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Comparison of Objective Yield to Combine Harvested Yield in Soybeans

Robert J. Battaglia and Ralph V. Matthews

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ABSTRACT

A comparison of objective yield and plot-combine yield was examined in this report. Objective yield harvest units (3-foot by 1-row) were laid out in seventy-two 16-foot by 4-row soybean plots. Estimated yields from the hand-harvested OY units were compared with plot-combine yields from the center 2 rows of the 16-foot plots. Results showed that OY units underestimated plot-combine yields by 2.87 bushels. The experiment will be repeated in 1986.

KEY WORDS: soybean objective yield, plot-combine yield, analysis of variance

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SUMMARY

The purpose of this research was to compare soybean yield estimation procedures used by the National Agricultural Statistics Service in its objective yield program with those used by agronomists to evaluate new varieties. It also allowed examination of OY procedures in a controlled environment, without the differences in training, enumerators, supervision, and cultural practices that are found in the operational program. The experiment was conducted with the cooperation of Agricultural Research Service agronomists.

Results showed that hand-harvested yields from a 3-foot by 1-row harvest unit underestimated yield obtained when a plot-combine was used to harvest a 16-foot by 2-row section.

These findings cannot be directly compared with operational OY results because of differences in procedures. Also, 1985 was the first year that the study was conducted. It is recommended that this research be continued in 1986 to verify the current results.

COMPARISON OF OBJECTIVE YIELD TO COMBINE HARVESTED YIELD IN SOYBEANS

Robert J. Battaglia
Ralph V. Matthews[1]

INTRODUCTION AND BACKGROUND

An experiment was conducted during 1985 at the University of Maryland's Wye Research Center to compare soybean yield estimation procedures of the National Agricultural Statistics Service with methods used by the Agricultural Research Service to evaluate new varieties in the Middle Atlantic Uniform Soybean Tests. The experiment compared yield estimates from 72 3-foot by 1 row hand harvested objective yield sections with an equal number of 16-foot by 2-row combine harvested ARS plots. The assumption tested was that hand-harvested yields were equal to plot-combine yields. A secondary purpose was to obtain background on soybean breeding research being conducted at the Beltsville Agricultural Research Center and for ARS researchers to become familiar with NASS methods of estimating yield.

ARS conducts performance trials to test new soybean varieties over numerous locations [2][2]. This experiment, conducted in conjunction with one of ARS's performance trials, consisted of 2 maturity groups, with 12 varieties in each, and 3 replications. Within each replication, treatments (varieties from maturity groups) were randomly assigned to 4-row by 20-foot plots. A seeding rate of 160 seeds per 20-foot row was used to insure adequate stands of plants. Plots were

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1 The authors are a mathematical statistician and a survey statistician with the National Agricultural Statistics Service, U.S. Department of Agriculture, Washington, D.C.

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

harvested at maturity, which was defined as the date when 95 percent of the pods were ripe. Before the plots were harvested, the two center rows of each plot were end trimmed to 16 feet to insure uniform plot size and to remove border effects.

The harvesting of a 3-foot section from each of the 72 plots was as follows. One of the 2 center rows of the 4-row plot was randomly selected. A 3-foot section was located in the selected row by measuring to a random starting point from the first plant in the row. Row widths were measured for each plot, although all pairs of center rows were sown using the same planter units. Soybean objective yield procedures were used to lay out the unit, but a 5-foot buffer was not used [9]. The 3-foot section of the soybean frame was used to delimit the plants to be harvested. The plants in the 3-foot section were broken off by hand at ground level and threshed in the field with a stationary thresher. The authors conducted all field work concerning the 3-foot sections. The center 2 rows of each 4-row plot were then harvested using a plot-combine. The plot-combine is a small combine which harvests two soybean rows. Only center rows were harvested to remove border effects.

Beans harvested from the 3-foot by 1-row section and the 16-foot by 2-row plot were air dried together to a constant moisture content and weighed. Bean weight for plot-combine yield was the sum of the bean weights from the two harvest methods. Yield in bushels per acre was calculated using bean weight per plot and plot area. Formulas are listed below with the plot names which will be used in the remainder of the report.

$$\text{Plot-combine yield (bu/ac)} = \frac{(\text{bean wt g from plot}) * (43560\ \text{ft}^2/\text{ac})}{(453.6\ \text{g/lb})*(60\ \text{lb/bu})*(32\ \text{ft})*(\text{row-width ft})}$$

$$\text{3-foot section yield (bu/ac)} = \frac{(\text{bean wt g from section}) * (43560\ \text{ft}^2/\text{ac})}{(453.6\ \text{g/lb})*(60\ \text{lb/bu})*(3\ \text{ft})*(\text{row-width ft})}$$

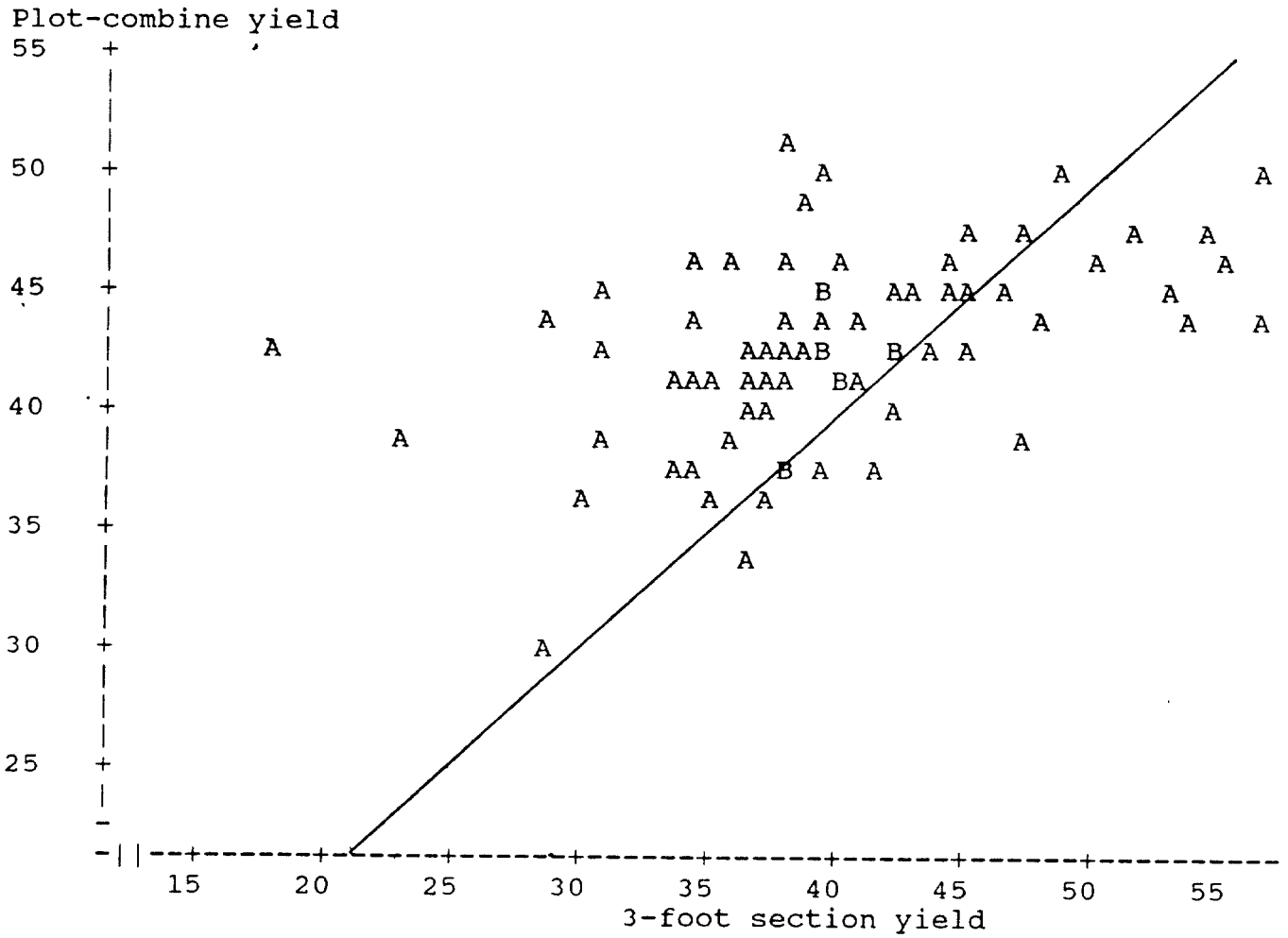
ANALYSIS

The first step of the analysis was to examine the distribution of yields from the plot-combine sections and the 3-foot sections. The plot-combine yields were normally distributed, based on a Shapiro-Wilk statistic., The 3-foot section yields were non-normally distributed with slight positive skewness. This result would make alpha levels for testing the 3-foot section data approximate but useable.

Figure 1 is a plot of yields from the 72 plots. The plot-combine yields are on the vertical axis while 3-foot section yields are on the horizontal axis. Plot-combine yield is assumed to be "true" yield while the 3-foot yield is a sample of one from all possible 3-foot sections in a plot. A line through the origin with slope=1 is shown for reference. Observations on the reference line have equal plot-combine and 3-foot section yields. In theory, we would expect the data points in figure 1 to be distributed along the reference line if the 3-foot section yield is an unbiased estimator of plot-combine yield. Figure 1 shows that data points are generally to the left of the reference line. If plot-combine yields are the actual yields, then the 3-foot sections underestimated yield. This is contrary to results which indicated that small plots overestimated yield [4,11]. However, the studies reviewed were conducted using jute, rice, and wheat rather than a row crop like soybeans. Also, these studies did not compare the difference between hand- and combine-harvest methods.

Plot-combine and 3-foot section yields were compared using an analysis of variance. This analysis is discussed below.

Figure 1: Plot-combine yield vs. 3-foot section yield,
Wye, Maryland, 1985



Legend: A = 1 obs, B = 2 obs, etc.

The reference line has a slope=1 and an intercept at 0.

Analysis of Variance Model

The model used to examine the data was an analysis of variance (ANOVA) model. Variety trials are conducted using randomized complete block designs. The varieties tested within a maturity group were randomly located on plots within each replication [3].

The form of the model is listed below:

$$D_{ijk} = U + M_i + V_{ik} + R_{ij} + E_{ijk}$$

where

D_{ijk} = Difference in yield between plot-combine and 3-foot section
U = Overall mean difference yield
M_i = Maturity Group (4 or 5)
V_{ik} = Variety (1 to 12)
R_{ij} = Replication (blocks 1 to 3)
E_{ijk} = Error term

This model assumes no interactions between varieties and replications and constant variances within replications. The ANOVA model was used to determine if maturity group, replication, and variety affected differences in yield between the plot-combine and 3-foot section yields. The results in table 1 show that maturity group, replication, and variety did not significantly affect differences in yield between the two methods of harvest.

Table 1: Analysis of variance for difference in soybean yield between plot-combine and 3-foot section, Wye, Maryland, 1985

Source	df	Sum of squares	F	Pr>F
Mean	1	591.3	15.29	.0003
Maturity	1	87.2	2.25	.1400
Replication	4	72.9	0.47	.7600
Variety	22	1110.2	1.30	.2200
Residual	44	1701.5		
Total	72	3563.1		

R^2 = .42 Overall model F = 1.22 Pr>F = .28
Mean difference in yield = 2.87 bushels

The ANOVA model also allowed a test of the hypothesis that the mean difference in yield from the two methods of harvest was significantly different from zero. This test is identical to a paired t test, since there were two methods of harvest in the ANOVA model and the maturity group, variety, and replication effects were not significant. The 2-tailed hypothesis used to compare the 3-foot section yields and the plot-combine yields was:

H_o: 3-foot section yield = plot-combine yield
H_a: 3-foot section yield $\neq$ plot-combine yield

Table 1 contains the results of this test. The F statistic for the mean was significant, and the null hypothesis of equal yields between the two harvest methods was rejected. The plot-combine yields averaged 2.87 bushels higher than the yields from the hand-harvested, 3-foot sections.

CONCLUSIONS AND RECOMMENDATIONS

The objective of the experiment was to compare hand-harvested, 3-foot section yields with plot-combine yields. The analysis showed that the yield from the OY 3-foot section underestimated the plot-combine yield. An analysis of variance model used to examine the difference in plot yield between the two methods of harvest indicated that components of the randomized block design (maturity group, replication, and variety) were not responsible for differences in plot-combine yield. Results of a test on the mean difference showed that the 2.87 bushel difference in yield was significant. The results were surprising because the 3-foot section yield underestimated plot-combine yield. These findings are not results from an operational OY survey. They are results from small plots at an experiment station where inputs and conditions are highly controlled. The study allowed examination of some OY procedures without the effects of enumerators, supervision, training and differences in cultural practices found in the operational program. Also, 1985 was the first year that the experiment was conducted and improvements in methods can be made.

Based on the findings, we recommend:

1. That the experiment be conducted again during 1986 with the cooperation of ARS personnel.

2. That the plot-combine be used to thresh the plants after hand harvesting the 3-foot section. This would remove a potential source of nonsampling error since the two harvest methods would then be subject to the same threshing loss.

3. That plot length be measured and be used as a variable in the yield expansion. The ARS method of end trimming plots may result in some plot lengths being slightly shorter than 16 feet. Since yield is expanded to bushels per acre assuming fixed plot length this would result in a downward bias in plot-combine yield.

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