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National Area Sample Allocation Analysis

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ABSTRACT

Multivariate optimum allocations based on three sets of National level coefficients of variation were computed. The computed allocations provide some insight for making future decisions concerning area sample distribution among States. **No recommendations** for decreases in States' sample sizes are made.

KEYWORDS: Stratified sampling, sample size, nonoverlap domain.

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Table of Contents

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SUMMARY

National-level multivariate optimal allocation analyses are performed to prioritize States for possible sample size increases. Some States which should be given high priority for increased area sample allocation, **should management decide** *to increase the National area sample size, are Texas, Iowa, Illinois, Kansas, Louisiana, Arkansas, Ohio, Mississippi, Nebraska and Oklahoma.* **No recommendations** for decreases in States' sample sizes are made.

BACKGROUND

About two years ago, due to the agency restructuring, the Area Frame Section was assigned the task of performing sample allocations for new area frames. As before, allocations were performed on a State at a time basis relative to the Area Sample for the June Survey. Around this same time, management expressed an interest in *what the allocation would be ... if we considered all States at the same time and based the allocation only on National level precision.* Some preliminary analysis was performed and results were published in a January 1988 staff report [1]. Since this preliminary analysis was performed, certain factors have motivated additional analysis. Primary motivating factors were the use of one area frame for nonoverlap estimates in all surveys, the development of standards relative to coefficients of variation (CVs) and a proposed twenty percent increase in the national area frame sample size [2]. This analysis provides some insight concerning which States should be given high priority for an increased area sample allocation.

INTRODUCTION

Multivariate area frame optimum allocation analyses at the National level were performed relative to the nonoverlap (NOL) component of multiple frame estimates. A different set of target coefficients of variation (CVs) were used in three analyses. One analysis was based on projected NOL CVs needed to conform with Policy and Standards Memorandum (PSM)45-88. Another was based on subjective specified target CVs. The other analysis was based on NOL CVs achieved in the June Agricultural Survey (JAS). Data from the 1987 JAS were used in each analysis. Items included were the NOL weighted estimates of cattle, hogs, corn stocks, and soybean stocks, and the tract NOL planted acreages of rice, corn, upland cotton, oats, sorghum, and winter wheat. The results should be helpful in making State level sample allocation decisions for improved National level precision. **No reductions in individual State level allocations are recommended.** *Where the optimum sample size for National estimates, based on any of the target CVs, is less than the current sample size, the State estimating program must also be considered.*

STANDARDS BASED ALLOCATION ANALYSIS

Multivariate area frame optimum allocation analysis at the National level were performed relative to the NOL component. Target NOL CVs were computed relative to the NOL component. Target NOL CVs were computed to conform with PSM45-88. In computing the target NOL CVs, the percent NOL and list CV were fixed for each item included in the analysis. Items included in the analysis and input target NOL CVs are shown in table 1. The following equation was applied:

$$CV_{mf}^2 = p_l^2 CV_l^2 + q_{nol}^2 CV_{pnol}^2$$

where

CV_{mf} – *multiple frame coefficient of variation*

CV_l – *list frame coefficient of variation*

CV_{pnol} – *projected nonoverlap coefficient of variation*

p_l – *proportion of list frame coverage*

q_{nol} – *proportion of list frame incompleteness.*

The PSM45-88 multiple frame CV cannot be met for soybean stocks unless the list CV is improved. The PSM45-88 standards are not satisfied for cattle, soybean stocks and rice planted. Optimal sample sizes by State are shown in table 2. In addition to the CV targets, two other self-imposed constraints were used. The sample size in any strata had to be a multiple of 5 and no projected expansion factor could exceed 750 in any strata.

The overall optimal allocation is 10,225 versus the 1987 sample size of 15,665 segments. A substantial increase in sample size is indicated for Illinois, Iowa, and Texas. If it is desirable to improve National level precision, these States should be given strong consideration for an increased area sample allocation.

Table 1. National Multivariate Optimum Allocation CV Comparisons.

Item	PSM45-88 Standards MF CV	1987 Multiple Frame CV	1987 NOL CV	Projected Standards NOL CV	Target NOL CV
Cattle	1.0	1.1	2.4*	2.1	2.0
Hogs	2.0	1.5	6.5*	9.5	5.0*
Corn Stocks	2.0	1.8	6.3	8.0	5.0
Soybean Stocks	2.0	3.0	8.3	**	7.0
PLANTED ACRES					
Rice	3.0	3.1	20.9*	18.0	18.0*
Corn	1.5	0.9	3.0*	6.4	3.0
Upland Cotton	3.0	3.0	8.4*	8.0*	8.0*
Oats	5.0	1.5	4.2*	19.4	5.0
Sorghum	5.0	2.4	8.9*	9.2*	9.0*
Soybeans	1.5	1.1	3.3*	5.7	3.0*
Winter wheat	1.5	1.4	4.5*	5.6*	4.0*

* Binding constraint (slight decreases in these CVs increases the sample size)
** The PSM45-88 multiple frame CV cannot be met unless the list CV is improved for soybean stocks. An input target CV of 5% was used in the analysis.

Table 2. National multivariate optimum allocation - based on area frame nonoverlap (NOL) domain - using June Survey data. Optimum allocation to conform with PSM45-88.

State	1987 Sample Size	Standards Sample Size	State	1987 Sample Size	Standards Sample Size
Alabama	359	285	Nebraska	390	365
Arizona	374	160	Nevada	104	60
Arkansas	400	325	New Hampshire	30	25
California	911	500	New Jersey	247	45
Colorado	457	355	New Mexico	292	90
Connecticut	48	35	New York	380	140
Delaware	72	30	North Carolina	391	150
Florida	425	160	North Dakota	376	140
Georgia	436	225	Ohio	324	300
Idaho	362	150	Oklahoma	360	295
Illinois	300	380	Oregon	372	190
Indiana	324	285	Pennsylvania	330	120
Iowa	298	855	Rhode Island	14	20
Kansas	435	355	South Carolina	335	105
Kentucky	338	130	South Dakota	352	135
Louisiana	376	345	Tennessee	349	200
Maine	150	45	Texas	840	990
Maryland	252	50	Utah	324	65
Massachusetts	48	45	Vermont	70	20
Michigan	343	220	Virginia	343	140
Minnesota	343	395	Washington	360	230
Mississippi	402	320	West Virginia	250	85
Missouri	450	275	Wisconsin	310	150
Montana	362	140	Wyoming	257	100
			TOTAL	15,665	10,225

TARGET BASED ALLOCATION ANALYSIS

Multivariate area frame optimal allocation analysis at the National level were performed relative to the nonoverlap (NOL) component. Target NOL CVs were subjectively determined based on an evaluation of existing survey levels and the CVs specified by the policy and standards memorandum. Items included in the analysis and target CVs are shown in table 1. Allocations by State are shown in table 3. The optimal National level sample size is 11,700 versus the 1987 size of 15,665 segments. A substantial increase in sample size is indicated for Arkansas, Iowa, Kansas, Louisiana, Ohio and Texas. If it is desirable to improve National level precision, these States should be given strong consideration for an increased area sample allocation.

Table 3. National multivariate optimum allocation - based on area frame nonoverlap (NOL) domain - using 1987 June Survey data. Optimum allocation to conform with Target Coefficients of Variation.

State	1987 Sample Size	Target Sample Size	State	1987 Sample Size	Target Sample Size
Alabama	359	235	Nebraska	390	375
Arizona	374	120	Nevada	104	55
Arkansas	400	590	New Hampshire	30	25
California	911	615	New Jersey	247	80
Colorado	457	345	New Mexico	292	105
Connecticut	48	35	New York	380	130
Delaware	72	35	North Carolina	391	180
Florida	425	145	North Dakota	376	135
Georgia	436	200	Ohio	324	405
Idaho	362	170	Oklahoma	360	320
Illinois	300	310	Oregon	372	180
Indiana	324	255	Pennsylvania	330	145
Iowa	298	735	Rhode Island	14	20
Kansas	435	575	South Carolina	335	155
Kentucky	338	140	South Dakota	352	240
Louisiana	376	625	Tennessee	349	210
Maine	150	45	Texas	840	1180
Maryland	252	70	Utah	324	85
Massachusetts	48	35	Vermont	70	25
Michigan	343	190	Virginia	343	165
Minnesota	343	295	Washington	360	230
Mississippi	402	405	West Virginia	250	90
Missouri	450	400	Wisconsin	310	235
Montana	362	270	Wyoming	257	90
			TOTAL	15,665	11,700

CHANGE BASED ALLOCATION ANALYSIS

Multivariate optimum area sample allocations were computed relative to 20%, 25% and 30% improvements in 1987 precision levels for June Survey nonoverlap (NOL) variables in National estimates. Increases to effect change can also be considered when making decisions relative to area sample allocations. Optimal area sample sizes by State and by percent reduction in coefficients of variation (CVs) are shown in table 4. These sample sizes are listed along with 1987 June Survey sample sizes and the required incremental increase in sample size to go from 20% reductions in CVs to 30% reductions.

Based on results shown in table 4, an initial group of States are recommended for increased area sample allocation. States were selected if the required increase in sample size to go from 20% reductions in CVs to 30% reductions was at least 150 or if the required increase in sample size to obtain a 25% reduction in CVs was at least 150. The States are Arkansas, Illinois, Iowa, Kansas, Louisiana, Mississippi, Nebraska, Oklahoma and Texas. The exact increase in any stratum will depend on the current area frame designs (number of sub-strata and current sample size), management decisions (total increase in sample size at the National level, maximum increase in any State and maximum increase in any stratum), State Statistical Office resources and other factors. Items included in the analysis were the NOL components of cattle, hogs, corn stocks, soybean stocks; and planted acreages of rice, corn, upland cotton, oats, sorghum, soybeans and winter wheat. Since rice affects the allocation in only a few States, the input target CV for rice was fixed at 18% in each analysis.

Table 4. Optimum sample sizes for various percent reductions in (1987 June Survey) coefficients of variation (CVs)

State	1987 Sample Size	Reduction in CV (%) 20%	25%	30%	Increase (30% - 20%)
Alabama	359	325	375	445	120
Arizona	374	165	185	210	45
Arkansas	400	600	620	665	65
California	911	635	655	720	85
Colorado	457	350	400	460	110
Connecticut	48	35	35	35	0
Delaware	72	40	40	45	5
Florida	425	155	160	180	25
Georgia	436	235	275	320	85
Idaho	362	190	210	235	45
Illinois	300	435	495	555	120
Indiana	324	310	350	395	85
Iowa	298	875	1005	1155	280
Kansas	435	740	850	975	235
Kentucky	338	145	170	190	45
Louisiana	376	660	670	705	45
Maine	150	45	45	45	0
Maryland	252	70	75	80	10
Massachusetts	48	35	35	35	0
Michigan	343	245	270	300	55
Minnesota	343	425	485	545	120
Mississippi	402	580	685	800	220
Missouri	450	380	425	485	105
Montana	362	330	370	425	95
Nebraska	390	560	650	735	175
Nevada	104	55	55	60	5
New Hampshire	30	25	25	25	0
New Jersey	247	45	50	55	10
New Mexico	292	125	135	145	20
New York	380	155	165	175	20
North Carolina	391	220	245	280	60
North Dakota	376	205	220	250	45
Ohio	324	405	455	520	115
Oklahoma	360	395	460	545	150
Oregon	372	200	230	270	70
Pennsylvania	330	165	180	195	30
Rhode Island	14	20	20	20	0
South Carolina	335	215	245	275	60
South Dakota	352	355	395	460	105
Tennessee	349	245	285	325	80
Texas	840	1360	1480	1700	340
Utah	324	95	100	100	5
Vermont	70	20	25	25	5
Virginia	343	180	200	225	45
Washington	360	230	250	285	55
West Virginia	250	90	90	90	0
Wisconsin	310	285	315	360	75
Wyoming	257	100	105	120	20
TOTAL	15665	13755	15265	17245	

DISCUSSION

Priority States by analysis are summarized in table 5. Texas and Iowa are priority States based on each analysis. Arkansas, Illinois, Kansas and Louisiana are priority States based on two of the three analyses. Ohio, Mississippi, Nebraska and Oklahoma are priority States based on one of the three analyses. The results illustrate the importance of setting realistic target CVs. Different target CVs can result in different results and interpretations.

Table 5. Priority States For Increased Area Allocations

Based on Standards Analysis	Based on Target Analysis	Based on Change Analysis
Texas	Texas	Texas
Iowa	Iowa	Iowa
Illinois		Illinois
	Kansas	Kansas
	Louisiana	Louisiana
	Arkansas	Arkansas
	Ohio	Mississippi
		Nebraska
		Oklahoma

The analysis based on percent reductions in CVs gives insight as to where the greatest improvement in precision for incremental increases in sample size can be obtained. For example, consider the increase in sample size to go from a 20% reduction in the National level CV to a 30% reduction relative to Iowa and Ohio. An increase of 280 sample units is required in Iowa versus an increase of 115 sample units for Ohio. The larger incremental increase for Iowa indicates a greater improvement in overall precision of the estimates could be obtained by adding more sample units in Iowa than in Ohio.

RECOMMENDATION

The following states: Texas, Iowa, Illinois, Kansas, Louisiana, Arkansas, Ohio, Mississippi, Nebraska and Oklahoma should be given strong consideration for an increased area sample allocation.

REFERENCE

[1] Mergerson, James W. (1988), *A Preliminary Look At A National Area Sample Allocation,* Staff Report SSB-88-01, U.S. Department of Agriculture, Washington, D.C.

[2] Nealon, Jack (1988), *National Area Frame Sample: A 20 Percent Increase,* Implementation Plan, U.S. Department of Agriculture, Washington, D.C.