K-STATE Research and Extension
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Estimating Wheat Yield

Wheat producers want to know as early as possible what their crop yield will be, especially when the yield potential is poor. Wheat yield may be a concern due to poor plant stands, drought, flooding, late freeze, or an opportunity to plant an alternative crops with increased economic potential.

To estimate yield, there must be an understanding of the difference in crop yield and yield potential. Yield potential is defined as the yield of a crop under ideal conditions. In this context, yield potential is the yield at the time of the estimation assuming favorable conditions after the evaluation takes place. Crop yield, however, is the harvested or final yield produced at the end of the growing season.

When estimating wheat yield, three yield components are used: heads per unit area, seeds per head, and seed weight. If the producer can accurately estimate how many tillers will produce a viable head and know the typical seed production per head, the result is yield potential.

Since deciding which tillers to count is difficult, current procedures require counting all tillers. Because of variations in growing conditions, the difficulty of an accurate estimate increases with smaller wheat plants. If an estimation must be made early in the life cycle of wheat, a good method is to use equations that represent years of wheat evaluations. If yield estimation can be delayed until the wheat has headed, counting the number of heads per foot will increase accuracy.

Although many procedures use stems per square foot for the estimation process, it is easier to simply count the number of stems in the drill row. First, measure the distance in inches between the wheat rows. Next, measure a given distance of a wheat row and count the number of stems or heads. As this is done, realize that counting multiple large areas results in a more accurate estimate for the first yield component.

The next yield component is seeds per head. This estimation can vary considerably as the number of seeds per head can vary greatly depending on conditions. It may be more useful to break this component into the number of spikelets and the number of seeds per spikelet. Typically, wheat plants produce 12 to 14 spikelets per head with two to four seeds per spikelet. Two seeds per spikelet will be most common and will generally result in 25 to 28 seeds per head, the most common number in Kansas being 26 seeds per head.

The final yield component is seed weight, which can vary depending on growing conditions and variety. There are inherent differences in seed weight among varieties and those with small seeds typically produce more heads and more seeds per head to compensate. The average value for seeds per pound is typically between 14,000 and 15,000 (about 30 to 32 grams thousand

Table 1. *Estimated wheat yield for western, central, and eastern Kansas before heading.*

Stems per foot	Row spacing (inches) for western, central, and eastern Kansas								
	Western Kansas			Central Kansas			Eastern Kansas		
	8	10	12	6	7.5	10	6	7.5	10
	Bushels per acre								
5	14	11	9	20	16	12	33	26	20
10	17	14	11	25	20	15	37	30	22
15	20	16	14	30	24	18	42	33	25
20	24	19	16	34	27	21	46	37	28
25	27	21	18	39	31	23	50	40	30
30	30	24	20	44	35	26	55	44	33
35	33	27	22	48	39	29	59	47	35
40	37	29	24	53	42	32	64	51	38
45	40	32	27	58	46	35	68	54	41
50	43	35	29	62	50	37	72	58	43
55	46	37	31	67	54	40	77	61	46
60	50	40	33	72	57	43	81	65	49
65	53	42	35	77	61	46	85	68	51
70	56	45	38	81	65	49	90	72	54
75	60	48	40	86	69	52	94	75	57
80	63	50	42	91	73	54	99	79	59

Table 2. *Wheat yield adjustments for western, central, and eastern Kansas before heading.*

Stems per foot	Row spacing (inches) for western, central, and eastern Kansas								
	Western Kansas			Central Kansas			Eastern Kansas		
	8	10	12	6	7.5	10	6	7.5	10
	Bushels per acre								
5	3	2	2	3	2	2	5	4	3
10	3	3	2	4	3	2	6	5	3
15	4	3	3	4	4	3	6	5	4
20	5	4	3	5	4	3	7	6	4
25	5	4	4	6	5	4	8	6	5
30	6	5	4	7	5	4	9	7	5
35	7	5	5	7	6	4	9	7	6
40	7	6	5	8	6	5	10	8	6
45	8	7	5	9	7	5	11	8	6
50	9	7	6	9	8	6	11	9	7
55	9	8	6	10	8	6	12	10	7
60	10	8	7	11	9	7	13	10	8
65	11	9	7	12	9	7	13	11	8
70	11	9	8	12	10	7	14	11	8
75	12	10	8	13	10	8	15	12	9
80	13	10	9	14	11	8	15	12	9

kernel weight, tkw), but this value may vary depending on variety.

The last two yield components, seeds per head and seed weight, can be combined in an estimate as the average seed weight per head. Kansas Agricultural Statistics has collected data to identify the average seed weight of a wheat head for western, central, or eastern Kansas. The environment, however, greatly affects the seed weight per head, which can be an additional source of error in estimating yields.

Procedures for Yield Estimation (Before Heading)

1) First, view the field and look for any patterns. The area to be evaluated must be representative of the field. Avoid any edges of the field or any areas that have been double drilled. If areas of the field are noticeably better than other areas, estimate the land area that belongs to each and make an estimate for each.
2) Measure the distance between rows in inches.
3) Count the number of stems or tillers per foot of row. Note: in this step, all stems or tillers should be counted. To get the most accurate estimate, a larger area should be counted in as many locations as possible. Determine the average number of tillers per foot of row, for example, by finding the average number of tillers in four, 5-foot segments of row in the field. In Table 1, follow the number of stems per foot to the area and row spacing that best corresponds to the field. For more details on the calculations and assumptions that are included in these tables, refer to the equation section.
4) Decide if the year being evaluated is an average year or if it is better or worse than average. If it is expected to be better than average, add the adjusted yield value from Table 2 to the value from Table 1. Conversely, if the yield expectation is poor, the adjusted yield value should be subtracted from the estimated yield.

Procedures for Yield Estimation (After Heading)

1) Use the procedures from the Before Heading section, except count the number of heads per foot of row.
2) Decide if the year being evaluated is an average year or if it is better or worse than average. If it is expected to be better than average, add the adjusted yield value from Table 4 to the value in Table 3. Conversely, if the yield expectation is poor, the adjusted yield value should be subtracted from the estimated yield.

Equations

The following equations were used to estimate yields in the above tables. These equations were developed by Kansas Agricultural Statistics and are updated each year to improve the accuracy of yield estimation.

Several assumptions and factors are included in these equations. For estimates before heading, the number of heads is estimated by the equation within the parenthesis (see below). These equations for the number of heads were collected over many years and locations and represent the predicted number of heads that will contribute to yield for each area of Kansas. This is then multiplied by the average seed weight per

head for each specific area of Kansas, which has also been observed over many years and locations. This is all divided by the row spacing and multiplied by a conversion factor to allow for a simple calculation resulting in bushels per acre. When yield is estimated after heading, the number of heads no longer has to be estimated. So, the number of heads is multiplied by the average head seed weight and converted to bushels per acre. By removing one large assumption, assessments after heading are more accurate than before heading.

Table 3. *Estimated wheat yield for western, central, and eastern Kansas after heading.*

Heads per foot	Row spacing (inches) for western, central, and eastern Kansas								
	Western Kansas			Central Kansas			Eastern Kansas		
	8	10	12	6	7.5	10	6	7.5	10
	Bushels per acre								
5	6	5	4	10	8	6	11	9	7
10	12	10	8	19	15	12	22	17	13
15	18	15	12	29	23	17	33	26	20
20	25	20	16	38	31	23	43	35	26
25	31	25	21	48	38	29	54	43	33
30	37	30	25	58	46	35	65	52	39
35	43	34	29	67	54	40	76	61	46
40	49	39	33	77	62	46	87	70	52
45	55	44	37	87	69	52	98	78	59
50	62	49	41	96	77	58	109	87	65
55	68	54	45	106	85	64	120	96	72
60	74	59	49	115	92	69	130	104	78
65	80	64	53	125	100	75	141	113	85
70	86	69	57	135	108	81	152	122	91
75	92	74	62	144	115	87	163	130	98
80	99	79	66	154	123	92	174	139	104

Western Kansas

$$\text{Yield estimated before heading (bu)} = \frac{(\text{stems per foot} \times 0.531 + 8.5) \times 0.531}{\text{row spacing (inches)}} \times 19.213$$

$$\text{Yield estimated after heading (bu)} = \frac{\text{heads per foot} \times 0.513}{\text{row spacing (inches)}} \times 19.213$$

Adjustments to yield: Replace the coefficient 0.513 with 0.409 for a poor year or 0.618 for a good year.

Central Kansas

$$\text{Yield estimated before heading (bu)} = \frac{(\text{stems per foot} \times 0.489 + 8.0) \times 0.601}{\text{row spacing (inches)}} \times 19.213$$

$$\text{Yield estimated after heading (bu)} = \frac{\text{heads per foot} \times 0.601}{\text{row spacing (inches)}} \times 19.213$$

Adjustments to yield: Replace the coefficient 0.601 with 0.510 for a poor year or 0.692 for a good year.

Eastern Kansas

$$\text{Yield estimated before heading (bu)} = \frac{(\text{stems per foot} \times 0.403 + 13.1) \times 0.679}{\text{row spacing (inches)}} \times 19.213$$

$$\text{Yield estimated after heading (bu)} = \frac{\text{heads per foot} \times 0.679}{\text{row spacing (inches)}} \times 19.213$$

Adjustments to yield: Replace the coefficient 0.679 with 0.573 for a poor year or 0.784 for a good year.

Example

A field in central Kansas is evaluated before heading. It has 7.5-inch row spacing and after thorough observation, the average number of stems per foot is 20. It has been an average year, which is expected to continue. Twenty will be entered into the central Kansas equation before heading.

$(20 \times 0.489 + 8.0) = 17.8$

Then, 17.8 will be multiplied by 0.601 to get 10.7. This number, 10.7, will be divided by 7.5 and multiplied by 19.213 to attain approximately 27 bushels per acre. By following through these numbers on Table 1, the yield will also be estimated at 27 bushels per acre.

Table 4. *Wheat yield adjustments for western, central, and eastern Kansas after heading.*

Heads per foot	Row spacing (inches) for western, central, and eastern Kansas								
	Western Kansas			Central Kansas			Eastern Kansas		
	8	10	12	6	7.5	10	6	7.5	10
	Bushels per acre								
5	1	1	1	1	1	1	2	1	1
10	3	2	2	3	2	2	3	3	2
15	4	3	3	4	3	3	5	4	3
20	5	4	3	6	5	3	7	5	4
25	6	5	4	7	6	4	8	7	5
30	8	6	5	9	7	5	10	8	6
35	9	7	6	10	8	6	12	9	7
40	10	8	7	12	9	7	14	11	8
45	11	9	8	13	10	8	15	12	9
50	13	10	8	15	12	9	17	14	10
55	14	11	9	16	13	10	19	15	11
60	15	12	10	17	14	10	20	16	12
65	16	13	11	19	15	11	22	18	13
70	18	14	12	20	16	12	24	19	14
75	19	15	13	22	17	13	25	20	15
80	20	16	13	23	19	14	27	22	16

Errors in Yield Estimation

Any yield estimation is subject to substantial errors depending on environmental conditions after the estimation takes place. When the estimation is conducted early in the growing season, there is more opportunity for environmental conditions to affect the yield in ways that cannot be predicted. For example, an assessment of western Kansas yield is 50 bushels per acre in an average year. If conditions after the evaluation are favorable, the yield may be greater than initially estimated. Also, the opposite may be true, and conditions could reduce yield below the expected estimate. In either case, it should be recognized that some error occurs with the evaluation.

Summary

Estimating wheat yields can be beneficial for planning and budgeting. The procedures presented in this document are based on sound, data-based yield estimation equations. During estimations, the evaluator must fully understand what plants and plant parts to count so the equations can be used correctly. As with anything that depends on representative samples, a larger area and number of samples evaluated decreases the error that comes from variability within the field. Although doing an attentive job of collecting this data can minimize variability, error will still be present and should be considered.

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