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# **The Effect Of Enumeration On Soybean Objective Yield**

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ABSTRACT

The effect of enumeration on soybean objective yield was examined in this report. Yield from research samples laid out at harvest in an undisturbed area was compared to yield from operational samples in the same field. Results from Georgia and Missouri showed no significant effect on final yield from enumeration. Further research is recommended for narrow-row units.

KEY WORDS

Soybean objective yield, plant damage, enumeration effect, yield estimation.

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## SUMMARY

The purpose of this research was to investigate the effect damage to plants around the soybean objective yield unit had on yield. A secondary objective was to determine whether a lab count of unit 2 pods with beans was necessary. Data for the project were collected in conjunction with the 1985 Soybean Objective Yield Survey in Georgia and Missouri.

Results showed that objective yield enumeration did not significantly affect soybean yields in either state. An analysis of narrow-row units in Missouri indicated that enumeration may cause reduced competition for plants in the unit, thereby increasing yield; however, the difference in yield between operational and undisturbed samples was not significant. Further study on narrow-row units is recommended. A comparative analysis of estimated to actual unit 2 pod counts showed no difference in either state. However, counting the pods with beans in unit 2 would allow independent yield estimates by unit.

# THE EFFECT OF ENUMERATION ON SOYBEAN OBJECTIVE YIELD

by Robert J. Battaglia<sup>1</sup>

## INTRODUCTION

The 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].<sup>2</sup> In the remaining states data collection begins in September. Two sample units are randomly located in each selected field. These units are visited monthly by enumerators. Plant counts and measurements are used to forecast final yield. When the soybeans are mature, sample units are hand picked prior to farmer harvest and gross yield is determined. After harvest, a subsample of the 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 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 units exists. Destructive counting studies (1978-80) focused on the effects of repeated enumeration on plant component counts made in the 6-inch count units [1,2]. Damage to plants around the unit 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.

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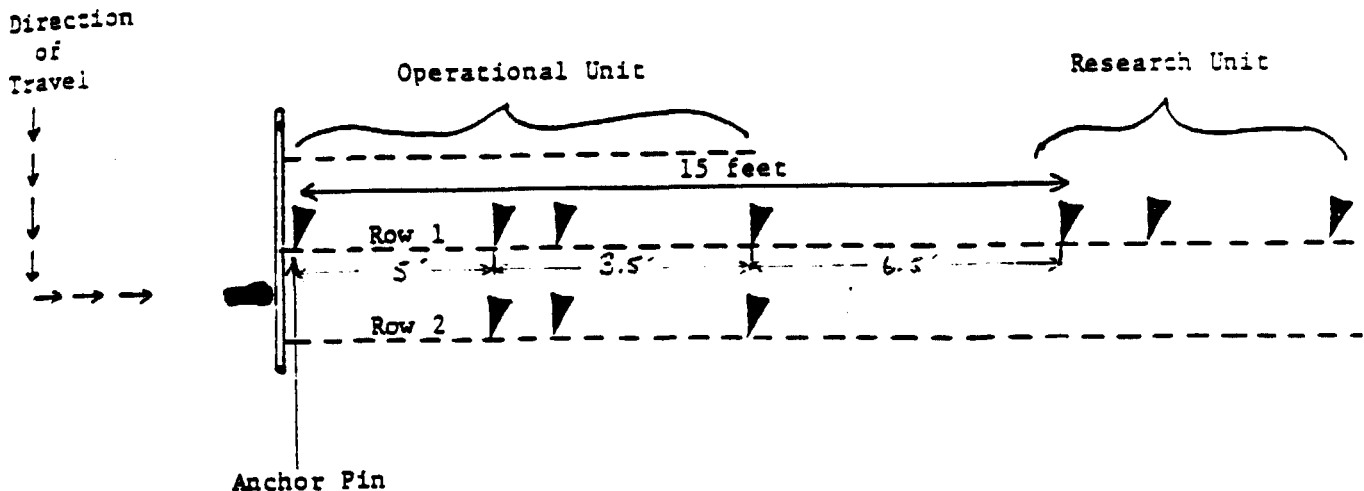
<sup>2</sup> Numbers in brackets refer to literature cited in the references at the end of the report.

## METHODS

### Data Collection

Georgia and Missouri were selected for this study. Data for the 1985 research project was collected in conjunction with the operational soybean objective yield survey. A complete description of OY procedures can be found in the Enumerator's and S&E manuals [4,6]. 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. Row width measurements were made, the number of plants in the three-foot section was counted, and the pods from those plants were harvested and sent to the regional lab [5]. Research units were harvested on the same day as corresponding operational units. A similar procedure was designed for broadcast fields.

Figure 1. Unit layout:



The 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. Unit data was then combined to produce a sample yield which could be compared with operational sample yield. In the operational procedure, pods from only one unit were counted; then,

beans from both units were combined, weighed and moisture content determined to produce a sample yield. A Generalized Edit procedure was developed for research data and used by survey statisticians in Georgia and Missouri to edit questionnaire and lab data.

### Analysis

The first part of the analysis compared yields between operational and research samples. Research units were laid out at harvest 6.5 feet from the operational unit in the undisturbed area (see figure 1). Gross yields in bushels per acre were calculated as follows [4]:

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

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 within each sampled field. A one-tailed hypothesis was used:

$$\begin{aligned} H_1 &: \text{operational sample yield} = \text{undisturbed sample yield} \\ H_0 &: \text{operational sample yield} > \text{undisturbed sample yield} \end{aligned}$$

The one-tailed test was used because of the initial assumption that repeated visits to the 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 research data to compare the actual count of pods with beans from research 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 with beans from both units to estimate the sample number of pods with beans. 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. Number of pods with beans from research unit 2 was estimated using the following formula from the S&E manual [4].

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

- $W_1$  = 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,  
row 1.

Unit 2 pod estimates were only made if pods were harvested from both research 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:

$H_0$  : estimated Unit 2 pod counts = actual counts  
 $H_a$  : estimated Unit 2 pod counts  $\neq$  actual counts

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

### RESULTS

Yields from the operational sample were compared to research sample 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.

For all samples in each state, the paired comparison showed that operational yields were slightly higher, but not significantly different than yield from research units. This indicates that repeated visits to the OY units did not significantly affect yield. The same comparison of yield between operational and research yields was made for narrow-row samples. Units were defined as narrow-row if the one-row width was less than 18 inches. The potential for damage in narrow-row units is greater since there is not much room for enumerators to work between rows. Georgia had no narrow-row units, while Missouri had 29. Results of the yield comparison between narrow-row operational and research samples are presented in table 2.

Table 1: Paired comparison of all samples  
(operational yield - research yield)

	Missouri	Georgia
Samples <sup>1</sup>	133	71
Yld <sup>2</sup> Operational (SE)	42.8 (1.3)	26.3 (1.6)
Yld Research (SE)	42.7 (1.4)	25.8 (1.6)
Mean Diff (SE)	.1 (1.0)	.5 (1.2)
Paired T	.1	.4
Pr> T	.9	.7

1/ Number of samples with positive operational and research data.

2/ Yields and mean differences are reported in bushels per acre.



Table 2: Paired comparison of narrow-row samples  
(operational - research yields)  
Missouri

Variable	Narrow samples	Mean diff	T
Yld (bu/A)	29	3.0	1.02
Wt. of beans (gms) <sup>1</sup>	29	12.5	1.53* <sup>3</sup>
Pods w/ beans <sup>2</sup>	29	9.7	1.56*

- 1/ Weight of threshed beans harvested from the 3-foot section.  
2/ Number of pods with beans harvested from the 3-foot section.  
3/ One-tailed test significant at alpha = .10.

This table shows the mean differences in yield and the components of yield between operational and research narrow-row samples. Yields for operational samples averaged 3 bushels higher, but the t-statistic was not significant. Mean differences for the weight of threshed beans and the number of pods with beans from the 3-foot section were included in table 2 to provide information on causes of the yield difference (the statistic of interest). Both weight of beans and number of pods with beans were higher for operational narrow-row samples. These differences may be the result of reduced competition due to damage to plants around the unit. A study on soybean seed yield reported that plants from "thinned" stands yielded 12.5 percent more per node with 11.5 percent higher seed weight due to decreased interplant competition [7]. The effect of the small number of observations should also be considered.

These results indicate that although the differences for narrow-row units were not significant, a 3-bushel difference in yield per acre warrants further investigation.

Results of a comparison of estimated pod counts to actual pod counts are presented in table 3. This table shows the actual and estimated mean pod counts, their standard errors, paired t-statistic and significance probability of the paired t.

There were no significant differences between estimated and actual counts in either state. Therefore, it is not necessary to count

pods from unit 2 to determine the number of pods with beans yield component in the operational program. However, a count of pods from unit 2 would allow yields to be estimated by unit. A unit level yield would be more effective in terms of detecting and correcting problems in data.

Table 3: Mean number of pods with beans, estimated and actual, unit 2

State	Units	Est Pods	SE	Actual Pods	SE	Paired T	Pr> T
Missouri	134	434	19.8	435	19.7	-0.22	.83
Georgia	71	541	35.4	533	34.4	0.87	.39

## RECOMMENDATIONS

The results of this study indicated that objective yield enumeration did not significantly affect the yields of operational units in Missouri and Georgia. An analysis of narrow-row units in Missouri indicated that enumeration may cause reduced competition for plants in the unit, thereby increasing yield, but differences were not significant. Also, a comparison of estimated to actual pod counts from unit 2 showed no difference in either state. However, counting the number of pods in unit 2 would allow independent yield calculations for each unit.

The following recommendations are based on these findings:

1. This research be conducted during 1986 in 2 states where narrow-row and/or broadcast soybeans are common (Ohio and Louisiana).
2. A lab count of pods with beans from unit 2 is not necessary unless independent yield estimates by unit are desired. Additional cost of obtaining unit 2 pod counts should be evaluated against benefits in editing, modeling and summarization.

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