UNITED STATES DEPARTMENT OF AGRICULTURE
STATISTICAL REPORTING SERVICE
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SUBJECT: 1969 Corn Validation Project

In the continuing effort to explain the difference between Board yields and objective yields, a corn validation project was undertaken in Iowa and Missouri in the fall of 1969. In addition to the difference in levels of yield, the validation project was undertaken because this was a Census year and comparability between the 1969 Census and earlier Censuses is questionable.

Validation and quality control work in the past have generally supported the objective yield procedures but usually indicate a small upward bias in the objective yield estimates. Weighing projects in 1965 and 1967 to establish "true" yield levels generally supported Board levels.

A summary of the project is enclosed. This summary does not include the Office Procedures Manual, the Interviewers Manual, the special forms and some of the other details concerning the project. A copy of these materials may be obtained with a direct request to the project leader.

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SUMMARY

1969

C O R N

V A L I D A T I O N

S T U D Y

IOWA and MISSOURI

U. S. Department of Agriculture
Statistical Reporting Service

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1969 Corn Yield Project

BACKGROUND:

Estimates from corn objective yield surveys have consistently been above yield levels adopted by the Crop Reporting Board. Historically, Board yields have been tied to levels of the U. S. Census of Agriculture. Numerous validation studies and continued quality control work have generally supported the procedures used in the Objective work. However, when compared with the weighed yield, some upward bias, about 3 to 5 percent, has usually been observed. Weighing projects in 1965 and 1967 to establish "true" yield have supported Board levels. However, the differences between Objective and Board published estimates for States included in these projects of 4 and 6 percent for 1965 and 1967, respectively, are considerably less than the usual spread. For the years 1966 through 1969 (ignoring any Board revisions still to be made) the average yield for all corn objective yield States from the Objective surveys has ranged from 10.0 to 11.4 percent above the comparable Board yield. In view of these inconsistencies and with 1969 being a Census year the current project was conducted.

OBJECTIVE:

The primary objective of the 1969 Corn Validation Study was to determine "true" yield, within sampling error, of corn in the States of Iowa and Missouri. Most of the field work was conducted in the fall of 1969 with a few sample fields completed in early 1970.

SURVEY PROCEDURES:

The sample consisted of fields containing the even numbered regular objective yield samples in Iowa and Missouri. This included about 175 fields, 100 of which were in Iowa and 75 in Missouri. A total of 153 sample fields were actually completed, 93 in Iowa and 60 in Missouri. The "true" yield was determined by harvesting and weighing production from measured areas in each of these sample fields.

The farm operators for these fields were contacted in late September to obtain their cooperation in the project. At this time enumerators explained the purpose of the survey, obtained information as to expected method of harvest, and drew a sketch of the sample field. The sketches and completed interview forms were returned to the State Office.

A small area of the field was selected as the sampling unit. Usually this area was two or four rows, depending upon the length. It was intended that production from the selected area be less than 50 bushels. The operator's equipment and situation dictated to some extent the number of rows to be included and the number of passes to be made through the field. The rows were randomly selected and designated to the enumerator before he arrived at the field to make his measurements, weighings, etc. As soon

as the farm operator harvested the corn from these rows, it was weighed on platform scales in the field and sampled for moisture determination. If the farm operator picked the corn in the ear, it was shelled by a team of enumerators at the farm with a portable sheller. Measurements of row length and average row width were made to compute area. In a few cases, the farmer weighed production from the entire field and field measurements were taken in order to derive the true yield.

In addition, two special objective yield units were randomly located and laid out just prior to harvest in rows adjacent to the weighed area. These units were laid out using regular objective yield procedures. All of the ears in both rows of each unit were harvested. Row 1 ears were weighed following regular objective yield procedures, and the third and fourth ears from each unit were sent to the State laboratory to determine shelling fraction and moisture. Then all ears, excluding the four ears sent to the laboratory, were weighed, shelled and a sample taken for moisture determination.

A part of one row in each sample field was hand harvested. This was usually one half of a row and was located near the weighed area. The length of row was measured and the harvested ears were also weighed, shelled and sampled for moisture.

After the operator had harvested the selected rows, two post-harvest units were randomly located in the harvested area and gleaned for harvest loss. Both row middles were gleaned for loose grain and, if more than two row harvesting equipment was used, the unit included as many rows as taken in one pass with the harvester. In addition, two post-harvest units were located in the field using regular objective yield procedures.

The work was done by statisticians, supervisory enumerators, and enumerators. Fifteen two-man teams were required to handle the peak workload. Five portable corn shellers and fifteen platform scales were purchased especially for this survey. These were used to shell and weigh the corn in the field.

RESULTS:

Number of Ears:

Estimated ears per acre were computed from ear counts made in the special units and compared with ears per acre derived from the regular objective units. The following table shows these results.

TABLE 1: Comparisons of Ears Per Acre

State	No. of Samples	No. of Ears Per Acre			"t"
		Reg. Obj.	Special Units	Diff	
Iowa	93	17,142	17,779	-637	-1.86
Missouri	56	13,910	14,296	-386	-1.16
Combined	149	15,927	16,470	-543	-2.19*

*Significant at .05 level.

Counts obtained from the special units were about 3 percent higher than those for the original units. This was due to a higher ear count, since average row space measurements were essentially the same for both pairs of units.

Weight Per Ear:

Average weight of grain per ear (adjusted to 15.5 percent moisture) was computed for the regular objective yield units and for the special units. Weight per ear for the special units was computed using two different procedures. Procedure "1" was the same as for the regular objective yield units, i.e., all ears in row one of each unit were weighed in the field with the third and fourth ears sent to State Laboratory for determination of shelling and dry matter fractions. Weight per ear for procedure "2" was determined by weighing shelled grain from all ears from both rows of each unit (excluding the third and fourth ear of row one) with moisture being determined from a sample of shelled grain sent to the State laboratory. Table 2 shows comparisons of these three estimates of net weight per ear.

TABLE 2: Comparisons of Weight Per Ear

State	No. of Samples	Pounds of Grain Per Ear			"t" Values for Differences		
		Reg. Obj. (1)	Special Units Proc. "1" (2)	Special Units Proc. "2" (3)	(1 vs 2)	(1 vs 3)	(2 vs 3)
Iowa	93	.369	.376	.367	- .98	.33	2.97*
Missouri	56	.319	.319	.314	- .04	.48	1.74
Combined	149	.350	.355	.347	- .76	.57	3.44*

* Significant at .05 level.

The difference was significant between the two procedures for the special units in Iowa and combined. This resulted from a different shelling fraction derived for each of the procedures. In no case was weight per ear from the special units significantly different from the regular objective yield.

Shelling Fraction:

Shelling fractions were computed for four different procedures. These were the regular objective yield, the two procedures from the special units, and for the hand harvested row. Shelling fraction for procedure "2" of the special units and the hand harvested row was derived from shelling and weighing done in the field with use of portable shellers and platform scales. In the regular objective yield, shelling fraction is determined from the sample ears sent to the State laboratory.

Form C data for some of the regular objective yield samples were never received from Iowa. Yields were computed using historic averages for shelling and dry matter fractions which were close to those obtained from completed form C's. For comparison, if averages from current form C's had been used, yields for these samples would have been about 1 percent higher. Comparisons of average shelling fraction are given in tables 3A and 3B.

TABLE 3A: Estimated Shelling Fraction

State	No. of Comparable Samples	Average Shelling Fraction			
		Reg. Obj. (1)	Special Units		Hand Harv. Row (4)
			Proc. "1" (2)	Proc. "2" (3)	
Iowa	93	---	.804	.782	---
	89	---	.804	.783	.795
	67	.782	.804	.788	---
	65	.783	---	---	.798
Missouri	56	.785	.810	.809	---
	50	.786	.810	.810	.815
Combined	149	---	.806	.792	---
	139	---	.806	.793	.802
	123	.783	.807	.797	---
	115	.784	---	---	.806

TABLE 3B: "t" Values for Difference - Shelling Fraction

State	(1 vs 2)	(1 vs 3)	(1 vs 4)	(2 vs 3)	(2 vs 4)	(3 vs 4)
Iowa	-4.13*	-0.88	-2.90*	5.68*	3.48*	-3.10*
Missouri	-4.76*	-4.10*	-5.86*	0.49	-1.30	-1.04
Combined	-6.24*	-3.13*	-5.72*	4.94*	1.73	-3.16*

1/ "t" value computed for highest number of comparable samples.
* Significant at .05 level.

Shelling fraction for the regular objective yield was, in all cases, less than for the other methods. This is probably associated with higher moisture and earlier harvest dates of the regular objective yield units. Averages for procedure "2" of the special units was less than for procedure "1" or for the hand harvest row. It is difficult to explain the difference between the hand harvested row and procedure "2" since both made use of the portable field shellers, and were completed at approximately the same time. Possibly some small losses of grain associated with the use of the portable sheller were not in proportion to the amount shelled and had more influence on the shelling fraction computed on the smaller quantity from the special units.

Dry Matter Fraction:

For most fields, moisture tests were made on five samples. Two of these, the regular objective yield and procedure "1" of the special units, were taken from the grain shelled from sample ears sent into the State laboratory. For the other tests, a sample of shelled grain was sent to the laboratory for testing. Comparisons of average dry matter fraction are given in Tables 4A and 4B.

TABLE 4A: Estimated Dry Matter Fraction

State	No. of Comparable Samples	Average Dry Matter Fraction				
		Reg. Obj. (1)	Special Units		Hand Harvest Row (4)	Farmer Harvest Rows (5)
			Proc. "1" (2)	Proc. "2" (3)		
Iowa	93	--	.746	.753	.755	.757
	67	.722	.748	.757	.759	.763
Missouri	56	.774	.829	.824	.825	--
	55	.773	.829	.825	.824	.831
Combined	149	--	.777	.780	.781	--
	148	--	.777	.780	.781	.785
	123	.746	.785	.788	.789	--
	122	.745	--	--	--	.794

TABLE 4B: "t" Values for Difference - Dry Matter Fraction 1/

State	Comparison					
	(2 vs 3)	(2 vs 4)	(2 vs 5)	(3 vs 4)	(3 vs 5)	(4 vs 5)
Iowa	-2.55*	-2.55*	-2.93*	-0.86	-1.46	-0.99
Missouri	2.08*	1.62	-0.99	-0.36	-4.36*	-4.33*
Combined	-1.44	-1.72	-3.07*	-0.92	-2.78*	-2.60*

1/ "t" value computed for highest number of comparable samples.

* Significant at .05 level.

Comparisons with the regular objective yield, which are not included in Table 4B, showed the objective yield to have a significantly lower dry matter fraction in all cases. This can be explained by the higher moisture associated with the earlier harvest dates. In Iowa, the dry matter fraction determined from the ear samples of the special units was less than for other samples taken at harvest. However, in determining net weight per ear, this was more than offset by a higher shelling fraction for these same samples.

Combined results indicate that the average dry matter fraction for samples from the farmer harvested rows was greater than from other samples. Possibly, some additional drying of the farmer harvested corn occurred during processing delays of these larger quantities of corn. This would have no effect on the weighed yield provided the sample was obtained at the time of weighing. Disregarding the dry matter fraction from the regular objective yield samples, the differences from the other methods have only a small effect on yield.

Gross Yield:

Gross or biological yield was computed for each of the pre-harvest sampling methods. Results and tests of differences are shown in Tables 5A and 5B.

TABLE 5A: Estimated Gross Yield

State	No. of Comparable Samples	Yield - Bushels Per Acre			
		Reg. Obj. (1)	Special Units		Hand Harv. Row (4)
			Proc. "1" (2)	Proc. "2" (3)	
Iowa	93	113.9	119.5	116.5	113.8
Missouri	56	80.1	83.2	81.6	75.3
Combined	149	101.2	105.9	103.4	99.3

TABLE 5B: "t" Values for Difference - Gross Yield

State	Comparison					
	(1 vs2)	(1 vs 3)	(1 vs 4)	(2 vs 3)	(2 vs 4)	(3 vs 4)
Iowa	-1.91	-0.92	0.03	3.01*	2.22*	1.06
Missouri	-0.94	-0.47	1.31	2.08*	2.89*	2.46*
Combined	-2.12*	-1.03	0.84	3.60*	3.43*	2.17*

*Significant at .05 level.

The regular objective yield and the hand harvested row were not significantly different. The higher yields from the special units were due to the higher count of ears. Yield from procedure "1" of the special units was greater than for procedure "2" because of higher weight per ear.

Harvest Loss:

Amount of grain remaining in the field after harvest was estimated from two pairs of units. One pair was based on the regular objective yield procedures and location was associated with the original objective units. The second pair was located in the farmer harvested rows and, if more than two-row harvesting equipment was used, included as many rows as taken with one pass of the harvester. Also, all row spaces were gleaned for loose grain. Table 6 provides the estimates of harvest loss from these units.

TABLE 6: Estimated Harvest Loss

State	No. of Comparable Samples	Loss - Bushels Per Acre			"t" value
		Reg. Obj.	Special Units	Diff.	
Iowa	89	7.6	7.3	0.3	0.46
Missouri	57	10.0	11.5	-1.5	-1.48
Combined	146	8.5	8.9	-0.4	-0.77

No significant differences were found.

Net Yield:

Net yield is derived by subtracting harvesting loss from gross yield. Losses measured using the regular procedures were used to estimate net yield for the regular objective yield. However, the regular gleaning units were not completed for four samples in Iowa and two in Missouri. For these samples, the average loss from completed samples was subtracted from gross yield. This follows the standard procedure for computing the final objective yield estimate.

Harvest loss computed from the additional gleaning units was used to derive net yield for the special units and the hand harvest row. Only samples for which gleanings had been obtained were included in these comparisons. This excluded one sample in Iowa for which the post-harvest work was not completed.

Weighed yield from the farmer harvested rows was computed directly by determining production actually harvested from a measured area. Tables 7A and 7B give results from estimates of net yield.

TABLE 7A: Estimated Net Yield

State	No. of Comparable Samples	Weighed Yield (1)	Yield - Bushels Per Acre			Hand Harv. Row (5)
			Reg. Obj. (2)	Special Units		
				Proc. "1" (3)	Proc. "2" (4)	
Iowa	93	102.9	106.2	---	---	---
	92	103.0	106.6	112.0	108.9	107.1
Missouri	60	65.6	71.5 1/	---	---	---
	56	66.0	70.2	72.0	70.4	64.1
Combined	153	88.3	92.6	---	---	---
	148	89.0	92.8	96.9	94.4	90.8

1/ Includes two samples harvested by farmer prior to final pre-harvest visit. Yield based on forecast from counts made on last visit.

TABLE 7B: "t" Values for Difference - Net Yield

State	Comparisons 1/						
	(1 vs 2):	(1 vs 3):	(1 vs 4):	(1 vs 5) :	(2 vs 3) :	(2 vs 4) :	(2 vs 5)
Iowa	-1.16	-4.05*	-2.71*	-2.10*	-1.91	-0.86	-0.17
Missouri	-1.78	-2.40*	-1.85	0.99	-0.55	-0.08	1.66
Combined	-2.04*	-4.70*	-3.25*	-1.25	-1.92	-0.77	0.87

1/ "t" values computed for highest number of comparable samples. Values for comparisons between 3, 4 and 5 will be same as found in Table 5B.

* Significant at .05 level.

A weighed yield was obtained on 93 samples in Iowa with an average yield of 102.9 bushels. The standard error of this average was 3.3 bushels. Included in the 93 were four alternate samples which replaced original samples for which weighed yield could not be obtained. In addition, there were five fields which were harvested by the farmer prior to the survey or without contacting the enumerator and no alternate was obtained. Seven more samples were refusals on the initial objective yield contact.

In Missouri, a weighed yield was obtained for 60 fields. Average yield was 65.6 with a standard error of 3.3 bushels. No alternate fields were used but there were ten additional fields that were lost because of early harvest or the enumerator was not contacted.

Net yield from the regular objective yield averaged less for fields in which a weighed production was obtained than for all samples. In Iowa, 195 objective yield samples averaged 108.0 compared to the 106.2 bushel yield from the 93 study fields. Similarly in Missouri, 139 samples averaged 73.2 compared with 60 survey fields averaging 71.5 bushels per acre.

The weighed yield was the lowest of the yield estimates and was significantly lower than yields computed from the regular and special objective yield units. The weighed yield averaged 4.6 percent less than the regular objective yield. Yields computed from the special units were highest in both States. In Missouri, yield from the hand harvest row was considerably below yields from the other pre-harvest units and even less than the weighed yield. In Iowa, yield from the hand harvested row was between yields from the regular and special units.

SUMMARY AND CONCLUSIONS:

More ears were counted in the special units than in the original objective units. Procedures for laying out the units were the same. Location of the special units was determined by the selection of the farmer harvested rows. Counting procedures were somewhat different in that only a count of the number of ears with evidence of kernel formation was made. Counts of stalks, stalks with ears and total ears and ear shoots were not made. Also, ears from both rows were harvested compared to only row one for the regular units. This difference in ear counts is not interpreted as being of major importance since there were some changes in the counting procedures. In the 1967 Iowa Corn Weighing project, fewer ears were counted in similar special units.

The only significant difference in weight per ear was between the two procedures used for the special objective yield units. This resulted from a higher shelling fraction for the four ears sent to the laboratory compared to the shelling fraction for all remaining ears as determined by shelling and weighing in the field. Shelling fraction computed for the hand harvest row was also greater than for procedure(2) of the special

units although shelling and weighing procedures were the same. It is suspected that some small amounts of grain were not accounted for in the shelling of ears from the special units. Small differences in the dry matter fraction are believed related to processing time required for each of the harvested samples of corn and had little effect on yield.

Comparisons from this study indicate the weighed yield is less than yields determined by any of the pre-harvest sampling methods used. Some of the questionable factors relating to the accuracy of the weighed production for the 1967 project in Iowa were eliminated for this project. However, for 1969, production for fields harvested in the ear was highly dependent on the success of the portable shellers. After some initial experimentation, the shellers are believed to have performed satisfactorily. Assuming the weighed to be "true" yield, the bias in the estimate from using the regular objective yield procedures was observed to be 4.6 or 6.1 percent depending on whether the yield indications from the special units are considered. The higher percent is derived by combining the yields from both the original and special units. Although procedure (1) for the special units was intended to be the same as for the regular objective yield, operationally the procedures may not have been comparable since significantly more ears were counted in the special units. Also, recognizing that additional work was done in the special units, conditions under which data from the original units was obtained more closely compare to those in the regular objective yield program.

One potential source of bias is the incomplete measure of harvest loss. The special additional gleaning units for this survey estimated about the same losses as the original units. Corn that is crushed or ground during harvest ("invisible loss") cannot be gleaned by conventional procedures. The amount of this invisible loss is unknown but would not likely account for all of the difference. Some disappearance of grain remaining after harvest was noted during the 1968 project involving two adjacent fields in Maryland. Weekly post-harvest observations made in fields in Wisconsin, Nebraska and Tennessee in 1969 did not measure similar losses which would be missed if gleaning did not promptly follow harvest.

Current Board yields are 98.0 and 70.0 for Iowa and Missouri, respectively. Average weighed yields were 102.9 and 65.6, each with a standard error of 3.3 bushels. The yield survey was designed to provide a probability sample of weighed fields. However, a few early fields were harvested before the initial contact was made. In addition, there were several fields which were harvested without contacting the enumerator and there were some refusals. If a ratio estimate were used based on the objective yield average for the sample fields compared to all objective yield fields in the State the weighed averages would adjust to 104.6 and 67.2 bushels per acre. This analysis would support (within one standard error) the current Board yield in Missouri, but would not support the yield in Iowa.