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NON-SAMPLING ERRORS IN NON-AGRICULTURAL STRATA OF THE 1980 KANSAS JUNE ENUMERATIVE SURVEY

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DOMESTIC CROPS AND LAND COVER

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I. Introduction

During July 19 - August 15, 1980, a Land Cover Survey (LCS) was conducted in Kansas using 86 segments from non-agricultural strata. Forty-three of these segments were June Enumerative Survey (JES) segments enumerated during the regular 1980 June survey. The remaining 43 segments were "rotated out" segments for the same strata from the previous five years and were only visited during the LCS. Therefore, on 43 segments, both a JES and LCS were conducted in 1980.

The objectives of the land cover project were to:

- o Test the feasibility of having regular enumerators and supervisors use land cover definitions to classify parcels of land.
- o Obtain preliminary variance information for direct expansions of cover types in the non-agricultural strata.
- o Determine the feasibility of jointly using ground and LANDSAT data to provide land cover acreage and map information.

A detailed discussion of the methodologies and results of the land cover study are documented in a report title, "Evolution of Land Cover Definitions and Survey for the Economics and Statistics Service". The purpose of this paper is to compare the JES enumeration and LCS measurement results for crop acreage in the 43 duplicated segments.

Because this data set has several limitations, statistical analyses and inferences were kept to a minimum. However, the presentation and discussion of the raw data can be helpful in understanding some of the non-sampling errors that can occur in the JES and it is hoped that this can benefit State Statistical Office personnel who conduct the June Enumerative Survey.

II. Land Cover Survey Procedures

Terms and definitions of land cover types used in the survey are given in Appendix A. A land cover school was held on July 17, 1980 in Salina, Kansas for twelve JES enumerators to train them on procedures for obtaining land cover data. A new term called "unit" replaced the JES concept of "tract" and "field" because this survey was not concerned with land operators. A unit is a continuous area of land devoted to one land cover type and at least one acre in size. A unit may extend beyond ownership or operating boundaries of a typical farm, but must remain within the segment. Therefore each land use inside a segment was observed and labeled as one of the defined land covers. The enumerator was not required to record acreages; these were obtained during digitization of unit boundaries. All of the enumeration was done using both color and black/white infrared photographs at a scale of eight inches to the mile. The photography had been acquired on April 28 and May 6, 1980.

The cropland category is of particular importance to this report. On the LCS the enumerator was not required to delineate and record individual crop fields. For example, if a contiguous area of agriculture land contained fields of wheat, corn and soybeans, the LCS enumerator drew a

boundary containing all three fields and called this delineation "cropland". The JES enumerator would have delineated each field and assigned the specific crop to these delineations. The LCS was done almost exclusively by visual observation whereas the JES was conducted by interviewing the operator.

III. Crop Acreage Comparisons

A. Stratum and Segment Statistics

The LCS was not designed as a quality control survey and therefore did not have the rigid control of procedures which would be required for a full non-sampling error project. Among the limitations of the LCS approach for explaining the source of discrepancies with the JES are:

- o LCS procedure of delineating parcels (units) of land use within the segment did combine some small portions of "waste" in cropland parcels. For example, a "hedge row" boundary between two crop fields might be included in cropland.

- o LCS did not require listing specific crops and most cropland is labeled only as such. This limits evaluation of which fields may be in error in cases of differences.

- o LCS was done by observation while the JES was done by interview.

- o Changes could occur between the date of LCS photography and survey period.

- o LCS surveys were obtained by digitizing field boundaries while JES acreages were obtained through interview.

- o Where the JES and LCS differ for a segment, no interview was made to determine if intentions may have changed, such as cutting a hay crop from a pasture.

The first step in the analysis was to determine acreage of total land within a segment from both the JES and LCS. In some segments there were slight differences between these two numbers. This was expected because segment boundaries were drawn on LCS photographs from county map locations rather than from the JES photos which might cause small differences. Some LCS photographs has segment boundaries right along the edge of the photographs so it was difficult to draw the segment boundary corresponding to the JES photo. Some differences might also result because of the use of digitized versus reported acres. To correct this situation, the total land acreage from the JES was treated as the "base". The LCS segment acreage was adjusted to this truth by proportioning any difference to each of the land cover units delineated within the segment. For example, if the total acreage of a segment was 1010 from the JES and 1000 from LCS and the LCS showed three land cover units having acreage of 500, 300, and 200 the adjusted acreages would be 505, 303, and 202.

After making the above adjustments, the summation of JES acres from each crop field within the segment was compared to the LCS cropland acreage.

A breakdown of the total number of segments and crop acreage is shown by stratum in Table I. Stratum 31-is Agri-Urban, 32-Residential/Commercial, 33-Resorts, 40-Rangeland, and 50-Non Agriculture. In all cases the LCS cropland acreage exceeds the acres of crops reported during the JES, at the stratum total level.

Table 1. Comparison of Cropland Acres and Acres of Cropland, by Stratum

Stratum	No. of Segs	LCS Cropland Acres	JES Acres of Crops	JES / LCS
31	12	203	66	.33
32	12	5	1	.20
33	2	95	81	.85
40	15	3,184	2,633	.83
50	2	638	410	.64

Tables 2-6 list the percent cropland (LCS cropland total divided by total segment acres), LCS crop acreage, JES crop acreage, and JES divided by LCS acreage ratio for each segment within a stratum. The average segment size and range of sizes are also given. These data for each segment along with the color infrared photograph, LCS unit boundaries overlay, and LCS questionnaire were used to analyze differences between the two surveys. On the color infrared photos, winter wheat and alfalfa were discernable by red colors and bare soil fields were various shades of greys and tans. The following is a brief summary of the findings:

STRATUM 31 - Five of the 12 segments had no cropland or matched exactly (1 acre on each survey). Another four of the 12 had no cropland on the JES but had from 6 to 47 acres on the LCS. One of these four segments had obvious enumerator omissions on the JES as does one of the three segments not mentioned to this point. One segment of the 12 had more acres of crops on the JES than cropland acres on the LCS.

STRATUM 32 - Only one of the 12 segments had any cropland. That segment had four small fields (5 acres) as cropland on LCS but only one field (1 acre) in crops on the JES.

STRATUM 33 - One of the two segments had no cropland. The other appears to differ only in native vegetation cut for hay which might be a legitimate change due to timing from JES to LCS.

STRATUM 40 - One of the 15 segments was in a salty area and had no cropland. Of the remaining 14 segments, only four of them agree on cropland within plus or minus 10% on the two surveys and a total of seven agree within plus or minus 25%. Segment size for these 15 segments ranged from 2003 to 3200 acres. One of the most striking results for this stratum is that six of the segments have small fields which appear to be cropland on the color IR which were not listed as

such on the LCS. Six segments have between 63 and 289 acres more cropland on the LCS than the JES. Two of these may have differences due partly to prairie hay, two are difficult to enumerate due to location of roads, and two have definite omissions of crop fields by the JES enumerator.

STRATUM 50 - These two segments, while not as large as in stratum 40, are difficult to enumerate. The LCS classifications do look correct for both segments based on the color IR. Acreage discrepancies are 66 and 162.

From the above analysis the following general conclusions were reached:

- o There are more survey to survey differences in cropland for individual segments than expected. That is, more segments varied by greater than 10% (or 20%) on cropland for the two surveys than might have been hypothesized. Only in the case of prairie hay does there seem to be a "legitimate" reason for change. (Prairie hay was called cropland on the LCS but not considered a crop on the JES.)

Table 2. Comparison of Cropland Acres and Acres of Cropland, Stratum 31

Average Segment Size - 142 acres
Segment Size Range - 80 to 220 acres

Segment No.	Percent Cropland	LCS Cropland Acres	JES Acres of Crops	JES / LCS
8391	31.4	44	52	1.18
8392	0	--	--	--
8393	3.9	6	0	0
0394	21.4	47	0	0
0395	0	--	--	--
0396	0	--	--	--
6397	28.8	23	11	.47
6398	.8	1	1	1.00
6399	0	--	--	--
7400	24.8	38	2	.05
7401	7.6	11	0	0
7402	28.7	33	0	0

Table 3. Comparison of Cropland Acres and Acres of Cropland, Stratum 33

Segment No. & Size	Percent Cropland	LCS Cropland Acres	JES Areas of Crops	JES / LCS
9415 - 136 AC.	69.9	95	81	.85
0416 - 168 AC.	0	--	--	--

Table 4. Comparison of Cropland Acres and Acres of Cropland, Stratum 32

Average Segment Size - 65 acres
Segment Size Range - 43 - 88 acres

Segment No.	Percent Cropland	LCS Cropland Acres	JES Acres of Crops	JES / LCS
8403	0	--	--	--
8404	6.3	5	1	20
8405	0	--	--	--
0406	0	--	--	--
0407	0	--	--	--
0408	0	--	--	--
6409	0	--	--	--
6410	0	--	--	--
6411	0	--	--	--
7412	0	--	--	--
7413	0	--	--	--
7414	0	--	--	--

Table 5. Comparison of Cropland Acres and Acres of Cropland, Stratum 50

Segment No. & Size	Percent Cropland	LCS Cropland Acres	JES Acres of Crops	JES / LCS
8432 - 614 AC.	66.0	405	243	.60
0433 - 749 AC.	31.1	233	167	.71

Table 6. Comparison of Cropland Acres and Acres of Cropland, Stratum 40

Average Segment Size - 2,555 acres
Segment Size Range - 2,003 - 3,200

Segment No.	Percent Cropland	LCS Cropland Acres	JES Acres of Cropland	JES / LCS
9417	2.4	65	81	1.25
9418	3.0	60	129	2.15
9419	0	--	--	--
0420	8.3	213	136	.63
0421	16.6	444	457	1.03
0422	3.4	74	80	1.08
6423	6.3	162	89	.55
6424	3.0	76	90	1.18
6425	6.9	184	121	.66
7426	5.3	123	36	.29
7427	18.5	467	178	.38
7428	7.8	223	250	1.12
8429	9.4	246	120	.49
8430	12.4	293	300	1.02
8431	21.9	555	566	1.01

- o Although there were more differences than expected, severe enumerator errors seemed confined to perhaps 3-5 segments, approximately ten percent of the segments.

- o Boundaries were noted for a few segments which might be legitimately improved through problem segment action but these problems were not apparently major contributors to JES-LCS differences.

- o It is difficult to enumerate cropland in the large range segments. All but one range segment had some cropland (mostly under 10 percent) and the cropland tended to be in scattered fields, often located some distance from roads.

Since cropland was observed in the LCS and acres of crops in specific fields were enumerated in the JES the difference in definition might slightly inflate the LCS totals (by inclusion of fence rows between adjacent fields or small acres of waste within cropland units in the cropland total.) This did not seem to be a significant factor, particularly in the rangeland stratum where cropland fields tended to be separated from other cropland fields.

B. Direct Expansion Estimates

Although some of the acreage differences between the JES and LCS appear to be small, these non-agriculture strata have large expansion factors. The segment data from each survey were expanded to obtain direct expansion estimates at the stratum level. The acreage estimates and associated coefficients of variation (C.V.'s) are given in Table 7. The total LCS estimate was 229,844 more acres than the JES with the majority of the difference coming from the Rangeland Stratum (40). All but one of the stratum C.V.'s for the LCS were equal to or smaller than the corresponding JES stratum C.V.'s.

Table 7. Direct Expansion Estimates of Cropland for Each Stratum

Stratum	LCS Cropland		JES Areas of Crops	
	Acres	C.V.%	Acres	C.V.%
31	47,954	32.73	13,536	78.61
32	1,151	99.80	0	0
33	11,996	99.57	11,103	99.57
40	658,133	20.02	498,372	22.49
50	93,686	28.57	60,065	18.40
TOTAL	812,920		583,076	

VI. Sources of Non-Sampling Errors

After a thorough review of the questionnaires from the LCS survey and the color infrared photography, ten segments were selected for a further review in the Kansas State Statistical Office. The purpose was to determine if

any patterns or situations were present which should be avoided in JES surveys in each state.

There are a few general comments which can be offered from review of these segments. Some enumerators have a tendency to write acreages and crop types on the segment aerial photo during the JES interview, particularly if the respondent is in a hurry. This can cause errors if a field is not listed later on the regular interview form or is copied over incorrectly.

Enumerators must be conscientious about driving completely through segments in the agri-urban stratum. These segments tend to be at the edges of towns or cities and often have roads every city block. Within the city limits may be some fields of crops. It does not require much time to drive these streets during the JES and to check on any large lots or fields which have been tilled or planted. They may be large multi-family garden plots and not reported but also might be small areas of field crops. This street by street check should be made regardless of the fact that no farm operators were detected during a prescreening visit.

The JES visit and prescreening visits should be made by different individuals when possible. The segment with the most obvious enumeration errors (all crop fields were missed) was a newly rotated in segment which was screened and enumerated on the JES by the same individual. There was some very serious misunderstanding on the part of the enumerator and there was no chance for another look at the segment.

None of these 43 segments (10 percent of all segments in Kansas) were selected for a supervisor "quality control" visit. The reason for this seems to be timing rather than a conscious effort since the supervisor revisits were after 4-5 days of the survey period and enumerators may tend to concentrate on the agriculture strata segments first. Efforts can be taken to insure that some non-agriculture strata segments are worked earlier in the survey period and to make sure supervisory enumerators consider them for quality control visits.

Some of the discrepancies for the 10 segments resulted from a combination of old photography and refusals. On the JES, survey enumerators must fill in field boundaries, acreages, and crop or land use for all fields. With fairly recent photography this is often not difficult. If, however, major changes to the surface features of the segment have occurred, outdated photography may be misleading. An example of the problem may be typified by one 1980 Kansas segment. The Army Corps of Engineers now controls a considerable portion of the 2500 acres in the segment. While not a refusal it is difficult to find a qualified "Operator" to report for that land. That portion of the segment has had major clearing activities but the color IR indicates that some crop fields have been left. More current black and white photography would have been of considerable help. (The Kansas SSO did receive current 35mm color aerial photography slides of all segments for use in the detailed edit for the remote sensing project. These slides do show current fields but it took 8 slides to completely cover this 2500 acre segment and they were difficult to use. In 1981 the SSO will use prints from the slides which will be easier to use.)

One common discrepancy between the JES and LCS was acreage of hay. As indicated earlier, cutting of native prairie hay was classifed differently on the two surveys. However, other differences were related to cutting pastures for hay. This may have been a particular 1980 problem since, due to dry conditions, some farmers may have cut hay from land that they normally would not have. However, it does point out the need to probe and be sure that cutting of hay is not overlooked on the JES.

V. Summary

All forty-three 1980 Kansas JES segments from non-agricultural strata received a second visit during the 1980 LCS. Survey comparisons for cropland acreage were made on a segment basis. Differences in enumeration procedures and the time span between the surveys limited the evaluation of discrepancies found in these segments. The total LCS cropland acreage was 29% higher than the reported acres of crops from the JES. Directly expanding the strata level acreages resulted in a LCS estimate that contain 40% more acres of cropland than the JES estimate.

Ten segments were selected for a detailed analysis to determine sources of non-sampling errors. Enumerators apparently failed to completely drive through and survey agri-urban and rangeland segments. Several small fields were missed within city limits and towns. These urban areas are dissected by numerous roads and street which allows access to these fields. Crop fields in rangeland areas were missed because these fields were not easily accessible via paved or dirt roads. Current photography would give the enumerator a better perspective of the cropland situation for these large rangeland segments. Many JES enumerators have the practice of putting crops and acreage on the photo while interviewing the respondent and then transfer these data to the questionnaire at a later time. This results in a potential for errors including a shortage of cropland acres.

Non-sampling errors could be reduced if the pre-screening and JES visits to a segment were made by different individuals. This would provide a check for catching fields that the first enumerator may have missed. None of the 43 segments received a supervisor quality control visit. Enumerators tend to work the agricultural strata segments first and the non-agricultural strata segments did not become candidates for quality control checks.

It is hoped that the results of this study can be used to improve the JES survey. Even though this work was conducted in Kansas, the possibility exits that these non-sampling errors occur in every state that conducts a JES.

VI. Recommendations

The comparison of Land Cover Survey results with the same June Enumerative Survey segments indicated two common sources of non-sampling errors. It seemed difficult to account for scattered, small fields of cropland in rangeland segments. Some small fields of crops were overlooked in agri-urban segments. To counteract these two factors some general recommendations are offered.

One of the most important factors in avoiding non-sampling errors is training. Present JES procedures which call for driving around and through segments and matching observed features with those reported by respondents are very good. However, most examples and most training focus attention on the agricultural strata segments and enumerators may somehow downplay the importance of the few non-agricultural strata segments that they are assigned. Training must address the particular problems which may be associated with very large range segments or with agri-urban segments with agricultural fields. Examples of particular relationships from previous years for non-agricultural strata segments should be included in each training session.

SSO personnel should review prescreening results closely, particularly for new agri-urban and residential-commercial segments. Does the available ASCS aerial photography indicate some agricultural fields or some possible farm headquarters not picked up in prescreening? If so, the new information is probably correct because development has occured since the date of the ASCS photo. However, it would be worthwhile having that situation identified for particular review during the JES. Another approach might be to acquire ASCS current 35mm photography (if it exists) for the new prescreened segments and review those slides before the JES survey as a quality control measure.

SSO's should consider procedures which result in some quality control supervision followups of non-agricultural strata segments. Supervisory enumerators should particularly review non-agricultural strata segments of enumerators who seem to be having problems with enumeration techniques or survey definitions.

It is particularly important to emphasize contacting the actual operator of rangeland segments whenever possible. In average sized agricultural strata segments, an enumerator can often observe each field and develop a good estimate of acreage if the interview is conducted with another family member or other party associated with the operation rather than the operator. It is much more difficult to see all fields or properly orient another "informed" person's thinking about cropland on large range segments. Thus, an interview with the operator is important to minimize errors.

The recommendations above do not involve changes in survey procedures. Instead, they emphasis the need for attention to details which SSO's should be able to accomplish through training and supervision.

APPENDIX

Land Cover Terms and Definitions Used for the 1980 Kansas LCS

10 URBAN	-- primarily vegetative cover: parks, golf courses, house lots, cemeteries
11 URBAN	-- residential; commercial and service; industrial; transportation, communication and utilities; industrial and commercial complexes
20 AGRICULTURAL	-- cropland
21 AGRICULTURAL	-- orchards, groves, vineyards, nurseries, and horticulture
22 AGRICULTURAL	-- confined feeding operations
23 AGRICULTURAL	-- pasture
24 AGRICULTURAL	-- other ag. land: farmsteads, roads, ditches, small ponds, corrals
30 RANGELAND	-- herbaceous, shrub, and brush
40 FOREST LAND	-- deciduous and evergreen
50 WATER	-- ponds, lakes, rivers
60 BARREN LAND	-- forest clearings, bare land for residences, shopping centers and industrial sites, strip mines, exposed rock