51	174.99	173.93	25.98	12.75	7.47	7.48	7.49	7.53
All Sheep	32.95	18.40	47.50	32.10	33.26	33.26	33.49	33.49	26.76	25.68	25.10	25.10	24.83	24.83
Farm Workers Hired	45.00	25.34	64.64	37.16	36.63	37.78	38.29	37.99	26.47	8.02	8.04	8.69	8.73	8.76

† All missing control values were set to zero before any computations were performed. The units of measure for the population totals and their estimates are:

- 1,000,000 acres for Total Land; \$1,000,000,000 for Farm Value Of Sales;
- 1,000,000 acres for Total Cropland; 10,000,000 bushels for On-Farm Grain Storage;
- 100,000 head for Cattle & Calves, Hogs & Pigs, and Sheep; 10,000 workers Farm Workers Hired.

U.S. Level Burden Reduction Using the Five Stage Algorithm

Table B10. For All Strata, U.S.: The Number of FCRS Samples and Percent of Total FCRS Samples by Sampling Configuration for the Initial, First Stage, Second Stage, Third Stage, Fourth Stage, Fifth Stage, Sixth Stage 1993 FCRS Samples.

Combination of Surveys (1)	Sampling Configuration † (2)	Count							Percent						
		Initial	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Initial	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
		(#)	(#)	(#)	(#)	(#)	(#)	(#)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
93 FCRS alone	1 0 0 0 0	6617	9095	9158	9227	9240	9245	9249	59.2	81.4	81.9	82.5	82.7	82.7	82.7
	Total	6617	9095	9158	9227	9240	9245	9249	59.2	81.4	81.9	82.5	82.7	82.7	82.7
93 FCRS plus one other survey	1 0 0 0 1	1110	597	607	631	635	637	638	9.9	5.3	5.4	5.7	5.7	5.7	5.7
	1 0 0 1 0	336	74	80	87	88	88	89	3.0	0.7	0.7	0.8	0.8	0.8	0.8
	1 0 1 0 0	1966	668	738	800	813	814	816	17.6	6.0	6.6	7.2	7.3	7.3	7.3
	1 1 0 0 0	191	305	160	41	19	10	4	1.7	2.7	1.4	0.4	0.2	0.1	0.0
	Total	3603	1644	1585	1559	1555	1549	1547	32.2	14.7	14.2	13.9	13.9	13.9	13.8
93 FCRS plus two other surveys	1 0 0 1 1	74	24	29	35	36	36	36	0.7	0.2	0.3	0.3	0.3	0.3	0.3
	1 0 1 0 1	414	189	206	231	234	235	235	3.7	1.7	1.8	2.1	2.1	2.1	2.1
	1 0 1 1 0	147	39	49	55	57	57	57	1.3	0.3	0.4	0.5	0.5	0.5	0.5
	1 1 0 0 1	59	44	31	7	4	4	4	0.5	0.4	0.3	0.1	0.0	0.0	0.0
	1 1 0 1 0	12	6	5	1	1	1	1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	Total	843	375	372	345	337	338	336	7.5	3.4	3.3	3.1	3.0	3.0	3.0
93 FCRS plus three other surveys	1 0 1 1 1	45	26	26	32	34	34	35	0.4	0.2	0.2	0.3	0.3	0.3	0.3
	1 1 0 1 1	6	2	2	0	0	0	0	0.1	0.0	0.0	0	0	0	0
	1 1 1 0 1	33	21	20	9	7	7	6	0.3	0.2	0.2	0.1	0.1	0.1	0.1
	Total	107	58	57	44	43	43	43	1.0	0.5	0.5	0.4	0.4	0.4	0.4
93 FCRS plus four other surveys	1 1 1 1 1	8	6	6	3	3	3	3	0.1	0.1	0.1	0.0	0.0	0.0	0.0
	Total	8	6	6	3	3	3	3	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Total		11,178	11,178	11,178	11,178	11,178	11,178	11,178	100.0	100.0	100.0	100.0	100.0	100.0	100.0

† Note: The **Sampling Configuration** indicates the sampling pattern for the 93FCRS, 92FCRS, 93QAS, 93ALS and 93CSS (Cattle and Sheep). For example, a 10001 indicates sample units selected for only the 93FCRS and 93CSS.

Table B11. For Stratum 90 and Above, U.S.: The Number of FCRS Samples and Percent of Total FCRS Samples by Sampling Configuration for the Initial, First Stage, Second Stage, Third Stage, Fourth Stage, Fifth Stage, Sixth Stage 1993 FCRS Samples.

Combination of Surveys (1)	Sampling Configuration † (2)	Count							Percent						
		Initial	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Initial	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
		(#)	(#)	(#)	(#)	(#)	(#)	(#)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
93 FCRS alone	1 0 0 0 0	1361	2260	2284	2323	2334	2337	2339	35.9	59.5	60.2	61.2	61.5	61.6	61.6
	Total	1361	2260	2284	2323	2334	2337	2339	35.9	59.5	60.2	61.2	61.5	61.6	61.6
93 FCRS plus one other survey	1 0 0 0 1	517	459	465	484	488	490	491	13.6	12.1	12.2	12.8	12.9	12.9	12.9
	1 0 0 1 0	159	42	46	51	52	52	52	4.2	1.1	1.2	1.3	1.4	1.4	1.4
	1 0 1 0 0	986	499	548	593	601	602	603	26.0	13.2	14.4	15.6	15.8	15.9	15.9
	1 1 0 0 0	98	175	99	26	11	4	1	2.6	4.6	2.6	0.7	0.3	0.1	0.0
	Total	1760	1175	1158	1154	1152	1148	1147	46.4	31.0	30.5	30.4	30.4	30.2	30.2
93 FCRS plus two other surveys	1 0 0 1 1	52	22	26	31	32	32	32	1.4	0.6	0.7	0.8	0.8	0.8	0.8
	1 0 1 0 1	293	158	173	193	196	197	197	7.7	4.2	4.6	5.1	5.2	5.2	5.2
	1 0 1 1 0	91	27	35	39	40	40	40	2.4	0.7	0.9	1.0	1.1	1.1	1.1
	1 1 0 0 1	47	39	26	6	3	3	3	1.2	1.0	0.7	0.2	0.1	0.1	0.1
	1 1 0 1 0	11	5	4	1	1	1	1	0.3	0.1	0.1	0.0	0.0	0.0	0.0
	1 1 1 0 0	92	59	40	13	3	3	1	2.4	1.6	1.1	0.3	0.1	0.1	0.0
Total	586	310	304	283	275	276	274	15.4	8.2	8.0	7.5	7.2	7.3	7.2	
93 FCRS plus three other surveys	1 0 1 1 1	36	23	23	27	29	29	30	0.9	0.6	0.6	0.7	0.8	0.8	0.8
	1 1 0 1 1	4	1	1	0	0	0	0	0.1	0.0	0.0	0	0	0	0
	1 1 1 0 1	25	16	15	6	4	4	4	0.7	0.4	0.4	0.2	0.1	0.1	0.1
	1 1 1 1 0	17	6	6	1	0	0	0	0.5	0.2	0.2	0.0	0	0	0
	Total	82	46	45	34	33	33	34	2.2	1.2	1.2	0.9	0.9	0.9	0.9
93 FCRS plus four other surveys	1 1 1 1 1	6	4	4	1	1	1	1	0.2	0.1	0.1	0.0	0.0	0.0	0.0
	Total	6	4	4	1	1	1	1	0.2	0.1	0.1	0.0	0.0	0.0	0.0
Total		3795	3795	3795	3795	3795	3795	3795	100.0	100.0	100.0	100.0	100.0	100.0	100.0

† Note: The **Sampling Configuration** indicates the sampling pattern for the 93FCRS, 92FCRS, 93QAS, 93ALS and 93CSS (Cattle and Sheep). For example, a 10001 indicates sample units selected for only the 93FCRS and 93CSS.

Table B12. For all Stratum 89 and Below, U.S.: The Number of FCRS Samples and Percent of Total FCRS Samples by Sampling Configuration for the Initial, First Stage, Second Stage, Third Stage, Fourth Stage, Fifth Stage, Sixth Stage 1993 FCRS Samples.

Combination of Surveys (1)	Sampling Configuration † (2)	Count								Percent							
		Initial	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Initial	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6		
		(#)	(#)	(#)	(#)	(#)	(#)	(#)	(%)	(%)	(%)	(%)	(%)	(%)	(%)		
93 FCRS alone	1 0 0 0 0	5256	6835	6874	6904	6906	6908	6910	71.2	92.6	93.1	93.5	93.5	93.6	93.6		
	Total	5256	6835	6874	6904	6906	6908	6910	71.2	92.6	93.1	93.5	93.5	93.6	93.6		
93 FCRS plus one other survey	1 0 0 0 1	593	138	142	147	147	147	147	8.0	1.9	1.9	2.0	2.0	2.0	2.0		
	1 0 0 1 0	177	32	34	36	36	36	37	2.4	0.4	0.5	0.5	0.5	0.5	0.5		
	1 0 1 0 0	980	169	190	207	212	212	213	13.3	2.3	2.6	2.8	2.9	2.9	2.9		
	1 1 0 0 0	93	130	61	15	8	6	3	1.3	1.8	0.8	0.2	0.1	0.1	0.0		
	Total	1843	469	427	405	403	401	400	25.0	6.3	5.8	5.5	5.5	5.4	5.4		
93 FCRS plus two other surveys	1 0 0 1 1	22	2	3	4	4	4	4	0.3	0.0	0.0	0.1	0.1	0.1	0.1		
	1 0 1 0 1	121	31	33	38	38	38	38	1.6	0.4	0.5	0.5	0.5	0.5	0.5		
	1 0 1 1 0	56	12	14	16	17	17	17	0.8	0.2	0.2	0.2	0.2	0.2	0.2		
	1 1 0 0 1	12	5	5	1	1	1	1	0.2	0.1	0.1	0.0	0.0	0.0	0.0		
	1 1 0 1 0	1	1	1	0	0	0	0	0.0	0.0	0.0	0	0	0	0		
	Total	257	65	68	62	62	62	62	3.5	0.9	0.9	0.8	0.8	0.8	0.8		
93 FCRS plus three other surveys	1 0 1 1 1	9	3	3	5	5	5	5	0.1	0.0	0.0	0.1	0.1	0.1	0.1		
	1 1 0 1 1	2	1	1	0	0	0	0	0.0	0.0	0.0	0	0	0	0		
	1 1 1 0 1	8	5	5	3	3	3	2	0.1	0.1	0.1	0.0	0.0	0.0	0.0		
	1 1 1 1 0	6	3	3	2	2	2	2	0.1	0.0	0.0	0.0	0.0	0.0	0.0		
	Total	25	12	12	10	10	10	9	0.3	0.2	0.2	0.1	0.1	0.1	0.1		
93 FCRS plus four other surveys	1 1 1 1 1	2	2	2	2	2	2	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	Total	2	2	2	2	2	2	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Total		7383	7383	7383	7383	7383	7383	7383	100.0	100.0	100.0	100.0	100.0	100.0	100.0		

† Note: The **Sampling Configuration** indicates the sampling pattern for the 93FCRS, 92FCRS, 93QAS, 93ALS and 93CSS (Cattle and Sheep). For example, a 10001 indicates sample units selected for only the 93FCRS and 93CSS.

Table B13. For All Strata: The Number of 1993 FCRS Samples by State that were in the 1992 FCRS Sample at each Stage of the Redrawing Process.

State	Overlap						
	Initial	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
01: Alabama	6	4	4	1			
04: Arizona	30	29	22	12	9	9	9
05: Arkansas	9	14	5	2			
06: California	26	21	13	2			
08: Colorado	16	17	13	4			
09: Connecticut	5	1	1	1	1	1	
10: Delaware	3	2	1				
12: Florida	11	10	5	2	2	1	
13: Georgia	5	4	4	1			
16: Idaho	15	14	10	2	1		
17: Illinois	15	12	5	1	1	1	
18: Indiana	6	13	5	1	1		
19: Iowa	23	22	13	2			
20: Kansas	18	19	11	1			
21: Kentucky	7	6	5	1			
22: Louisiana	12	15	8	2	2		
23: Maine	3	2					
24: Maryland	6	5	4	1	1	1	
25: Massachusetts	2	3	2				
26: Michigan	11	14	4	1	1		
27: Minnesota	21	18	16	4			
28: Mississippi	13	12	4	1			
29: Missouri	8	7	2	1	1	1	
30: Montana	2	7	5				
31: Nebraska	16	16	9	3			
32: Nevada	6	4	1	1			
33: New Hampshire	9	7	7	6	6	6	6
34: New Jersey	2	3	3				
36: New York	2	4	2				
37: North Carolina	12	14	10	1			
38: North Dakota	17	17	8	1			
39: Ohio	9	9	1	1	1		
40: Oklahoma	1	1					
41: Oregon	8	7	4				
42: Pennsylvania	9	6	3				
44: Rhode Island	12	11	11	6	6	6	6
45: South Carolina	9	12	8	2	2	2	1
46: South Dakota	18	19	13	2			
47: Tennessee	4	5	2	1			
48: Texas	19	17	12	4			
49: Utah	3	4	2	1			
50: Vermont	8	9	5	2	2	2	1
51: Virginia	4	4	2	2	1		
53: Washington	7	8	4	1	1		
54: West Virginia	4	3	3				
55: Wisconsin	2	3	2	1			
56: Wyoming	15	12	11	2	2	2	
Total	469	466	285	80	41	32	23
Cumulative Percent Reduction		0.6%	39.2%	82.9%	91.3%	93.2%	95.1%

Table B14. For Stratum 90 and above: The Number of 1993 FCRS Samples by State that were in the 1992 FCRS Sample at each Stage of the Redrawing Process.

State	Overlap						
	Initial	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
01: Alabama	2	2	2				
04: Arizona	17	18	14	5	3	3	3
05: Arkansas	7	10	5	2			
06: California	23	18	11	2			
08: Colorado	8	9	7	2			
09: Connecticut	1						
10: Delaware	2	1	1				
12: Florida	8	4	2	1	1		
13: Georgia	4	4	4	1			
16: Idaho	6	7	6	1			
17: Illinois	12	10	5	1	1	1	
18: Indiana	3	8	1				
19: Iowa	18	16	11	2			
20: Kansas	16	18	11	1			
21: Kentucky	4	4	3	1			
22: Louisiana	7	8	4	2	2		
23: Maine	2	2					
24: Maryland	5	4	4	1	1	1	
25: Massachusetts	2	3	2				
26: Michigan	6	6	3	1	1		
27: Minnesota	13	13	13	4			
28: Mississippi	8	8	1				
29: Missouri		1					
30: Montana		2	1				
31: Nebraska	13	12	8	3			
32: Nevada	4	3	1	1			
33: New Hampshire	7	7	7	6	6	6	6
34: New Jersey	2	3	3				
36: New York	2	4	2				
37: North Carolina	10	11	8	1			
38: North Dakota	13	12	6	1			
39: Ohio	5	6	1	1	1		
40: Oklahoma	1	1					
41: Oregon	4	4	2				
42: Pennsylvania	7	4	2				
45: South Carolina	7	9	7	2	2	2	1
46: South Dakota	14	14	9	2			
47: Tennessee	1	2	1				
48: Texas	17	16	11	4			
49: Utah		1	1	1			
50: Vermont	2	4	2	2	2	2	1
51: Virginia	2	3	1	1	1		
53: Washington	5	4	3	1	1		
54: West Virginia	3	2	2				
55: Wisconsin		1	1				
56: Wyoming	7	6	6	1	1	1	
Total	300	305	195	54	23	16	11
Cumulative Percent Reduction		-1.7%	35.0%	82.0%	92.3%	94.7%	95.1%

Table B15. For Stratum 89 and below: The Number of 1993 FCRS Samples by State that were in the 1992 FCRS Sample at each Stage of the Redrawing Process.

State	Overlap						
	Initial	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
01: Alabama	4	2	2	1			
04: Arizona	13	11	8	7	6	6	6
05: Arkansas	2	4					
06: California	3	3	2				
08: Colorado	8	8	6	2			
09: Connecticut	4	1	1	1	1	1	
10: Delaware	1	1					
12: Florida	3	6	3	1	1	1	
13: Georgia	1						
16: Idaho	9	7	4	1	1		
17: Illinois	3	2					
18: Indiana	3	5	4	1	1		
19: Iowa	5	6	2				
20: Kansas	2	1					
21: Kentucky	3	2	2				
22: Louisiana	5	7	4				
23: Maine	1						
24: Maryland	1	1					
26: Michigan	5	8	1				
27: Minnesota	8	5	3				
28: Mississippi	5	4	3	1			
29: Missouri	8	6	2	1	1	1	
30: Montana	2	5	4				
31: Nebraska	3	4	1				
32: Nevada	2	1					
33: New Hampshire	2						
37: North Carolina	2	3	2				
38: North Dakota	4	5	2				
39: Ohio	4	3					
41: Oregon	4	3	2				
42: Pennsylvania	2	2	1				
44: Rhode Island	12	11	11	6	6	6	6
45: South Carolina	2	3	1				
46: South Dakota	4	5	4				
47: Tennessee	3	3	1	1			
48: Texas	2	1	1				
49: Utah	3	3	1				
50: Vermont	6	5	3				
51: Virginia	2	1	1	1			
53: Washington	2	4	1				
54: West Virginia	1	1	1				
55: Wisconsin	2	2	1	1			
56: Wyoming	8	6	5	1	1	1	
Total	169	161	90	26	18	16	12
Cumulative Percent Reduction		4.7%	46.7%	84.6%	89.3%	90.5%	92.9%

U.S. Level Control Value Estimates Using the Five Stage Algorithm

Table B16. For All Strata, U.S.: The Estimated 1993 Population Control Variables, Initial, First Stage, Second Stage, Third Stage, Fourth Stage, Fifth Stage, and Sixth Stage 1993 FCRS Samples.

Control Variable† (1)	Pop. Total (#) (2)	90% Lower Bound (#) (3)	90% Upper Bound (#) (4)	Estimated Total						Exact CV of Estimated Total (%) (12)	Exact CV of Estimated Total			
				Initial Sample (#) (5)	Stage 1 Sample (#) (6)	Stage 2 Sample (#) (7)	Stage 3 Sample (#) (8)	Stage 4 Sample (#) (9)	Stage 5 Sample (#) (10)		Stage 6 Sample (#) (11)	Initial Sample (%) (13)	Stage 1 Sample (%) (14)	Stage 2 Sample (%) (15)
Total Land in Farm	862.52	47.04	1678.01	791.28	798.17	792.91	790.77	790.81	790.67	790.89	57.30	2.31	2.46	2.46
Farm Value of Sales	150.53	148.44	152.62	151.96	151.93	151.91	151.91	151.92	151.90	151.90	0.84	0.86	0.85	0.85
Total Cropland	363.62	327.21	400.03	363.54	365.83	365.45	364.63	364.57	364.50	364.48	6.07	1.11	1.07	1.07
On-Farm Grain Storage	947.58	902.34	992.81	992.67	990.91	989.17	992.07	990.66	990.48	990.49	2.89	2.98	2.88	2.88
All Cattle & Calves	850.13	811.07	889.19	821.80	829.07	825.44	830.78	831.88	832.10	832.38	2.78	3.05	3.21	3.21
Total Hogs & Pigs	547.15	457.17	637.12	588.76	576.22	573.72	573.26	571.33	571.33	571.31	9.97	5.33	4.08	4.08
All Sheep	114.96	88.60	141.32	106.15	103.90	104.15	100.09	101.15	101.15	101.39	13.90	13.02	13.13	13.13
Farm Workers Hired	127.21	58.80	195.61	102.40	102.54	103.75	104.50	104.45	104.47	104.58	32.59	5.22	5.31	5.31

† All missing control values were set to zero before any computations were performed. The units of measurement and their estimates are:

- 1, 000, 000 acres for Total Land; \$1, 000, 000, 000 for Farm Value Of Sales;
- 1, 000, 000 acres for Total Cropland; 10, 000, 000 bushels for On-Farm Grain Storage;
- 100, 000 head for Cattle & Calves, Hogs & Pigs, and Sheep; 10, 000 workers Farm Workers Hired.

Table B17. For Stratum 90 and Above, U.S.: The Estimated 1993 Population Control Variables, Initial, First Stage, Second Stage, Third Stage, Fourth Stage, Fifth Stage, and Sixth Stage 1993 FCRS Samples.

Control Variable† (1)	Pop. Total (#) (2)	90% Lower Bound (#) (3)	90% Upper Bound (#) (4)	Estimated Total						Exact CV of Estimated Total (%) (12)	Exact CV of Estimated Total			
				Initial Sample (#) (5)	Stage 1 Sample (#) (6)	Stage 2 Sample (#) (7)	Stage 3 Sample (#) (8)	Stage 4 Sample (#) (9)	Stage 5 Sample (#) (10)		Stage 6 Sample (#) (11)	Initial Sample (%) (13)	Stage 1 Sample (%) (14)	Stage 2 Sample (%) (15)
Total Land in Farm	200.12	160.57	239.67	196.58	192.54	191.11	188.35	188.56	188.42	188.71	11.98	5.19	5.16	5.16

