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Estimating Corn Grain Yields

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To estimate the grain yield of a corn crop before harvest, farmers can collect samples from a corn field and use this data to calculate the yield estimate. An interactive grain yield calculator is provided in the Appendix of the pdf version of this publication. The calculator is also located in the publication online at http://agrilifebookstore.org/.

The procedure is based on the Yield Component Method and adapted from various Extension agronomy programs across the United States. Grain yield estimates are used to evaluate:

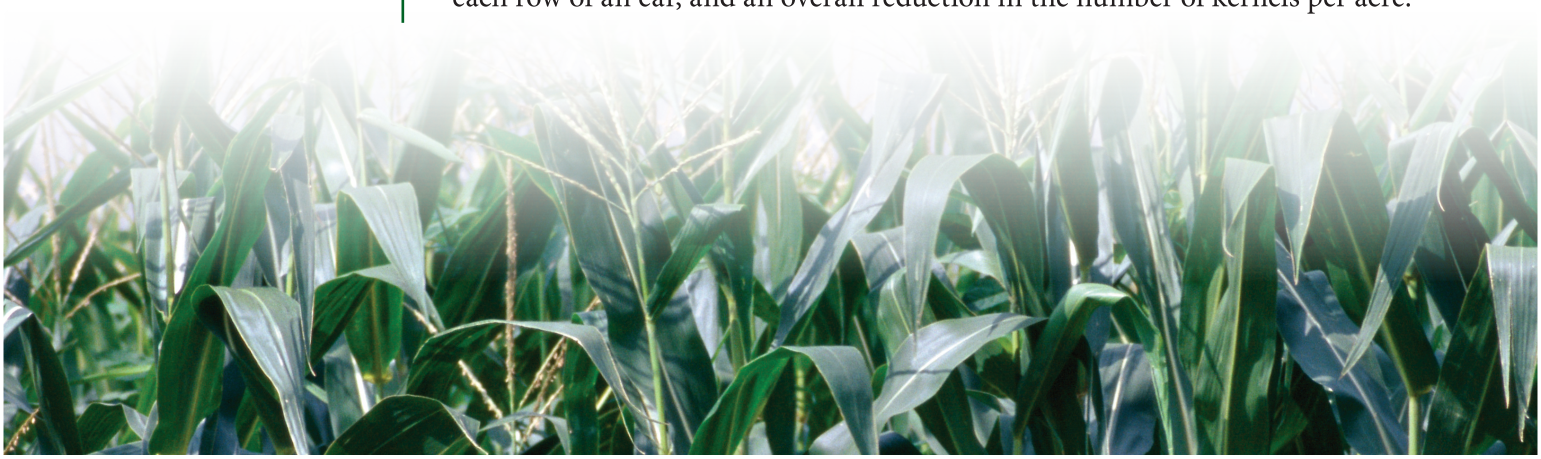
- Drought-stress losses relevant to potential crop insurance claims,
- A corn crop for harvest as silage during the milk stage (R3), and
- Grain yields of corn at the dent (R5) or physiological maturity (R6) stage of development when planning harvest and post-harvest grain storage needs.

Background

Moisture stress caused by drought will reduce corn grain yields by disrupting kernel development, lowering grade, and impeding grain fill. Kernel development of the corn plant is most affected by drought during early vegetative growth stages (V3 to V5) before the growing point emerges above the soil, 2 weeks before pollination, during pollination, and 2 weeks after pollination (VT stage).

Even though a corn seedling (pre-V5) can tolerate severe above-ground damage such as freeze and hail damage without affecting final grain yields, drought stress at this early stage of growth will disrupt initial ear formation by decreasing the potential number of rows of kernels and kernels per row of the ear.

Drought conditions at later stages of development (V8 and V9) also cause the corn plant to develop fewer kernels and to abort developing pollen tubes and kernels. The result is fewer filled rows and fewer developed kernels within each row of an ear, and an overall reduction in the number of kernels per acre.



The production of malformed rows of kernels is associated with moisture stress during the VT stage of development, 2 weeks before pollination, during pollination, and 2 weeks after pollination where the row space of unpollinated or aborted kernels is occupied by pollinated kernels of adjacent rows.

Grain test weight is one of the factors used to determine market grade and is most affected during kernel fill. Moisture stress can slow or stop grain fill by disrupting photosynthetic activity and the subsequent transport of starch into the grain.

Kernel fill begins after the silk stage and occurs from pollination to physiological maturity. The length of time that a corn plant is in grain fill strongly influences kernel size and test weights. Consistently high temperatures of more than 86°F during grain fill will accelerate the rate of growing degree day (GDD) accumulation and in turn shorten the window of time needed to accomplish complete grain fill.

The combination of drought stress and excessively high temperatures during grain fill will lower grain yields and grade, which translates into considerable docking of grain prices at the elevator.

Estimating grain yields

Three steps to estimate grain yields:

1. Plan and prepare for sample and data collection.
2. Collect field samples and record data.
3. Analyze the data using the interactive grain yield calculator in the Appendix.

Plan and prepare for sample and data collection

Predetermine sample locations. Consider the variability of soils in the field. If available, examine historical yield monitor maps of the field. Also check a soil survey to better understand your soils and their yield potentials.

In fields with uniform soils, choose for sampling at least three areas per 40-acre field; in fields with highly variable soils, sample at least three areas per 10 acres. Your grain yield estimates will be more accurate as you increase the size and number of individual counts—a vital consideration for highly variable fields.

The objective is to accurately represent each zone within a field by strategically positioning one or more sample areas on each of the soil types. Adjust the number of sample areas within each soil type up or down, according to the total area or extent of each soil type in relation to that of the other soils and the overall size of the field. This method of positioning the distribution of sample areas will give you a more accurate representation of the grain yield for the entire field.

For example: Consider a production field that has three soil types, each with a different yield potential, and each soil type occupying about a third of the total field area. For this field, you would position the same number of yield sample areas within each soil type.

A more complicated scenario is a field in which the acreage of each soil type varies. Consider a production field that has two soil types: Soil 1 occupies one-third of the field acreage, and Soil 2 occupies two-thirds. In this case, you would need twice the number of sample areas on Soil 2 as on Soil 1. This method of distributing the samples will enable you to more accurately estimate the grain yield of the entire field.

Length of sample area. Each sample area should be $\frac{1}{500}$ acre and consist of two adjacent rows of equal length. Prepare a measuring device that will not stretch, such as a plastic chain or pvc pipe, cut to a length that defines your sample area. Refer to the table below to determine the length of row to use with your planter row spacing.

Table 1. Lengths of sample areas for corn fields according to row spacing.

Row spacing	Length of sample area
20 in	26 ft 1 in
28 in	18 ft 8 in
30 in	17 ft 5 in
32 in	16 ft 4 in
36 in	14 ft 6 in
38 in	13 ft 9 in
40 in	13 ft 1 in

Field data records. Acquire a note pad or field data device to record kernel and ear counts, and general observations of crop condition, including kernel size for selecting the appropriate kernels per bushel factor that is used when calculating the grain yield estimate. Refer to Fig 1 to see examples of small, medium, and large kernels.

Collect field samples and record data

1. *Sample area.* Select a length of row that is similar to the surrounding rows. Position your measuring device along adjacent rows. When selecting the sampling area, avoid unusual planter skips and non-uniform within-row plant spacing.
2. *Ears per sample area.* Count and record the number of potentially harvestable ears in the length of the two adjacent rows. Gathering data from more than one planted row improves the sampling accuracy by increasing the sample size. It also diminishes any minor differences between rows that were introduced by a planter unit, such as fertilizer placement, planting depth, or seed-soil contact. Some corn plants in the sample areas may be barren; others may have more than one harvestable ear.
3. *Kernels per ear data.* Select and hand-harvest six representative potentially harvestable ears from the sample area. Do not collect ear samples from fallen or lodged plants that would not be mechanically harvested by a combine. Count and record the number of rows of kernels and the average number of potentially harvestable kernels per row for each hand-harvested ear. Drought conditions that stress the crop during pollination may cause the formation of partial and nonuniform rows of kernels. Count and record total number of kernels per ear of malformed ears.
4. Navigate to the next sample area and repeat the field sample and data collection process until data is gathered from all pre-determined sample areas.

Analyze the data

Corn Grain Yield Calculator. Use the interactive grain yield calculator in the Appendix to analyze your field data. The interactive form is designed to analyze sample data for up to five sample areas, with a minimum of six ear samples per area.

Calculate the number of kernels per ear. For each hand-harvested ear sample, multiply the number of rows of kernels per ear by the average number of kernels per row. Record the number of kernels per ear.

Kernels per ear =
Rows of kernels × Number of kernels per row

Kernels per bushel factor. Drought stress during the reproductive stage of corn reduces the number of developed kernels per ear, kernel size, and kernel density. Kernel size is closely associated to hybrid corn genetics, but one will generally observe that drought-stressed corn has approximately 110,000 small kernels per bushel, versus 90,000 medium-sized kernels per bushel of normal corn, or 70,000 large kernels per bushel of exceptional corn.

The kernel per bushel factor for drought-stressed corn approximates an 18 percent grain yield reduction, relative to grain yields of normal corn with medium-sized kernels. Refer to Fig 1 for examples of representative kernel sizes.

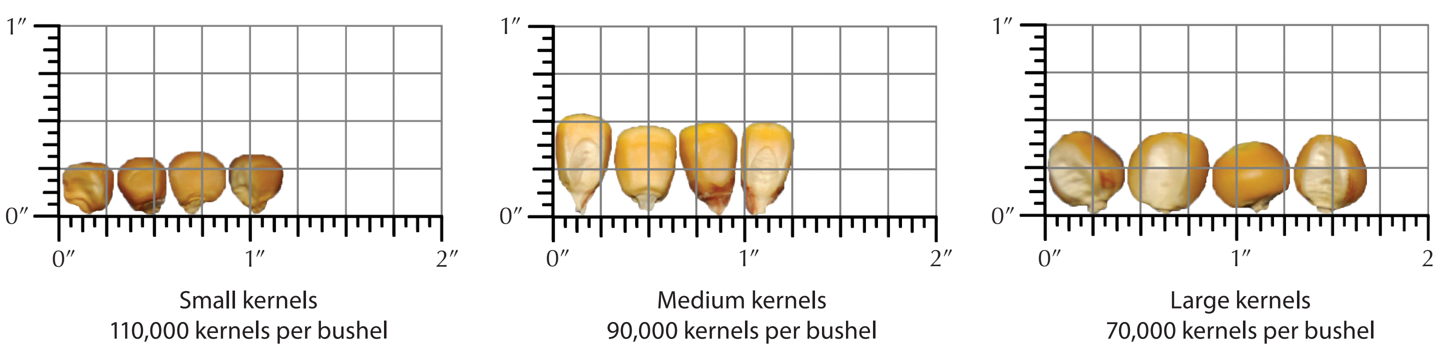


Figure 1. Representative kernel sizes. A key for determining the "kernels per bushel factor."

Estimate the grain yields of the sample areas. To calculate the number of kernels per acre, multiply the number of ears for each sample area by the average number of kernels per ear; then multiply that number by 500 to change the unit of measure from 1/500 acre to a per-acre basis. Divide this product by the kernels per bushel factor that best represents the average kernel size of the sample area: small, medium, or large.

Sample area yield =
Number of ears × Average kernels per ear ×
500 ÷ Kernels per bushel factor

Estimate the whole-field grain yield. Calculate the average of the sample area grain yield estimates by adding together the sample area yield estimates and dividing the sum by the number of sample areas.

Example of a grain yield estimate

A field of dryland corn with three soil types, each representing about one-third of the total field area, was under moisture stress during the early vegetative stages and pollination; it was under moderate drought stress during kernel fill.

Soils A and B are clay loam soils with moderately high water-holding capacities, but Soil C is the sandy phase of loam and has a moderately low water-holding capacity, significantly lower than Soils A and B.

The field was sampled at late dent (R5) stage at one area within each soil type. Planter row spacing was 30 inches, so a two-row sample length of 17 feet, 5 inches was used to represent 1/500 acre.

We counted an average of 43 ears per sample area, 1/500th of an acre. The crop was drought-stressed during early vegetative stages and developed an average of only 14 rows of kernels per ear, and were "tipped back" due to drought stress at pollination. We counted an average of only 20 kernels per row and 282 kernels per ear. Average kernel size of corn grown on Soils A and B was medium and small on Soil C.

Table 2 shows the field data collected for the sample areas. Table 3 shows the estimated grain yields for each sample area and for the entire field.

Checklist

1. **Choose sample area locations.** Evaluate historical yield data, and partition the field into zones according to differing productivity potentials. Refer to a soil survey to review your soils' yield potentials and physical characteristics, such as soil texture and water-holding capacity. Assign one or more sample areas to each soil type or yield zone.
2. **Prepare sampling equipment.** Prepare a measuring device cut to length for your planter row spacing as described. Refer to Table 1.
3. **Make calculations.** Evaluate the dominant kernel size within each sample area and apply the appropriate "kernels per bushel factor" (Fig. 1.) when estimating grain yield of each sample area. Calculate a yield estimate for each sample area and the whole field average yield.
4. **Use the grain yield calculator.** Analyze the field data using the interactive pdf grain yield calculator in the Appendix to the pdf version of this publication or at http://agrilifebookstore.org/.

For more information

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Table 2. Field data and sample area calculations

Sample areas	Ear samples	Ears per sample area	Rows per ear	Kernels per row	Kernels per ear	Average kernel size
Soil A	1	44	15	20	300	Medium
	2		14	20	280	
	3		12	22	264	
	4		15	22	330	
	5		14	21	294	
	6		14	20	280	
Soil B	1	43	14	19	266	Medium
	2		18	18	324	
	3		17	21	357	
	4		15	22	330	
	5		17	21	357	
	6		18	19	342	
Soil C	1	42	12	18	216	Small
	2		14	20	280	
	3		11	20	220	
	4		12	21	252	
	5		10	18	180	
	6		11	19	209	
Soil A	*Averages*	44	14.0	20.8	292	90,000 kernels/bu
Soil B		43	16.5	20.0	330	90,000 kernels/bu
Soil C		42	11.7	19.3	226	110,000 kernels/bu

Table 3. Estimated grain yield calculations.

Sample area	Number of ears		Average kernels per ear		Convert sample area to acre		Kernels per bushel factor		Grain yield estimates (bu/acre)
Soil A	44	x	292	x	500	÷	90,000	=	71
Soil B	43	x	330	x	500	÷	90,000	=	79
Soil C	42	x	226	x	500	÷	110,000	=	43
					Whole field average grain yield estimate			=	**64**

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Corn Grain Yield Calculator:

Sample Areas	Ear Samples	Ears per Sample Area	Rows per Ear	Kernels per Row	Kernels per Ear	Average Kernel Size
	1				0	
	2				0	
	3				0	SMALL
	4				0	
	5				0	
	6				0	
	1				0	
	2				0	
	3				0	SMALL
	4				0	
	5				0	
	6				0	
	1				0	
	2				0	
	3				0	SMALL
	4				0	
	5				0	
	6				0	
	1				0	
	2				0	
	3				0	SMALL
	4				0	
	5				0	
	6				0	
	1				0	
	2				0	
	3				0	SMALL
	4				0	
	5				0	
	6				0	
	Averages	0	0.0	0.0	0	110,000 kernels/bu
		0	0.0	0.0	0	110,000 kernels/bu
		0	0.0	0.0	0	110,000 kernels/bu
		0	0.0	0.0	0	110,000 kernels/bu
		0	0.0	0.0	0	110,000 kernels/bu

Sample Areas	Number of Ears		Average Kernels per Ear		Convert Sample Area to Acre		Kernels per Bushel Factor		Grain Yield Estimates (bu/acre)
	0	×	0	×	500	÷	110,000	=	0
	0	×	0	×	500	÷	110,000	=	0
	0	×	0	×	500	÷	110,000	=	0
	0	×	0	×	500	÷	110,000	=	0
	0	×	0	×	500	÷	110,000	=	0
Whole Field Average Grain Yield Estimate								=	**0**

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