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The Effect Of Enumeration On Soybean Objective Yield, 1986

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ABSTRACT

The results of a second study on the effect of enumeration on soybean objective yield are presented in this report. For each field, yields from objective yield units laid out at harvest in an undisturbed area were compared to operational samples that were visited four times over the survey period. The findings indicate that enumeration causes damage to plants around units during field work in narrow-row and broadcast fields. The effect of this damage is to make the objective yield unit not representative of the field since the plants inside the unit enjoy reduced competition which results in higher yields. In wide-row fields there is enough room between rows for enumerators to work without damaging plants. A second objective compared estimated to actual pod counts for unit 2 since pod counts were made for both units. Operationally sample yield is computed using pod counts from unit 1 only. Results showed that the estimated counts were higher in both States.

Keywords: Soybean objective yield, enumeration effect, yield estimation.

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CONTENTS

SUMMARY

This report presents the results of a second year of research on the effects of objective yield enumeration on final yield. A secondary objective was to determine whether a lab count of unit 2 pods with beans was necessary. Data for the project was collected in Louisiana and Ohio in conjunction with the 1986 Soybean Objective Yield Survey.

A comparison of yield from units laid out at harvest in an undisturbed area to the operational objective yield units was made. Results showed that the mean difference was significantly greater for operational narrow-row units in Ohio (6.5 bushels) and operational broadcast units in Louisiana (3.2 bushels) at an alpha of .05 in each case. The mean difference for wide-row units was not significant in either State, which was consistent with results from the 1985 study conducted in Georgia and Missouri. The findings indicate that enumeration causes damage to plants around units during field work in narrow-row and broadcast fields. The effect of this damage is to make the objective yield unit not representative of the field since the plants inside the unit enjoy reduced competition which results in higher yields. In wide-row fields there is enough room between rows for enumerators to work without damaging plants. It is recommended that in narrow-row and broadcast fields, harvest units be located in undisturbed areas and that these units be harvested with the operational units. This recommendation will not affect current forecast procedures.

A comparative analysis of estimated to actual unit 2 pod counts showed that estimated counts were significantly higher in both States. The 1985 study showed no differences in either State. In light of these inconclusive results it is recommended that pod counts be made for both units providing an independent yield estimate for each unit.

THE EFFECT OF ENUMERATION ON SOYBEAN OBJECTIVE YIELD, 1986

Robert J. Battaglia[1]

INTRODUCTION

This report presents results from the second year of a research project that examined the effects of enumeration on soybean objective yield. The initial study was conducted in Georgia and Missouri during 1985 [1][2]. A recommendation from the 1985 study was that further research be conducted in two States where narrow-row and/or broadcast soybeans are common. Therefore, the 1986 study was conducted in Louisiana and Ohio based on an examination of frequencies of wide-row, narrow-row and broadcast units by State [2].

A Soybean Objective Yield Survey is conducted in 15 States. In six major producing States (Illinois, Indiana, Iowa, Minnesota, Missouri, and Ohio) data collection begins in August and is completed in November [3]. In the nine remaining States (Alabama, Arkansas, Georgia, Kentucky, Louisiana, Mississippi, Nebraska, North Carolina, and Tennessee) data collection begins in September. Two sample units are randomly located in each selected field. These units are visited monthly by enumerators. Counts of plants, plant components, and row width measurements are made and used in monthly yield forecasts. When the soybeans are mature, sample units are hand harvested prior to farmer harvest and gross yield is determined. After harvest a subsample of selected fields is visited to determine harvest loss. Gross yield from sampled fields can then be adjusted to a net yield per acre estimate.

The procedure described above assumes that plants in objective yield (OY) units are randomly located and have growing conditions which are representative of the other plants in the field. Since OY units are visited three or four times during the survey period, the possibility of damage to plants around the unit

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[2] Numbers in brackets refer to literature cited in the references at the end of the report.

may cause reduced competition for plants in the OY unit resulting in higher yields than from plants in undisturbed areas. The primary objective of this study was to measure the effects of enumeration on yield. A secondary objective was to determine whether a count of the number of pods with beans from unit 2, in addition to unit 1 pods, is necessary on the C-2 form.

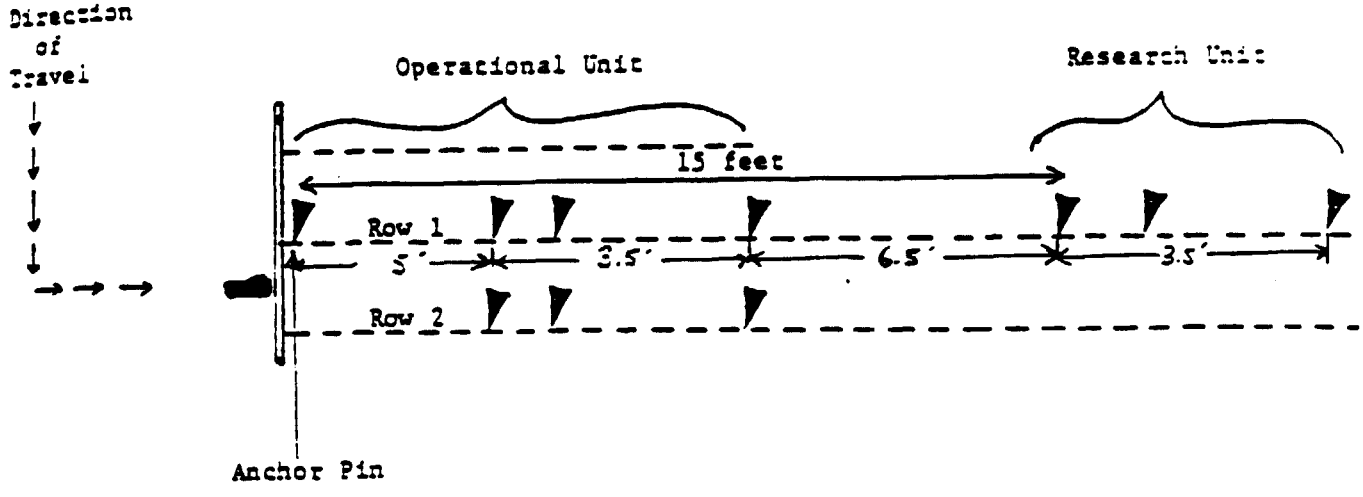
METHODS

Data Collection

Louisiana and Ohio were selected for the 1986 study because of the high frequencies of narrow-row and broadcast soybean objective yield units. Data for the research project was collected in conjunction with the operational soybean objective yield survey. A complete description of OY procedures can be found in the Enumerators and S&E manuals [5,3]. After the operational soybean OY units were harvested (maturity stage 5), research units were laid out 15 feet beyond the operational unit anchor stakes. These units were constructed in row 1 since only plants from row 1 are harvested to determine yield.

A diagram of a research unit for fields with rows is below. The research unit was located 6.5 feet from the end of the operational unit, in an area which should be undisturbed. After the research unit had been laid out, row width measurements were made, the number of plants in the 3-foot section counted, and the pods from those plants were harvested and sent to the regional lab. No counts were made in the 6-inch section [4]. Research units were harvested the same day as corresponding operational units. A similar procedure was designed for broadcast fields.

Figure 1. Unit layout:



Pods harvested from the research units were processed by unit in the regional lab. This allowed a count of pods with beans, weight of beans, moisture content and yield to be determined for each unit. Operational samples were also processed by unit in Louisiana and Ohio so that operational and research yields could be compared at the unit level. A Generalized Edit procedure was developed for research data used by survey statisticians in Louisiana and Ohio to edit questionnaire and lab data.

ANALYSIS

The first part of the analysis compared yields between operational and research units. Research units were laid out at harvest 6.5 feet from the operational unit in an undisturbed area (see figure 1). Gross yields in bushels per acre were calculated as follows [3]:

$$\text{Gross yield} = \left(\begin{array}{c}\text{Number of pods with}\\ \text{beans per 18 sq. ft.}\end{array}\right)\left(\begin{array}{c}\text{weight of beans}\\ \text{per pods with beans}\end{array}\right)\left(\begin{array}{c}\text{conversion}\\ \text{factor}\end{array}\right)$$

The conversion factor adjusts gross yield from grams per 18 square feet to bushels per acre. Comparisons of operational and research yields were made only if both units were enumerator harvested (unit status code 4). A paired t-test was used to compare mean differences between operational and research yields at the unit level. A one-tailed hypothesis was used:

Ho: operational sample yield = undisturbed sample yield
Ha: operational sample yield > undisturbed sample yield

The one-tailed test was used because of the initial assumption that repeated visits to operational units can cause damage to plants around the unit, resulting in reduced competition for the plants in the 3-foot section.

The second step of the analysis used operational data to compare the actual count of beans from the harvested 3-foot section in unit 2 to a count estimated using the operational procedure. The operational procedure uses the count of pods with beans from unit 1 with the weight of pods and beans from both units to estimate number of pods with beans for the entire sample (unit 1 + unit 2). This procedure assumes that the relationship between number and weight of pods with beans is the same for the unit in which the pods are not counted (unit 2). The number of pods with beans from unit 2 was estimated using the following formula from the S&E manual [3].

$N_2 = [(N_1 * W_{12})/W_1] - N_1$ where:

W_1 = Weight of pods and beans from unit 1, Row 1.
N_1 = Number of pods with beans from unit 1, Row 1.
W_{12} = Weight of pods and beans from both units.
N_2 = Estimated number of pods with beans from unit 2.

Unit 2 pod estimates were only made if pods were harvested from both units. A univariate paired t-test was used to compare estimated and actual pod counts by unit. The two-tailed hypothesis used for this test was:

Ho: estimated Unit 2 pod counts = actual counts
Ha: estimated Unit 2 pod counts $\neq$ actual counts

If the null hypothesis was rejected, then a count of pods with beans from both units may be necessary to determine the number of pods with beans component of yield.

RESULTS

Comparison of Yields

Yields from the operational unit were compared to research unit yields. Research units were laid out at harvest 6.5 feet from the operational units in an undisturbed area (see figure 1). Table 1 shows the results of the paired t-test on operational and corresponding research samples at the State level.

For all units in Louisiana the paired comparison shows that operational yields were not significantly different than yields from research units which were laid out in undisturbed areas. In Ohio however, table 1 shows that operational yield was significantly higher than yield from research units by 4.5 bushels. This indicates that repeated visits to OY units significantly affected yields in Ohio.

A detectable difference was calculated for each test. It is a mean of a distribution which can be detected as significantly different from the null hypothesis of row difference in yield with power of .75 when alpha = .05. Power is the probability of

Table 1: Paired Comparison of State Level Yield
(operational yield - research yield)

	Louisiana	Ohio
Units[1]	160	200
Yld[2] Operational (SE)	22.9 (1.1)	52.2 (2.5)
Yld Research (SE)	22.2 (1.2)	47.7 (2.3)
Mean Diff. (SE)	0.6 (.76)	4.5 (2.0)
Paired t	.81	2.3
Pr>|t|[3]	.21	.01
Detectable difference[4]	2.2	3.0

[1] Number of units with unit status = 4 (enumerator harvested).
[2] Yields, mean differences and detectable differences are reported in bushels per acre.
[3] One tailed significance probability.
[4] Significantly different from null hypothesis at alpha = .05 with power of .75.

rejecting the null hypothesis when false. A power level of .75 was chosen for this study.

The same comparisons of yield between operational and research units were made for narrow-row, wide-row and broadcast units in each State. Narrow-row units were defined as having a row width less than 18 inches. Broadcast units were constructed when rows could not be identified. The potential for change in narrow-row or broadcast units is greater since there is not much room for enumerators to work between rows or plants. Table 2 shows the comparisons for narrow-row, wide-row and broadcast units. Louisiana had only 7 narrow-row units and Ohio only 8 broadcast units so those categories have been excluded from Table 2 for those States.

In wide-row units the difference in yield between operational units and research units laid out at harvest was not significant in either State. This could indicate that there is enough room between the rows for enumerators to work.

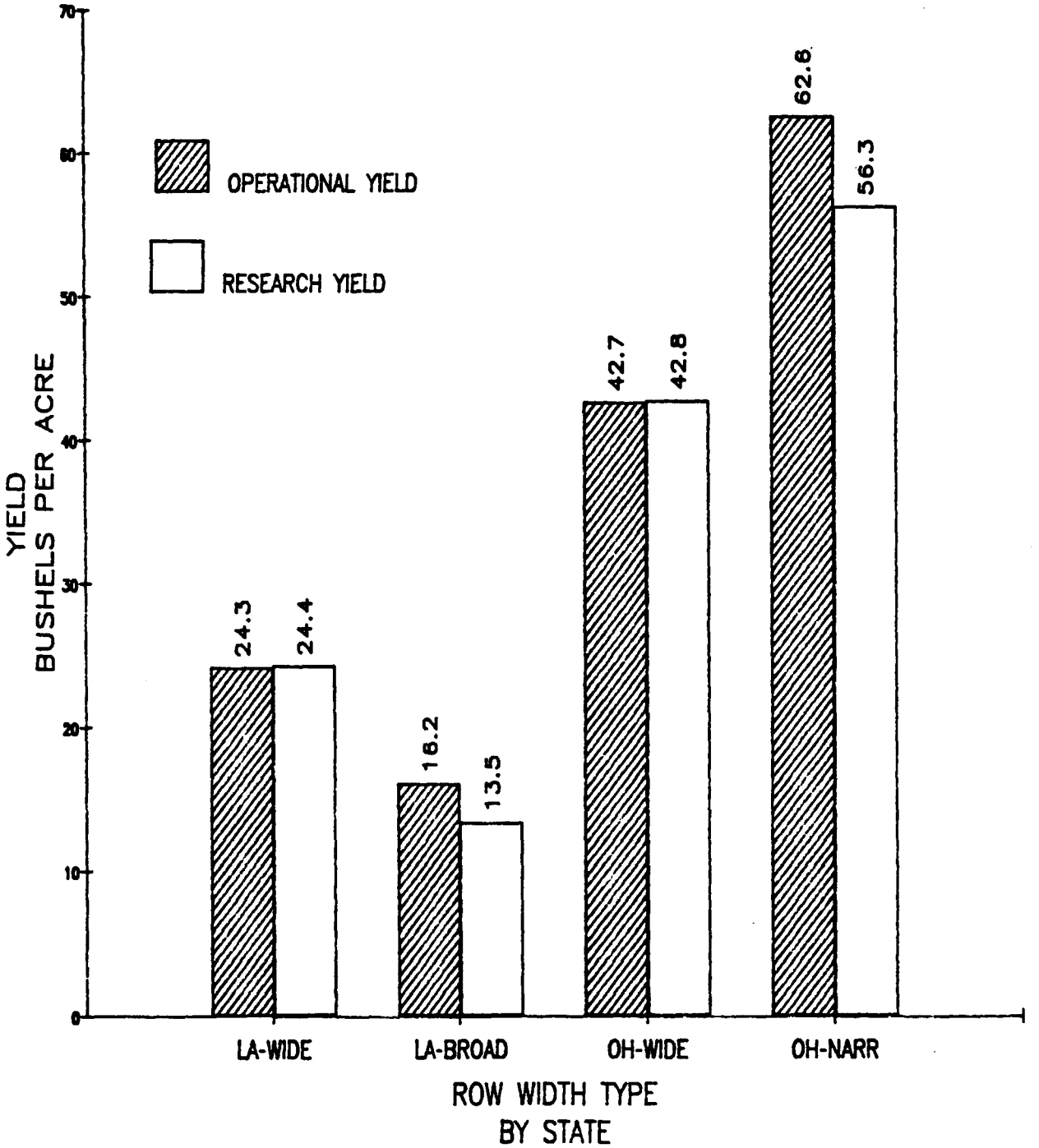
Table 2: Paired Comparison of Unit Yield By Row-Width Type (operational - research yields)

	Louisiana	Ohio
Wide-Row		
Units[1]	123	100
Yld[2] Operational (SE)	24.3 (1.2)	42.7 (1.6)
Yld Research (SE)	24.4 (1.4)	42.8 (1.5)
Mean Diff. (SE)	-.01 (.86)	-.13 (1.3)
Paired t	-.01	-.10
Pr>|t|[3]	.50	.46
Detectable Diff.[4]	2.2	2.5
Narrow-Row		
Units	7	92
Yld Operational (SE)	-	62.6 (4.8)
Yld Research (SE)	-	56.3 (4.6)
Mean Diff. (SE)	-	6.5 (3.7)
Paired t	-	1.74
Pr>|t|	-	.04
Detectable Diff.	-	4.2
Broadcast		
Units	30	8
Yld Operational (SE)	16.2 (2.1)	-
Yld Research (SE)	13.5 (2.0)	-
Mean Diff. (SE)	3.2 (1.9)	-
Paired t	1.72	-
Pr>|t|	.05	-
Detectable Diff.	2.9	-

[1] Number of units with unit status = 4 (enumerator harvested).
[2] Yield, mean difference and detectable differences are reported in bushels per acre.
[3] One tailed significance probability.
[4] Significantly different from null hypothesis at alpha = .05 with power of .75.

If, plants in rows bordering OY units are not damaged, plants in operational OY units are more likely to have growing conditions representative of other plants in the field. These results are consistent with the 1985 study. The comparison for narrow-row units in Ohio shows a significant difference between operational and research yield.

Figure 2. Soybean yield comparison
Operational vs research unit yields
Ohio & Louisiana 1986



The mean difference indicated that operational narrow-row unit yield averaged 6.5 bushels higher than yield from the unit laid out at harvest. Note that the difference between mean operational wide-row and narrow-row yields in Ohio is nearly 20 bushels per acre. This difference is unusually high since a previous study [2] and agronometric research suggest that the difference in yield between the two row types should be about 6 bushels per acre. This study was not designed to examine between field yield differences but this topic will be addressed in future research. Results for broadcast units in Louisiana also showed that yields from operational OY units were significantly higher (3.2 bushels) than yields from units laid out at harvest in an undisturbed area.

The data from table 2 shows that yields from OY units laid out in narrow-row or broadcast fields were higher than yields from units laid out at harvest in an undisturbed area. Figure 2 shows these results in chart form. OY units are enumerated 3 to 4 times prior to harvest. In narrow-row and broadcast fields it is difficult for enumerators not to damage plants around units when laying out units or making counts. If plants around OY units are damaged then competition for light and other resources will be reduced for plants inside the units. A study on soybean seed yield reported that plants from "thinned" stands yielded 12.5 percent more pods per node with 11.5 percent higher seed weight due to decreased interplant competition [6].

These results indicate that changes to OY harvest procedures may be necessary for narrow-row and broadcast units to remove the effects of enumeration on final yield.

Comparison of Estimated to Actual Pod Counts

Results of a comparison of estimated pod counts to actual pod counts are presented in table 3. The operational procedure uses the count of pods with beans from one unit and the weight of beans from both units to estimate the number of pods with beans for the entire sample. Not counting the number of pods with beans in the second unit reduces the amount of lab work but requires an assumption that the number of pods with beans and the weight have the same linear relationship in both units. In Louisiana and Ohio the number of pods with beans was counted for each unit. Table 3 shows the actual and estimated mean pod counts, their standard errors, paired t-statistic, significance probability and the detectable difference.

The mean difference of estimated to actual pod counts was significant at alpha = .10 in both States. The estimated pod numbers were higher than the actual counts in both States. These results are different from the 1985 study where there was no difference between estimated and actual counts in Georgia and Missouri.

The Ohio and Missouri data was processed by the Illinois regional soybean lab, Louisiana data by the Arkansas lab and Georgia data by the Iowa lab. Since the conclusions differed over the two study years the significance of the 1986 results does not imply that the operational lab procedure should be changed. However, the differences between operational and estimated pod counts should be further investigated.

Table 3: Comparison of Estimated to Actual Number of Pods with Beans, Unit 2.

	Louisiana	Ohio
Units	77	99
Est. Pods (SE)	503 (34)	378 (24)
Act. Pods (SE)	490 (33)	369 (23)
Mean Diff. (SE)	12.5 (7.0)	8.6 (5.2)
Paired-t	1.77	1.64
Pr>|t|[1]	.08	.10
Detectable Diff.[2]	6.4	5.2

[1] Two-tailed significance probability.
[2] Significantly different from null hypothesis at alpha = .10 with power of .75.

RECOMMENDATIONS

The results of this study indicated that objective yield enumeration significantly affected the yields of narrow-row units in Ohio and broadcast units in Louisiana. Yields in operational OY units were significantly higher than yields from units laid out at harvest in undisturbed areas for these two row-width types. It seems that damage to plants around the units resulted in decreased competition for the plants inside the unit. The results for wide-row units, of no difference in yield between plots, were consistent with the 1985 results. Enumeration did not affect the yield of wide-row units in either State.

A comparison of estimated to actual pod counts from unit 2 was significant. In both States estimated pod counts were significantly higher than the actual counts. These results were inconsistent with the 1985 survey where the difference was not significant in either State.

The following recommendations are based on these findings.

1. Plots used to determine at-harvest yield should be located in undisturbed areas for units in narrow-row and broadcast fields. The procedures used in this study to lay out plots at harvest could be followed. Both units (operational and at-harvest) could be harvested to allow creation of a ratio estimator. A ratio estimator would allow the forecast models to account for the effect of damage in narrow-row and broadcast fields. No changes in procedure are necessary for units in wide-row fields. This recommendation will result in an increase in enumeration cost of approximately $4 per narrow-row or broadcast unit.

2. Since the results of the pod count comparisons were inconsistent across years it is recommended that a lab count of unit 2 pods with beans be made. This would allow independent estimates of yield by unit.

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