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Head Count Differences Between Sample Plots in the 1983-1985 Wheat Objective Yield Surveys

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ABSTRACT

The National Agricultural Statistics Service conducts the objective yield surveys to forecast and estimate crop yield and production. An OY sample unit is comprised of two sample plots in which data are collected. The final head count variable in the wheat OY survey was analyzed in the 1983 through 1985 data to determine if differences existed between the sample plots. The difference between sample plots with and without a 5-foot buffer zone was also analyzed in the 1985 data. All state-wheat type combinations were analyzed, and the numbers of significant results ($\alpha = .10$) for sample plot differences were 7, 2, and 0 for the 1983, 1984, and 1985 data, respectively. For the 1985 buffer zone difference, none were significant. The differences which could be detected with power of .75 averaged 8.3, 8.0, and 14.0 percent of the state-level means in 1983, 1984, and 1985, respectively. Differences of this magnitude made it questionable whether observed differences of the magnitude usually associated with nonsampling error studies could be detected.

KEY WORDS: wheat objective yield, plot location bias, buffer zone, linear contrast, paired t test, detectable difference

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*      This paper was prepared for limited distribution to       *
*      the research community outside the U.S. Department of     *
*      Agriculture.                                              *
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CONTENTS

SUMMARY

The objective yield surveys of the National Agricultural Statistics Service are conducted to forecast and estimate crop yield and production. A typical sample field contains two sample plots in which data are collected. It is assumed that the expected value for the variables counted or measured is the same for both sample plots. The objective of this research was to check the validity of that assumption by analyzing the final head count variable in the winter, spring, and durum wheat OY surveys.

In 1983, the difference in final head count between sample plots was significant (α = .10) in 7 of 22 state-wheat type paired t tests; the 1984 results showed 2 of 19 significant. The use of a buffer zone between the enumerator's last pace into the field and the sample plot was tested in 1985 on a split sample basis. The 1983 and 1984 results served as reference points for the 1985 analysis in which both sample plot differences and buffer zone differences were analyzed.

In 1985, linear contrasts of state-level means were tested, and none were significant (α = .10) for either the sample plot or buffer zone effect. Although few significant results occurred for the sample plot effect in 1983 and 1984, they indicated that differences between sample plots occurred in some states in some years.

The average differences that could be detected as significant with the t tests (α = .10, power = .75) were 8.3, 8.0, and 14.0 percent of the state means for 1983, 1984, and 1985, respectively. The magnitude of these differences made it questionable whether nonsampling error differences less than five percent could be detected by either the paired t test or linear contrast approach.

HEAD COUNT DIFFERENCES BETWEEN SAMPLE PLOTS IN THE 1983-1985 WHEAT OBJECTIVE YIELD SURVEYS

By Ralph V. Matthews[1]

INTRODUCTION

The National Agricultural Statistics Service conducts the objective yield surveys to forecast and estimate crop yield and production. In a sample field, one or more sample units are located; each sample unit consists of two sample plots in which data are collected. In all of the OY surveys, a 5-foot buffer is measured between the ending point of the enumerator's last pace into the field and the beginning of each of the sample plots [2,3,4,11][2]. This procedure is followed to reduce bias in locating the sample plots.

Prior to 1985, a buffer zone was not used in wheat OY. The report on the 1984 wheat validation study [1] recommended using a buffer zone, and the NASS Program Planning Committee directed that an experiment be conducted in 1985 to measure the buffer's effect on the OY yield indication [7]. Data were collected during the 1985 survey, and an analysis was included in the 1986 wheat OY specifications [10]. The buffer was adopted by the PPC as a survey procedure beginning with the 1986 season. This report examines differences that existed between sample plots in 1983 and 1984 before the buffer zone was tested. A re-analysis of the 1985 data is presented in which the sample plot differences and the buffer zone effect are analyzed simultaneously.

[1] The author is a survey statistician with the National Agricultural Statistics Service, U.S. Department of Agriculture.

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

ANALYSES

1983 and 1984 Data

The 1983 and 1984 wheat OY Form B data were analyzed to compare counts from the two sample plots in each sample unit. Appendix 1 contains the Form B used in 1984. Pre-harvest head count, the sum of emerged and detached heads, was the variable examined. Each sample unit's gross yield estimate is equal to the number of heads from both sample plots multiplied by the weight per head determined in the laboratory. As components of the yield estimates, the head counts are part of the yield forecast models for five subsequent years [9].

In the 1983 wheat OY survey, the original sample size was 2,422. Problems such as field abandonment and farmer refusal reduced the number of sample units analyzed for this report to 1,748. Fourteen sample units had one blank sample plot, and three sample units had two blank sample plots. In the 1984 survey, the original sample size of 2,450 was reduced to 1,813. Thirteen sample units had one blank sample plot, and two sample units had two blank sample plots. The sample units with one or two blank sample plots were included in the analyses, since they were a result of the sampling process.

Sample plots differ due to causes such as variation in winter survival, disease, and fertilization. Two systematic factors may also cause differences between the counts obtained from sample plots:

1. Sample plot 1 is located and counted before sample plot 2;

2. Sample plot 1 is located with random numbers of paces, and sample plot 2 is located 30 additional paces along the field edge and 30 additional paces into the field from sample plot 1.

All other aspects of marking the boundaries and counting the heads in the sample plots are identical. The differences between the sample plot head counts within sample units should have a mean of zero in each state; if not, the systematic factors may cause the difference. The i^{th} sample plot in the j^{th} sample unit can be written as the sum of three components:

$$\mu + \tau_i + \epsilon_{ij}$$

where μ = population mean
τ_i = sample plot effect (i=1,2)
ϵ_{ij} = random error effect (j=1 to n for n sample units).

The head counts in the two sample plots were analyzed with a paired t test as sample plot 1 minus sample plot 2. The null hypothesis of the test was that the sample plot effects within sample units were equal. The alternative hypothesis was that the sample plot effects within sample units were unequal.

The form of the t test was

$$t = \frac{d - D}{s_d}$$

where d = observed mean difference
D = 0, the hypothesized difference
s_d = standard error of the mean difference.

The difference between sample plot 1 and sample plot 2 was an estimate of:

$$(\mu + \tau_1 + \epsilon_{1j}) - (\mu + \tau_2 + \epsilon_{2j}).$$

Assuming equal random error terms, the paired difference estimated the quantity $\tau_1 - \tau_2$, the difference between the two sample plot effects.

1985 Data

The objective of the buffer analysis presented in the 1986 wheat OY specifications [10] was to determine if the modeled number of heads or the modeled gross yield level changed when a buffer zone was included in one-half of the sample plots in a split sample test. The test was conducted within the regular OY survey, and instructions were included in the Enumerator's Manual [8] for locating a 5-foot buffer zone in one-half of the sample plots. Appendix 2 contains the Form B used in 1985.

The objective of the present analysis was to examine the head counts without the modeling or summarization process and determine if differences existed in the raw data. Both the sample plot effect and the buffer effect were analyzed.

Randomization of the buffer zones in the sample plots and the components of each state-level mean were as follows:

Sample unit number	Sample plot	Buffer zone	Components	State mean
odd	1	buffered	$\mu + \tau_1 + \beta + \epsilon_{1j}$	X_{1b}
odd	2	unbuffered	$\mu + \tau_2 + \epsilon_{2j}$	X_{2u}
even	1	unbuffered	$\mu + \tau_1 + \epsilon_{1j}$	X_{1u}
even	2	buffered	$\mu + \tau_2 + \beta + \epsilon_{2j}$	X_{2b}

where μ = population mean
τ_i = sample plot effect (i=1,2)
β = buffer effect
ϵ_{ij} = random error effect (j=1 to n for n sample units).

The paired t test used in 1983 and 1984 was not used with the 1985 data, because sample plot effects and buffer effects would both contribute to the paired difference of sample plot 1 minus sample plot 2 in the same sample unit. Instead, the state final head count means were calculated for both sample plots in the odd- and even-numbered sample units, and linear contrasts of the means were tested.

A linear combination of means,

$$c = c_1\bar{X}_1 + c_2\bar{X}_2 + \ldots + c_i\bar{X}_i,$$

is defined as a contrast if the sum of the coefficients, Σc_i, equals zero [5, p.225]. The observed value of the contrast was compared with a hypothesized value using the standard error of the contrast to form a t statistic.

The form of the t test was

$$t = \frac{c - C}{s_c}$$

where c = observed contrast
C = 0, the hypothesized contrast
s_c = standard error of the contrast.

If the sample sizes of the groups being compared, n_i, are not equal, the standard error of the contrast is

$$\left[(s^2) \; \Sigma \frac{c_i^2}{n_i} \right]^{1/2} .$$

The pooled variance, s^2, is the sum of the individual variances weighted by their respective degrees of freedom [12, p.96]. It is calculated as

$$s^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2 + \ldots + (n_i-1)s_i^2}{(n_1-1) + (n_2-1) + \ldots + (n_i-1)} .$$

The pooled variance is the correct form to use if the individual variances do not differ from one another. A Bartlett's test for the homogeneity of variances [12, p.471] was rejected at $\alpha = .10$ in only 1 of the 21 state-wheat type combinations: Indiana winter wheat. For that case, the test statistic did not follow the t distribution. Instead, the distribution was that of t' with the standard error calculated using the unpooled variances and the approximate degrees of freedom calculated with Satterthwaite's approximation [5, p.97].

For testing the difference between plot 1 and plot 2, the contrast was

$$\tfrac{1}{2}(\bar{X}_{1b}) - \tfrac{1}{2}(\bar{X}_{2u}) + \tfrac{1}{2}(\bar{X}_{1u}) - \tfrac{1}{2}(\bar{X}_{2b}).$$

Substituting the components represented by each mean resulted in:

$$\tfrac{1}{2}(\mu+\tau_1+\beta+\epsilon_{1j}) - \tfrac{1}{2}(\mu+\tau_2+\epsilon_{2j}) + \tfrac{1}{2}(\mu+\tau_1+\epsilon_{1j}) - \tfrac{1}{2}(\mu+\tau_2+\beta+\epsilon_{2j})$$

$$= \tfrac{1}{2}(\tau_1) - \tfrac{1}{2}(\tau_2) + \tfrac{1}{2}(\tau_1) - \tfrac{1}{2}(\tau_2)$$

$$= \tau_1 - \tau_2.$$

Assuming equal random error terms, the quantity estimated by the observed contrast was equal to the quantity estimated by the paired t test on the 1983 and 1984 data.

To test buffered plots versus unbuffered plots, the contrast was

$$\tfrac{1}{2}(\bar{X}_{1b}) - \tfrac{1}{2}(\bar{X}_{2u}) - \tfrac{1}{2}(\bar{X}_{1u}) + \tfrac{1}{2}(\bar{X}_{2b}).$$

Substitution of the components in the buffer zone contrast showed that it estimated β, the buffer zone effect.

$$\tfrac{1}{2}(\mu+\tau_1+\beta+\epsilon_{1j}) - \tfrac{1}{2}(\mu+\tau_2+\epsilon_{2j}) - \tfrac{1}{2}(\mu+\tau_1+\epsilon_{1j}) + \tfrac{1}{2}(\mu+\tau_2+\beta+\epsilon_{2j})$$

$$= \tfrac{1}{2}(\beta) + \tfrac{1}{2}(\beta)$$

$$= \beta.$$

The four state means do not represent four independent treatments, which is the requirement for the use of linear contrasts. The sample fields are located randomly and independently, but the two sample plots are not, since sample plot 2 is located a pre-defined number of paces from sample plot 1. In addition, the sample plots cannot be thought of as random treatments if the data from sample plot 1 is always collected before that from sample plot 2.

The contrast approach was used in spite of these limitations, because the two contrasts are orthogonal [5, p.226]. This was shown by the fact that the sum of the cross products of the coefficients equaled zero. The two contrasts were examined simultaneously, and the conclusion drawn about one contrast was completely independent of the other contrast.

RESULTS

1983 and 1984 Data

Tables 1 and 2 contain the results for the 1983 and 1984 data, respectively. The degrees of freedom for the paired t tests were the number of sample units minus one. The head count differences between sample plots were calculated as sample plot 1 minus sample plot 2. The means, d, and the standard errors, s_d, of the head count differences appear in the table. The probability of a greater absolute t value for a null hypothesis of no difference between sample plots is shown.

The detectable differences are means of distributions which can be detected as significantly different from the null hypothesis of no difference between sample plots with power of .75 when α = .10. The power is the probability of rejecting the null hypothesis when it is false [5 p.111; 12 p.113]. The power level of .75 was chosen arbitrarily, and different detectable differences would be identified using a different power value.

Both the observed differences and the detectable differences are presented as percentages of the overall state-wheat type means. An observed difference can be evaluated for its significance (Prob. > |t|) and compared with its respective detectable difference. The detectable differences are important for future surveys, because they indicate differences which were detectable in experiments conducted to monitor procedural changes.

Table 1 -- Mean final head count differences, d, and standard errors, s_d, of the paired t test between sample plots, 1983 wheat objective yield survey

State	Wheat type[2]	df	State mean	d	s_d	Detect.[1] diff.	Prob. > |t|	Percent of state mean |d|	Percent of state mean Detect. diff.
			heads						
CO	W	46	201.0	17.1	11.0	26.0	.13	9	13
ID	W	67	144.4	-3.6	6.5	15.2	.58	2	11
ID	S	41	165.3	-1.7	8.0	18.9	.83	1	11
IL	W	62	171.9	-5.8	7.3	17.3	.43	3	10
IN	W	51	174.5	-4.9	6.9	16.4	.48	3	9
KS	W	217	209.7	9.7	4.3	10.0	.03*[3]	5	5
MI	W	36	149.7	-19.8	8.2	19.4	.02*	13	13
MN	S	61	128.3	-4.8	3.8	9.0	.21	4	7
MO	W	79	144.1	-1.8	5.6	13.2	.74	1	9
MT	W	76	174.6	0.0	6.5	15.2	1.00	0	9
MT	S	60	118.1	0.4	5.5	12.9	.94	≈0	11
MT	D	25	61.5	9.8	3.3	8.0	.01*	16	13
NE	W	81	243.2	-4.0	12.1	28.4	.74	2	12
ND	S	117	103.3	1.4	2.8	6.4	.62	1	6
ND	D	112	73.8	1.8	2.1	4.9	.39	2	7
OH	W	67	163.2	-9.7	5.4	12.7	.08*	6	8
OK	W	102	174.7	12.8	7.5	17.5	.09*	7	10
OR	W	106	148.2	11.2	3.9	9.1	.01*	8	6
SD	S	47	100.6	6.9	3.9	9.3	.08*	7	9
SD	D	9	61.2	-2.3	4.9	12.6	.65	4	21
TX	W	109	152.6	-0.2	4.7	11.0	.96	≈0	7
WA	W	155	176.7	6.8	4.9	11.5	.17	4	7
Avg.[4]								3.9	8.3

[1] Mean of a distribution which can be detected as different from the hypothesized mean with power of .75.

[2] W = winter wheat
S = spring wheat other than durum
D = durum wheat.

[3] An asterisk indicates significance at $\alpha = .10$.

[4] Weighted by degrees of freedom.

Table 2 -- Mean final head count differences, d, and standard errors, s_d, of the paired t test between sample plots, 1984 wheat objective yield survey

State	Wheat type[2]	df	State mean	d	s_d	Detect. diff.[1]	Prob. > |t|	Percent of state mean: |d|	Percent of state mean: Detect. diff.
			heads	heads	heads	heads			
CO	W	88	185.1	24.9	8.8	20.6	.01*[3]	13	11
ID	W	77	154.9	-7.8	5.1	12.0	.13	5	8
ID	S	44	130.7	3.5	9.7	23.0	.72	3	18
IL	W	72	162.7	9.1	5.1	11.9	.08*	6	7
IN	W	48	162.0	1.5	6.2	14.6	.81	1	9
KS	W	215	189.0	7.2	4.8	11.2	.14	4	6
MN	S	73	136.8	-1.1	4.9	11.4	.82	1	8
MO	W	77	159.2	4.1	5.6	13.3	.47	3	8
MT	W	104	173.2	0.9	5.7	13.4	.88	1	8
MT	S	59	95.0	-5.4	4.5	10.7	.24	6	11
NE	W	69	215.8	-6.0	9.3	21.9	.52	3	10
ND	S	110	120.1	3.4	3.2	7.5	.30	3	6
ND	D	135	77.8	-1.5	1.9	4.5	.43	2	6
OH	W	63	158.0	1.7	6.8	16.1	.80	1	10
OK	W	137	171.2	-7.2	5.4	12.7	.19	4	7
OR	W	98	139.7	0.7	5.5	12.8	.89	1	9
SD	S	44	122.6	-0.8	4.7	11.0	.86	1	9
TX	W	134	138.5	-0.5	4.6	10.8	.92	≈0	8
WA	W	147	185.2	4.4	4.8	11.1	.35	2	6
Avg.[4]								3.1	8.0

[1] Mean of a distribution which can be detected as different from the hypothesized mean with power of .75.

[2] W = winter wheat
S = spring wheat other than durum
D = durum wheat.

[3] An asterisk indicates significance at $\alpha = .10$.

[4] Weighted by degrees of freedom.

The numbers of significant results (α = .10) were 7 of 22 in 1983 and 2 of 19 in 1984.[*] Of the 41 state-wheat type combinations in the 2 years, 9 results were significant. For α = .10, 4 significant results will occur even if the hypothesis of no difference is true. Nine significant results indicated that true differences between sample plots within sample units did occur in some state-wheat type combinations.

A conclusion of a significant difference was reached when the observed difference was approximately equal to the detectable difference. In the nonsignificant state-wheat type combinations, the detectable differences ranged from 3 to 17 percentage points greater than the observed differences when each was expressed as a percent of the state mean.

The average of the detectable difference percentages, weighted by the degrees of freedom, was 8.3 percent in 1983 and 8.0 percent in 1984. Fifteen of the 41 detectable differences equaled or exceeded 10 percent of the state-level mean. There was little likelihood of detecting differences less than 10 percent of the state-level mean in these cases. The possibility of such an outcome must be recognized before answers are sought through experimentation. A new procedure which caused a difference of up to 10 percent of the state mean would go undetected by a paired t test (α = .10, power = .75) between the sample plots in approximately one-third of the state-wheat type combinations.

No patterns occurred indicating possible bias in one direction. In 1983, 10 of the observed differences were positive, 11 were negative, and 1 showed no difference. Of the 19 differences in 1984, 11 were positive and 8 were negative.

Seven state-wheat type combinations were significant in 1983. Two of these seven could not be compared between the two years, since they were not included in the 1984 OY survey. The remaining five state-wheat type combinations were nonsignificant in 1984. The two significant results in 1984 were nonsignificant in 1983. Thus, no consistencies between years occurred for any state-wheat type combinations.

The results of the 1983 and 1984 analyses provided useful background information for the analysis of the 1985 data. Since differences between sample plots existed in some cases, the buffer zone analysis required a method by which sample plot differences could also be examined.

[*] Three state-wheat type combinations were eliminated before the 1984 OY survey due to low acreage and production figures compared with other states. These changes were documented in the Yield Review Task Force Report [6].

1985 Data

Table 3 contains the results of the sample plot 1 versus sample plot 2 contrast. Arkansas and California winter wheat were added to the OY survey in 1985 due to increases in their acreage and production. The degrees of freedom for the contrast were the same as those for the pooled variance used in the standard error of the contrast. The one exception was Indiana winter wheat for which the degrees of freedom were calculated with Satterthwaite's approximation. The state-level means for head count are presented with the observed contrasts, c, and their standard errors, s_c. The probability of an absolute t value greater than the one observed shows that no state-wheat type combinations were significant at $\alpha = .10$. The observed contrast and the alternative mean which can be detected with power of .75 are listed, and each is expressed as a percent of the state-level mean.

The 1985 percentage values can be compared directly with the 1983 and 1984 percentages, since both estimated $\tau_1 - \tau_2$. The observed contrast percentages averaged 2.8 percent in 1985. The 1983 and 1984 percentages were 3.9 and 3.1 percent, respectively. The detectable difference percentages averaged 14.0 percent in 1985 and ranged from 9 to 21 percent. The detectable difference percentages were 8.3 percent in 1983 and 8.0 percent in 1984. The lower values for the detectable differences in 1983 and 1984 reflected the smaller standard errors of the paired t test and its ability to detect smaller differences as significant. However, an 8 percent detectable difference may not be small enough to detect nonsampling error differences.

Bias in one direction was not indicated from these results, since 9 of the state-wheat type contrasts were negative, 11 were positive, and 1 showed no difference.

Table 4 contains the results of the buffer zone versus no buffer zone contrast: the actual value of the contrast, the probability of the observed contrast, and the percentage of the state mean. The remainder of the table is identical to table 3.

None of the contrasts were significant at $\alpha = .10$, although two had observed probabilities less than .15. When expressed as percentages of the state-level mean, those two contrasts were each 11 percent; all other observed contrasts were 6 percent or less and averaged 3.5 percent. All of the detectable percentages were at least 5 percentage points greater than those observed.

Table 3 -- Mean final head count contrasts, c, and standard errors, s_c, of the linear contrasts between sample plots, 1985 wheat objective yield survey

State	Wheat type[2]	df	State mean	c	s_c	Detect. diff.[1]	Prob. > |t|	Percent of state mean: |c|	Percent of state mean: Detect. diff.
			-----------	heads	-----------				
AR	W	114	108.7	-11.2	9.5	22.3	.24	10	21
CA	W	156	146.1	0.0	9.7	22.6	1.00	0	15
CO	W	182	208.1	-1.2	12.0	28.1	.92	1	14
ID	W	176	121.1	-2.7	8.3	19.5	.74	2	16
ID	S	92	121.4	10.2	10.6	24.8	.34	8	20
IL	W	136	149.5	-2.9	9.4	22.0	.76	2	15
IN[3]	W	103	158.8	-0.3	9.7	23.2	.95	≈0	15
KS	W	500	190.4	9.5	6.9	16.2	.17	5	9
MN	S	120	123.3	4.8	9.1	21.3	.60	4	17
MO	W	156	136.1	2.5	9.8	23.0	.80	2	17
MT	W	148	100.1	-1.9	8.9	21.0	.83	2	21
MT	S	146	86.5	1.5	7.3	17.0	.83	2	20
NE	W	202	229.1	7.3	17.0	39.6	.67	3	17
ND	S	234	116.4	6.0	5.0	11.6	.23	5	10
ND	D	248	76.2	0.9	4.1	9.6	.83	1	13
OH	W	130	172.2	-1.0	7.0	16.4	.89	1	10
OK	W	284	156.9	-4.4	7.8	18.1	.58	3	12
OR	W	224	120.4	-1.0	6.3	14.7	.87	1	12
SD	S	94	104.8	1.7	9.2	21.5	.86	2	21
TX	W	268	157.6	2.9	8.7	20.2	.74	2	13
WA	W	306	132.8	4.5	6.8	15.9	.51	3	12
Avg.[4]								2.8	14.0

[1] Mean of a distribution which can be detected as different from the hypothesized mean with power of .75.

[2] W = winter wheat
S = spring wheat other than durum
D = durum wheat.

[3] Due to non-homogeneity of variances, df are by Satterthwaite's approximation and test statistic is t′.

[4] Weighted by degrees of freedom.

Table 4 -- Mean final head count contrasts, c, and standard errors, s_c, of the linear contrasts between buffered and unbuffered sample plots, 1985 wheat objective yield survey

State	Wheat type[2]	df	State mean	c	s_c	Detect.[1] diff.	Prob. > |t|	Percent of state mean: |c|	Percent of state mean: Detect. diff.
			-----------	heads	-------------				
AR	W	114	108.7	-4.6	9.5	22.3	.63	4	21
CA	W	156	146.1	0.0	9.7	22.6	1.00	0	15
CO	W	182	208.1	-12.2	12.0	28.1	.31	6	14
ID	W	176	121.1	-13.1	8.3	19.5	.12	11	16
ID	S	92	121.4	-1.0	10.6	24.8	.93	1	20
IL	W	136	149.5	-7.6	9.4	22.0	.42	5	15
IN[3]	W	103	158.8	-0.4	9.7	23.2	.96	≈0	15
KS	W	500	190.4	-6.7	6.9	16.2	.33	4	9
MN	S	120	123.3	-5.5	9.1	21.3	.55	4	17
MO	W	156	136.1	-14.5	9.8	23.0	.14	11	17
MT	W	148	100.1	-3.4	8.9	21.0	.70	3	21
MT	S	146	86.5	0.3	7.3	17.0	.97	≈0	20
NE	W	202	229.1	-8.6	17.0	39.6	.61	4	17
ND	S	234	116.4	0.8	5.0	11.6	.87	1	10
ND	D	248	76.2	-2.4	4.1	9.6	.56	3	13
OH	W	130	172.2	-1.6	7.0	16.4	.82	1	10
OK	W	284	156.9	6.2	7.8	18.1	.43	4	12
OR	W	224	120.4	-6.5	6.3	14.7	.30	5	12
SD	S	94	104.8	1.7	9.2	21.5	.86	2	21
TX	W	268	157.6	3.8	8.7	20.2	.66	2	13
WA	W	306	132.8	-0.7	6.8	15.9	.92	1	12
Avg.[4]								3.5	14.0

[1] Mean of a distribution which can be detected as different from the hypothesized mean with power of .75.

[2] W = winter wheat
S = spring wheat other than durum
D = durum wheat.

[3] Due to non-homogeneity of variances, df are by Satterthwaite's approximation and test statistic is t′.

[4] Weighted by degrees of freedom.

Although no buffer zone contrasts were significant, the number of positive and negative results indicated a consistency in one direction. Of the 21 contrasts, 15 were negative, 5 were positive, and 1 showed no difference. The median of the 21 observed contrasts was -4.7. The approximate 95 percent confidence limits for the population median [5, p.137] were -13.4 and 0.0. An upper limit of zero for the confidence interval was evidence that the population median was negative.

Since the buffer zone difference was calculated as the buffered plot minus the unbuffered plot, the results indicated that fewer heads were counted in the buffered sample plots. The large number of negative results indicated a possible shift in one direction could occur as the buffer zone is adopted operationally.

CONCLUSIONS

In 1983, 7 of 22 state-wheat type combinations were significant in number of heads counted for the sample plot effect at $\alpha = .10$ when compared by a paired t test; the 1984 results showed 2 of 19 significant. Although few in number, there was evidence that true differences existed in some cases.

In 1985, the use of a buffer zone was implemented to reduce plot location bias. No significant differences existed for the sample plot effect or the buffer zone effect when tested with linear contrasts of the state-level means. A trend was observed towards fewer heads counted in the buffered sample plots, but the differences were not significant.

For the planning of future experiments, the detectable differences ($\alpha = .10$, power = .75) as percentages of the state mean were calculated for each year. These were 8.3, 8.0, and 14.0 percent of the state means for 1983, 1984, and 1985, respectively. The magnitude of these differences made it questionable whether small differences due to changes in procedures could be detected by either the paired t test or linear contrast approach.

RECOMMENDATIONS

Based on the conclusions, the following recommendations are made:

1. Evaluate the 1986 wheat OY data to see if the operational use of the buffer zone in both sample plots eliminates the between-plot differences observed in 1983 and 1984.

2. Establish criteria for further examination if differences exist. For example, if significant differences occur in two out of three years, the data could be checked further to determine why the differences occurred.

3. When split-sample tests are done, the design of the experiment should allow the use of linear contrasts of the means to make use of all the information available in the data. This might involve an experiment conducted on a smaller scale, instead of using the entire survey. Such an experiment would require true randomization of treatments; data could not always be collected from sample plot 1 before sample plot 2.

4. The power of the test should also be considered during the design phase. If only large differences are detectable, the results of the experiment may be of little practical value. Resources should be conserved rather than testing for the significance of small differences when only large ones can be detected.

5. Since year to year differences occurred in the sample plot effect, differences in the buffer zone effect probably also would vary from year to year. For this reason, at least two years of testing should be done whenever a new procedure is tested on a split sample.

REFERENCES

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UNITED STATES DEPARTMENT OF AGRICULTURE
STATISTICAL REPORTING SERVICE

Form Approved
O.M.B. Number 0535-0088
Expiration Date 7/31/86

FORM B: WHEAT YIELD COUNTS - 1984

12-31B

	CROP CODE
Winter	1
Spring (Other than Durum)	6
Durum	7

YEAR, CROP, FORM, MONTH (1-4)

4 __ 3 __

UNIT LOCATION /p. 39—47/

	UNIT 1		UNIT 2
Number of paces along edge of field		+ 30	
Number of paces into field		+ 30	

Date (________________) ... 370

Starting Time *(Military Time)* ... 371

ROW SPACE MEASUREMENTS /p. 61—63/

	UNIT 1	UNIT 2
1.a. Is this the same unit that was laid out last month? Check No *if this is the first visit to lay out the units or if unit is relocated. For unit(s) checked: ☐ YES - skip to Item 2. ☐ NO - complete Item 1(b).* ENTER 1 for YES, 2 for NO	305	307
b. Width across 5 row spaces *(measure distance from stalks in Row 1 to stalks in Row 6)* ... Feet and Tenths	301 .	303 .

2. **STAGE OF MATURITY**: (Circle one stage code for each unit) /p. 64—67/

Maturity Stage	Pre-Flag	Flag or Early Boot	Late Boot or Flower	Milk	Soft Dough	Hard Dough	Ripe	Blank
UNIT 1	300 1	300 2	300 3	300 4	300 5	300 6	300 7	300 8
UNIT 2	302 1	302 2	302 3	302 4	302 5	302 6	302 7	302 8
	If the lowest maturity code of either unit is Code 1 or 2 start counts with Item 3.		*If the lowest maturity code of either unit is Codes 3 thru 7, start counts with Item 4. For Codes 6 or 7, first see Items 7 and 9.*					

COUNTS WITHIN UNITS /p. 67—71/

	UNIT 1 Row 1	UNIT 1 Row 2	UNIT 1 Row 3	UNIT 2 Row 1	UNIT 2 Row 2	UNIT 2 Row 3
3. Number of stalks (stems) in row	311	312	313	314	315	316
4. No. of heads in LATE BOOT	351	352	353	354	355	356
5. a. Number of emerged heads on all stalks	331	332	333	334	335	336
b. No. of detached heads in unit (complete Only on Final PRE-HARVEST VISIT)	←	341	→	←	344	→

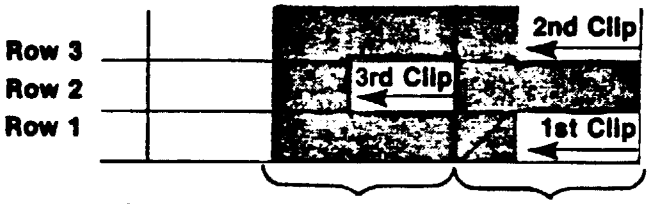
6. **SAMPLE UNIT CONDITION OBSERVATION** /p. 72—76/

Observe field and enter code for each unit that best represents each of the different field conditions. Specific instructions for each code are covered in enumerator's manual.

MOISTURE	WEEDINESS	FROST FREEZE	DISEASE INSECT	HAIL	LODGING
Dry ... 1	None To Few ... 1	None To Slight ... 1	None To Slight ... 1	None To Slight ... 1	None To Slight ... 1
Moist ... 2	Light ... 2	Light ... 2	Light ... 2	Light ... 2	Light ... 2
Wet ... 3	Moderate ... 3	Moderate ... 3	Moderate ... 3	Moderate ... 3	Moderate ... 3
Saturated ... 4	Heavy ... 4	Heavy ... 4	Heavy ... 4	Heavy ... 4	Heavy ... 4
Standing Water ... 5	Severe ... 5	Severe ... 5	Severe ... 5	Severe ... 5	Severe ... 5
Unknown ... 6	Unknown ... 6	Unknown ... 6	Unknown ... 6	Unknown ... 6	Unknown ... 6
U1 358	U1 360	U1 362	U1 364	U1 366	U1 368
U2 359	U2 361	U2 363	U2 365	U2 367	U2 369

FORM B: WHEAT (Cont'd)

Lay out Units 1 and 2 as shown below:



CLIPPING ORDER

Both Units (Item 8)

First Clipping — Row 1 in Clip Area A

Second Clipping — Row 3 in Clip Area B

Third Clipping — Row 2 in Clip Area A

7. If the LOWEST MATURITY CODE Circled in Item 2 for EITHER Unit is:

(a) Code 1 or 2: SKIP Items 8 and 9. Enter time and sign name.

(b) Code 3, 4 or 5: Go to Item 8.

(c) Code 6 or 7: Go to Item 9.

8. WITHIN CLIP AREAS — Make clippings in the designated ROW within Clip Areas Of EACH unit following steps below. p. 80—82

Step 1 — Mark half-way point in specified row in clip area.

Step 2 — **MOW** *(cut stalk within 2 inches of base)* all wheat stalks in specified row until **5 Emerged Heads** *(if that many) are obtained* **OR** until one-half the row is completely mowed. Begin mowing at end of row farthest from count area and mow in direction of count area. Examine each stalk for emerged head as it is mowed; if present, clip stalk 1/2 inch below the head. Place the 5 *(or less)* emerged heads in 3# bag. Record count on State *(yellow)* I.D. tag. Also when mowing, clip and count any heads in **late boot** and place in 5# bag.

Step 3 — **MOW** remaining stalks up to the half-way mark. Examine each stalk and determine which ones are **emerged heads** and which ones are **late boot heads. CLIP** the stalk 1/2 inch below the head. Place the **remaining emerged heads** in the 8# bags and the **late boot heads** in the 5# bag.

Step 4 — Record the count of the remaining emerged heads and the late boot heads on the State *(yellow)* I.D. tag.

Repeat steps 1 thru 4 for Unit 2 using same bags for emerged heads and late boot heads as used in Unit 1.

Prepare one I.D. tag. Label all bags with sample number. Seal and place 3# and 5# bags in the 8# bag.

Verify State *(yellow)* I.D. tag and attach to outside of 8# bag.

Check here ☐ *after placing 8# bag in a cloth mailing sack addressed to* **STATE LAB.**
ENTER time and sign name.

9. WITHIN COUNT AREAS — Clip and Count all heads in count area of BOTH units following steps below. Use a separate 8# bag for each unit. p. 80, 82—88

Step 1 — Clip and Count all Heads in **Late Boot in Row 1 - Record in Item 4.**

Step 2 — Clip and Count all **Emerged Heads in Row 1 — Record in Item 5a** and place emerged heads in same bag with late boot heads.

Step 3 — Repeat steps 1 and 2 for **ROW 2 and 3.** — Record counts.

Step 4 — Pick up and Count all **Detached Heads** on ground in unit and **Record in Item 5b.** Place in bag with clipped heads.

Record heads clipped in Items 4 and 5 of Form B and on Regional (White) I.D. Tags. Attach one I.D. Tag to each 8# bag. Check here [ ] after placing bags in cloth mailing sack addressed to **REGIONAL LABORATORY.** *Enter time and sign name.*

Enumerator ______________________

ENDING TIME *(Military Time)*. [372]

STATUS CODE [380]

Enumerator Number [390]

Supervisor Number [391]

UNITED STATES DEPARTMENT OF AGRICULTURE
STATISTICAL REPORTING SERVICE

Form Approved
O.M.B. Number 0535-0088
Expiration Date 7/31/86

C.E. 12-318

FORM B: WHEAT YIELD COUNTS - 1985

	CROP CODE
Winter	1
Spring (Other than Durum)	6
Durum	7

YEAR, CROP, FORM, MONTH (1-4)

5 __ 3 __

Has operator applied pesticides with organophosphorous content since last field visit? YES ☐ NO ☐
If YES, enter latest application date ________ *and name of pesticide* ________

UNIT LOCATION p. 52–67

Sample Number is
- Odd ☐ - Lay out 5 ft. buffer zone in Unit 1 Only.
- Even ☐ - Lay out 5 ft. buffer zone in Unit 2 Only.

	UNIT 1		UNIT 2
Number of paces along edge of field		+ 30	
Number of paces into field		+ 30	

Date (________) ... 370
Starting Time *(Military Time)* ... 371

UNIT LOCATION CODE

a. First visit to lay out unit ... Code 1
b. Unit relocated this month ... Code 2
c. Same unit laid out previously ... Code 3
} Enter

Go To Item 2 when coded 3 otherwise go to Item 1.

UNIT 1	UNIT 2
305	307

1. **ROW SPACE MEASUREMENTS** p. 77–78

	UNIT 1	UNIT 2
a. Width across 4 row spaces *(measure distance from stalks in Row 1 to stalks in Row 5)* ... Feet and Tenths	304 .	306 .
b. Width across 5 row spaces *(measure distance from stalks in Row 1 to stalks in Row 6)* ... Feet and Tenths	301 .	303 .

2. **STAGE OF MATURITY**: (Circle one stage code for each unit) p. 79–82

Maturity Stage	Pre-Flag	Flag or Early Boot	Late Boot or Flower	Milk	Soft Dough	Hard Dough	Ripe	Blank
UNIT 1	300 1	300 2	300 3	300 4	300 5	300 6	300 7	300 8
UNIT 2	302 1	302 2	302 3	302 4	302 5	302 6	302 7	302 8

If the lowest maturity code of either unit is Code 1 or 2 start counts with Item 3.

If the lowest maturity code of either unit is Codes 3 thru 7, start counts with Item 4. For Codes 6 or 7, first see Items 7 and 9.

COUNTS WITHIN UNITS p. 82–86

	UNIT 1 Row 1	UNIT 1 Row 2	UNIT 1 Row 3	UNIT 2 Row 1	UNIT 2 Row 2	UNIT 2 Row 3
3. Number of stalks (stems) in row	311	312	313	314	315	316
4. No. of heads in LATE BOOT	351	352	353	354	355	356
5. a. Number of emerged heads on all stalks	331	332	333	334	335	336
b. No. of detached heads in unit (complete Only on Final PRE-HARVEST VISIT)	←	341	→	←	344	→

SAMPLE UNIT CONDITION OBSERVATION p. 87–91

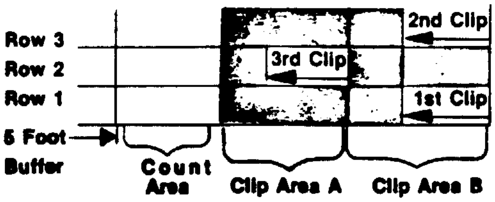
Observe unit and enter code for each unit that best represents each of the different field conditions. Specific instructions for each code are covered in enumerator's manual.

MOISTURE	WEEDINESS	FROST FREEZE	DISEASE/INSECT/ANIMAL	HAIL	LODGING
Dry ... 1	None To Few ... 1	None To Slight ... 1	None To Slight ... 1	None To Slight . 1	None To Slight . 1
Moist ... 2	Light ... 2	Light ... 2	Light ... 2	Light ... 2	Light ... 2
Wet ... 3	Moderate ... 3	Moderate ... 3	Moderate ... 3	Moderate ... 3	Moderate ... 3
Saturated ... 4	Heavy ... 4	Heavy ... 4	Heavy ... 4	Heavy ... 4	Heavy ... 4
Standing Water . 5	Severe ... 5	Severe ... 5	Severe ... 5	Severe ... 5	Severe ... 5
Unknown ... 6	Unknown ... 6	Unknown ... 6	Unknown ... 6	Unknown ... 6	Unknown ... 6
U1 358	U1 360	U1 362	U1 364	U1 366	U1 368
U2 359	U2 361	U2 363	U2 365	U2 367	U2 369

FORM B: WHEAT (Cont'd)

CLIPPING ORDER

Lay out Units 1 and 2 as shown below:
Buffer Zone in Unit 1 Odd Samples and Unit 2 even Samples Only.



Both Units (Item 8)

First Clipping — Row 1 in Clip Area B

Second Clipping — Row 3 in Clip Area B

Third Clipping — Row 2 in Clip Area A

7. If the LOWEST MATURITY CODE Circled in Item 2 for EITHER Unit is:

(a) Code 1 or 2: SKIP Items 8 and 9. Enter time and sign name.

(b) Code 3, 4 or 5: Go to Item 8.

(c) Code 6 or 7: Go to Item 9.

8. WITHIN CLIP AREAS — Make clippings in the designated ROW within Clip Areas Of EACH unit following steps below.

p. 95–97

Step 1 — Mark half-way point in specified row in clip area.

Step 2 — **MOW** *(cut stalk within 2 inches of base)* all wheat stalks in specified row until 5 **Emerged Heads** *(if that many) are obtained* **OR** until one-half the row is completely mowed. Begin mowing at end of row farthest from count area and mow in direction of count area. Examine each stalk for emerged head as it is mowed; if present, clip stalk 1/2 inch below the head. Place the 5 *(or less)* emerged heads in 3# bag. Record count on State *(yellow)* I.D. tag. Also when mowing, clip and count any heads in **late boot** and place in 5# bag.

Step 3 — **MOW** remaining stalks up to the half-way mark. Examine each stalk and determine which ones are **emerg heads** and which ones are **late boot heads. CLIP** the stalk 1/2 inch below the head. Place the **remaining emerged heads** in the 8# bags and the **late boot heads** in the 5# bag.

Step 4 — Record the count of the remaining emerged heads and the late boot heads on the State *(yellow)* I.D. tag.

Repeat steps 1 thru 4 for Unit 2 using same bags for emerged heads and late boot heads as used in Unit 1.

Prepare one I.D. tag. Label all bags with sample number. Seal and place 3# and 5# bags in the 8# bag.

Verify State *(yellow)* I.D. tag and attach to outside of 8# bag.

Check here ☐ *after placing 8# bag in a cloth mailing sack addressed to* **STATE LAB.**
ENTER time and sign name.

9. WITHIN COUNT AREAS — Clip and Count all heads in count area of BOTH units following steps below. Use a separate 8# bag for each unit.

p. 97–100

Step 1 — Clip and Count all Heads in **Late Boot in Row 1 - Record in Item 4.**

Step 2 — Clip and Count all **Emerged Heads in Row 1 — Record in Item 5a** and place emerged heads in same bag with late boot heads.

Step 3 — Repeat steps 1 and 2 for **ROW 2 and 3. —** Record counts.

Step 4 — Pick up and Count all **Detached Heads** on ground in unit and **Record in Item 5b.** Place in bag with clipped heads.

Record heads clipped in Items 4 and 5 of Form B and on Regional (Pink) I.D. Tags. Attach one I.D. Tag to each 8# bag.
Check here [ ] after placing bags in cloth mailing sack addressed to **REGIONAL LABORATORY.** *Enter time and sign nai*

ENDING TIME *(Military Time)* [372]

Enumerator ______________________

STATUS CODE [380]

Enumerator Number [380]

Supervisor Number [381]