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## TECHNICAL MEMORANDUM

AGGREGATION OF LARGE AREA CROP INVENTORY EXPERIMENT (LACIE)  
TRANSITION YEAR DATA USING LACIE PHASE III SOFTWARE

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## ABBREVIATIONS

APU	Agrophysical unit
CAMS	Classification and Mensuration Subsystem
CAS	Crop Assessment Subsystem
CMR	CAS Monthly Report
CRD	Crop reporting district
ESCS	Economics, Statistics, and Cooperative Service of the USDA
LACIE	Large Area Crop Inventory Experiment
NSS	New sampling strategy
RS	Refined stratum
USDA	U.S. Department of Agriculture
USGP	U.S. Great Plains

## 1. INTRODUCTION

In the Large Area Crop Inventory Experiment (LACIE) Crop Assessment Subsystem (CAS) Monthly Report (CMR) dated July 1978, the winter wheat area of seven states in the U.S. Great Plains (USGP) is estimated to be 31 848 000 acres. This estimate was computed with the new sampling strategy (NSS) aggregation software. On July 11, 1978, the Economics, Statistics, and Cooperative Service (ESCS) of the U.S. Department of Agriculture (USDA) released an estimate of 26 850 000 acres for the same area. The results of a comparative study of the Classification and Mensuration Subsystem (CAMS) estimates for sample segments and ground truth data for the same segments indicate that the CAMS estimates are negatively biased if they are biased at all. Hence, the only remaining sources of a possible positive bias are sampling and/or aggregation.

In the current analysis, the LACIE Phase III software aggregations are used as references to determine the NSS aggregation bias, and a sum-of-counties historical wheat data base is used to determine apportionment or sample bias. The aggregations are listed in table 1. Table 2 lists the number of sample segments used in aggregating the full set and common-county set of segments at both the state refined stratum (RS)<sup>1</sup> and crop reporting district (CRD) levels. Table 3 lists the wheat acreages at the RS level for the apportioned and summed cases.

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<sup>1</sup>An RS is the intersection of agrophysical units (APU's) and states. An APU is an agriculturally and climatologically homogeneous area. A type-A RS is a high wheat density area with at least two segments allocated and available for aggregation. A type-B RS is either a low or high wheat density area with less than two segments allocated or available for aggregation.

TABLE 1.— WHEAT AGGREGATIONS

[Acres × 10<sup>3</sup>]

State	a. July CMR using NSS	b. July CMR with LACIE Phase III	c. Common- county using NSS	d. Common- county with LACIE Phase III	e. APU = Σ counties using NSS	f. Common- county APU = Σ counties using NSS	g. ESCS on 7/11/78
Colorado	3 349	2 872	3 665	2 851	2 996	3 285	2 350
Kansas	11 163	10 960	11 325	10 978	11 191	11 357	10 300
Montana	2 701	3 267	2 800	3 252	3 456	3 603	2 600
Nebraska	4 322	3 089	6 470	3 399	4 390	6 127	2 600
Oklahoma	5 803	5 951	5 922	5 647	5 803	5 626	5 600
South Dakota	1 215	1 073	1 003	1 514	1 041	1 139	700
Texas	3 295	3 285	5 718	2 979	3 298	4 533	2 700
Total	31 848	30 497	36 903	30 620	32 175	35 670	26 850

Column descriptions:

- a. These estimates were published in the July CMR.
- b. The sample segments are the same as those used for the column-a aggregation. However, the data base has been restructured to the format of the LACIE Phase III data base, and the LACIE Phase III software has been used for the aggregation.
- c. Only data for those counties that were allocated segments in both the LACIE Phase III end-of-year aggregations and the LACIE Transition Year aggregations are aggregated using the NSS software.
- d. The estimates for the sample segments used for the column-c aggregation are aggregated using the LACIE Phase III software.
- e. The sample segments are the same as those used for the column-a aggregation; however, the epoch year wheat acreage is summed for all counties in the RS. (In column a, the state wheat acreage is apportioned to the RS as a function of the RS's agricultural area.)
- f. The historical data base and software are the same as those used for the column-e aggregation, but the sample segments are those used for the column-c aggregation.
- g. These are the ESCS state estimates dated July 11, 1978.

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TABLE 2.— NUMBER OF SEGMENTS AGGREGATED

Refined stratum	CMR sample segments	Common-county sample segments	CRD	CMR sample segments	Common-county sample segments
<u>Colorado:</u>					
CO-9	4	4	20	6	6
CO-10	22	19	60	18	14
CO-11	2	0	90	4	3
Total	28	23		28	23
<u>Kansas:</u>					
KS-7	10	10	10	14	14
KS-8	7	7	20	7	7
KS-9	10	10	30	8	8
KS-11	23	23	40	13	13
KS-12	21	21	50	18	18
KS-13	7	4	60	14	14
KS-14	9	8	70	9	8
KS-15	3	3	80	8	4
KS-60	2	2	90	6	4
KS-102	5	2			
Total	97	90		97	90
<u>Montana:</u>					
MT-21	5	5	20	4	4
MT-22	5	5	30	9	9
MT-23	3	3	70	1	0
MT-104	7	6	80	3	3
			90	3	3
Total	20	19		20	19
<u>Nebraska:</u>					
NE-10	5	5	10	7	6
NE-11	5	5	20	3	0
NE-14	3	3	30	3	0
NE-15	12	5	50	4	1
NE-16	2	0	60	3	2
NE-17	1	1	70	5	5
NE-103	3	2	80	3	3
NE-104	1	0	90	4	4
Total	32	21		32	21

TABLE 2.— Concluded.

Refined stratum	CMR sample segments	Common-county sample segments	CRD	CMR sample segments	Common-county sample segments
<u>Oklahoma:</u>					
OK-3	9	0	10	7	7
OK-7	26	24	20	6	6
OK-9	5	5	30	9	8
OK-60	7	6	40	10	10
OK-102	9	1	50	7	5
			60	12	0
			70	1	0
			80	3	0
			90	1	0
Total	56	36		56	36
<u>South Dakota:</u>					
SD-15	1	0	10	2	2
SD-16	3	1	20	3	3
SD-17	3	1	30	2	1
SD-18	3	2	40	3	2
SD-19	4	3	50	1	0
SD-21	4	4	60	2	1
			70	2	1
			80	3	1
Total	18	11		18	11
<u>Texas:</u>					
TX-2	8	1	11	4	4
TX-3	8	0	12	6	0
TX-4	8	2	21	5	2
TX-5	7	4	22	7	1
TX-9	2	2	30	5	1
TX-61	3	0	40	8	1
TX-102	6	0	70	1	0
			81	6	0
Total	42	9		42	9

TABLE 3.-- COMPARISON OF HISTORICAL WHEAT AREA

[Acres × 10<sup>3</sup>]

Refined stratum	Apportioned wheat	Summed wheat
<u>Colorado:</u>		
CO-9	471	555
CO-10	1728	1902
CO-11	130	151
CO-101	447	173
<u>Kansas:</u>		
KS-7	1206	2241
KS-8	1195	1375
KS-9	1447	1625
KS-10	54	95
KS-11	2093	2301
KS-12	1647	1821
KS-13	1525	463
KS-14	882	284
KS-15	202	261
KS-60	221	327
KS-102	423	68
<u>Montana:</u>		
MT-21	389	29
MT-22	339	302
MT-23	1043	1597
MT-104	695	537
<u>Nebraska:</u>		
NE-10	377	918
NE-11	483	668
NE-14	301	278
NE-15	1130	685
NE-16	194	8
NE-17	126	210
NE-103	161	3
NE-104	7	6
<u>Oklahoma:</u>		
OK-3	127	64
OK-7	3367	3695
OK-9	733	414
OK-60	1068	1474
OK-102	559	145

TABLE 3.— Concluded.

[Acres × 10<sup>3</sup>]

Refined stratum	Apportioned wheat	Summed wheat
<u>South Dakota:</u>		
SD-15	67	2
SD-16	330	235
SD-17	89	350
SD-18	73	197
SD-19	190	47
SD-21	132	40
SD-104	19	28
<u>Texas:</u>		
TX-2	330	192
TX-3	774	436
TX-4	1121	821
TX-5	106	459
TX-7	43	0
TX-9	310	707
TX-60	33	202
TX-61	250	438
TX-101	182	76
TX-102	352	119

## 2. ANALYSIS

### 2.1 NEBRASKA AGGREGATIONS

In the initial comparison, counties with segment estimates for both the LACIE Transition Year and Phase III are aggregated with the LACIE Phase III software and compared to the aggregations in the July CMR. (See columns d and a, respectively, in table 1.) The largest difference occurs for Nebraska, which is estimated at  $4322 \times 10^3$  acres of wheat in column a, but  $3399 \times 10^3$  acres of wheat in column d. However, it cannot be said that this change is caused by sampling and/or aggregation models because the number of sample segments used in the Nebraska aggregation also changes. The column-a estimate is based on 32 sample segments, whereas the column-d estimate is based on 21 sample segments (see table 2). Hence, additional aggregations have been made to establish a common ground for comparison.

A LACIE Phase III type of data base has been constructed for the entire USGP area and aggregated accordingly. The result for Nebraska (table 1, column b) shows a further decline to  $3089 \times 10^3$  acres.

A LACIE Transition Year type of data base has also been constructed for only the common-county segments and has been aggregated accordingly. The estimates for the 11 Nebraska sample segments that are included in the LACIE Phase III data base but not in this one are nine estimates of 0-percent wheat, one estimate of 1.6-percent wheat, and one estimate of 9.0-percent wheat. Also, of these 11 sample segments, only 3 fall into the redesignated-counties category which was established during LACIE Phase III when group I counties were redesignated as group III.<sup>2</sup> The LACIE Transition Year aggregation (table 1, column c) shows a marked increase in the estimate for Nebraska, up to  $6470 \times 10^3$  acres.

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<sup>2</sup>The group I counties are high wheat density counties with at least one segment allocated for aggregation. The group III counties are sparse wheat or no wheat counties and were allocated no segments at all.

An assessment of this last aggregation (table 1, column c) and the original July CMR estimates (column a) shows that the change caused by eliminating the 11 segments is too severe to allow a possible comparison between the July CMR estimates and the estimates that result when the LACIE Phase III aggregation software is applied to the same common-county data (column d). However, a valid comparison might still be made between the July CMR estimates and the estimates in the total July data base that are aggregated with the LACIE Phase III software (column b) if it could be shown that the LACIE Transition Year aggregation with the apportioned wheat acres (column a) is not significantly different from the aggregation made with the summed county wheat acres (column e). The result for Nebraska is  $4390 \times 10^3$  acres of wheat (column e) and indicates that no significant difference in the aggregation can be attributed to the historical wheat acreage used.

In the LACIE Transition Year NSS data base and aggregation (table 1, column a), Nebraska is comprised of eight RS's. Of these, six are type A and two (RS 17 and RS 104) are type B. The ratio of the current estimate to the historical data generated by the type-A RS's and applied to the type-B RS's is approximately 1.50. In the LACIE Phase III type of data base and aggregation (column b), there are no group III CRD's, which are comparable to the type-B RS's in the LACIE Transition Year, because at least three required segments are available for aggregation for each CRD. However, if there were a group III CRD, the calculated ratio from this software would be only 1.08. The same data for the aggregations and data bases in columns c and d yield the same trend: a LACIE Transition Year ratio of approximately 2.30 and a LACIE Phase III ratio of approximately 1.20. This consistently high state ratio has prompted a further investigation of the components in the aggregation and data base used to derive the data sets listed in column e. In this case the ratio is approximately 1.60.

If it is assumed that the ESCS estimate (table 1, column g) is correct at the state level, then it must also be assumed that the estimate in column b is the LACIE best estimate and that the NSS software and/or sampling contains a bias. This bias, then, is a result of the CAMS data for each segment being

a better estimate for the county and CRD in which that segment is located than for the RS in which the segment is located in the LACIE Transition Year data base.

## 2.2 COLORADO AGGREGATIONS

The same rationalization procedure has been used on the Colorado data. However, no conclusion is drawn concerning aggregation and/or sampling bias because most of the differences are smaller and the apportioned-versus-summed wheat data appear to be significant.

## 2.3 MONTANA AGGREGATIONS

The July CMR estimate for Montana is extremely close to the ESCS estimate. However, the aggregations and data bases have been scrutinized in an attempt to determine why the NSS aggregations (table 1, columns a and c) are substantially lower than the comparable LACIE Phase III aggregations (columns b and d), which have been used as references to determine bias. When the NSS software and the CAMS estimates are aggregated with a historical data base of summed county wheat data (columns e and f), the discrepancies become slightly positive and substantially positive, respectively.

Further investigation shows that the entire fluctuation in the Montana estimate is due to the single type-B RS (RS 22). Its reclassification threshold is eight, which means eight segments must be available for aggregation before it can become a type-A RS. In the July CMR, only three segments are available for aggregation. Therefore, this type-B RS is estimated by the following equation:

$$\begin{aligned} \text{Total wheat in RS} = & \left( \frac{\text{Number of segments available}}{\text{Reclassification threshold}} \right) * \left( \begin{array}{l} \text{Estimate for RS using} \\ \text{number of segments} \\ \text{available} \end{array} \right) \\ & + \left( 1 - \frac{\text{Number of segments available}}{\text{Reclassification threshold}} \right) \\ & * \left( \frac{\text{Sum of all type-A RS's in state}}{\text{Sum of all historical wheat}} \right) * \left( \begin{array}{l} \text{Historical wheat} \\ \text{for type-B RS's} \\ \text{being calculated} \end{array} \right) \end{aligned}$$

Unfortunately, this RS has the most wheat in both the apportioned and summed historical wheat data bases. In the apportioned data base it accounts for 42 percent of the historical wheat, and in the other data base it accounts for 65 percent. This explains why the estimate rises when the summed county historical wheat data are used. In this case, apportioned wheat has an effect opposite to that encountered in the Colorado case.

### 3. CONCLUSIONS

This comparative analysis of the LACIE Phase III and Transition Year sampling, aggregations, and data bases indicates that each has both good and bad applications, usually negatively correlated. This seems to indicate that in some cases the LACIE Phase III sampling and aggregation are more accurate, while in other instances the LACIE Transition Year sampling and aggregation are preferable.

A study to determine the repeatability of this occurrence might indicate that a composite type of sampling and aggregation is a better approach.