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G82-602 Predicting the Last Irrigation for Corn, Grain Sorghum and Soybeans (Revised August 1991)

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Predicting the Last Irrigation for Corn, Grain Sorghum and Soybeans

This NebGuide presents criteria and "rules of thumb" for predicting the last irrigation for corn, grain sorghum and soybeans.

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Determining when to apply the last irrigation of the season is an important water management decision. One extra irrigation may mean wasting an additional one to three inches of water and two to five gallons of diesel fuel per acre. On the other hand, applying that one extra irrigation could mean several bushels per acre in crop yield.

Criteria for Estimating the Last Irrigation

Irrigation management near the end of the season should accomplish the following goals:

1. Enough soil moisture available in the root zone to carry the crop to maturity and to produce best yields.
2. Soil moisture reservoir depleted as far as possible to allow room for storing off-season precipitation and to minimize fuel, labor, and water demands for the present season.

Although these requirements appear to conflict, the problem can be solved if adequate field information is available or is predictable. The following information is necessary to predict the date of the last irrigation:

- Predicted crop maturity date.
- Predicted water use by the crop to maturity.
- Remaining usable moisture in the root zone.
- Probability of significant amounts of rainfall before crop maturity.

Obviously, rainfall is difficult to predict. Consequently, we assume that no rainfall will occur. The procedures presented are designed for maximum crop yield.

Physiological maturity is defined as the time when kernels or seeds have stopped filling. For corn and grain sorghum, black layer formation at the tip of the kernel is a good indicator of maturity. For soybeans, beginning maturity is when one normal pod on the main stem has reached its mature pod color. Further information on soybean growth stages is given in *Table I*.

Table I. Reproductive stages of soybean plant development.

Stage	Description
Beginning Flower R1	One open flower at any node on the main stem.
Full Flower R2	An open flower at one of the two uppermost nodes on the main stem with a fully developed leaf.
Full Pod Development R4	A pod 3/4 inch long at one of the four uppermost nodes on the main stem with a fully developed leaf.
Beginning Seed Fill R5	The presence (felt when pod is squeezed) of bean seeds in pods at one of the four uppermost nodes on the main stem with a fully developed leaf.
Full Seed Fill R6	A pod with full-size green beans (bean is full size when it fills pod cavity) at one of the four uppermost nodes on the main stem with a fully developed leaf.
Beginning Maturity R7	One normal pod on the main stem has reached its mature pod color.

Corn, sorghum and soybean plants require some moisture up to the time of physiological maturity. Since some of the required moisture can come from the soil moisture reservoir, the last irrigation can usually be applied two to four weeks before physiological maturity.

The water requirements between a given stage of growth and physiological maturity given in *Table II* were calculated by using crop development rates and normal water use patterns for Nebraska.

Table II. Normal water requirements for corn, grain sorghum and soybeans between various stages of growth and maturity in Nebraska.

Stage of growth	Approximate number of days to maturity	Water use to maturity
		(inches)
Corn		
Blister kernel	45	10.5
Dough	34	7.5
Beginning dent	24	5.0
Full dent	13	2.5
Physiological maturity	0	0.0

Grain Sorghum		
Half bloom	34	9.0
Soft dough	23	5.0
Hard dough	12	2.0
Physiological maturity	0	0.0
Soybeans		
Full pod development (R4) ^a	37	9.0
Beginning seed fill (R5)	29	6.5
Full seed fill (R6)	17	3.5
Beginning maturity (R7)	0	0.0
^a The R-number corresponds to the soybean growth stage number.		

To apply the information in this NebGuide you need to be familiar with at least one of the following methods for estimating soil moisture status: soil-probe hand-feel method, checkbook (crop water use) scheduling method, soil moisture blocks, or tensiometers. Following is a list of publications that describe these methods:

- *G84-690, Estimating Soil Moisture by Appearance and Feel*
- *G85-753, Irrigation Scheduling Using Crop Water Use Data*
- *EC 89-723, Irrigation Scheduling Using Soil Moisture Blocks in Deep Soil*
- *EC 89-724, Irrigation Scheduling Using Tensiometers in Sandy Soils*

There are two general approaches to expressing soil moisture status: soil water balance and soil moisture deficit. **Soil water balance** refers to the available water remaining in the soil. **Soil moisture deficit** refers to the portion of the available water that has already been removed. As an example, when the available soil moisture is 40 percent depleted (deficit), 60 percent of the available moisture is remaining (balance).

In this NebGuide information is presented using the soil moisture deficit approach, but the corresponding data for the soil water balance method are shown in parenthesis.

Remaining usable moisture in the root zone is the difference between the current soil moisture deficit (current water balance for soil water balanced method) and the allowable soil moisture deficit (minimum water balance for soil water balance method) at maturity. Research shows that 60 percent of the available moisture in the top four feet of the root zone can be depleted at crop maturity and not reduce grain yield. Therefore, the allowable soil moisture deficit can be calculated by the following equation:

$$\text{ASMD} = 0.60 \times \text{AWC} \times \text{RZD}.$$

ASMD = allowable soil moisture deficit in inches.

AWC = available water capacity of the soil in inches per foot.

RZD = root zone depth in feet (use four feet or less).

For the soil water balance method, the minimum allowable balance can be calculated using the following equation:

MAB = 0.4 x AWC x RZD.

MAB = minimum allowable balance.

Calculated allowable soil moisture deficits and minimum allowable balances at crop maturity for various soils are presented in *Table III*. Refer to a county soil survey to determine the available water capacity for your soil. If you suspect that the root zone is less than four feet due to hardpans or gravel layers, use one of the equations above rather than *Table III* for your situation.

Table III. Allowable soil moisture deficits and minimum allowable balances at physiological maturity.

<i>Soil type</i>	<i>Available water capacity</i>	<i>Allowable soil moisture deficit in top 4 feet of soil profile^a</i>	<i>Minimum allowable balance in top 4 feet of soil profile^a</i>
	(Inches/foot)	------(inches)-----	
Silty			
clay loam	1.6	3.8	2.6
Upland			
soil loam	2.0	4.8	3.2
Bottomland			
silt loam	2.5	6.0	4.0
Very fine			
sandy loam	1.8	4.3	2.9
Sandy loam	1.4	3.4	2.2
Fine sands	1.0	2.4	1.6
^a Based on depletion of 60 percent of the available water.			

Predicting the Last Irrigation

The following form can be used in conjunction with *Tables II* and *III* as a guide to decide if one or more irrigation is necessary, and how much more water is needed. An example is included.

For maximum efficiency, the effective water applied during the last irrigation should not exceed the calculated irrigation requirement. If another irrigation is required, wait until at least 50 percent of the available moisture in the top three feet is depleted. By delaying irrigation, the probability of receiving enough rainfall to fulfill the water requirement increases.

An important item in the prediction procedure is the measurement of the current soil moisture deficit or current soil water balance. If this information is not available guidelines shown in *Table IV* can be used to determine the date of the last irrigation, assuming the root zone is refilled at that time. However, since refilling the root zone is not a recommended practice, it is better to measure soil moisture deficits or balances for scheduling the last irrigation. On soils that have low intake rates, it is virtually impossible to refill the root zone with the last irrigation.

Table IV. Guidelines for determining date of last irrigation, assuming the root zone is completely refilled at that time.

Soil type	Stage of growth for last irrigation		
	Corn	Grain sorghum	Soybeans
Silty			
clay loam	4 days after beginning dent	4 days after soft dough	1 day after full seed fill
Upland			
soil loam	1 day after beginning dent	1 day after soft dough	9 days after beginning seed fill
Bottomland			
silt loam	5 days after dough stage	10 days after half bloom	4 days after beginning seed fill
Very fine			
sandy loam	3 days after beginning dent	3 days after soft dough	11 days after beginning seed fill
Sandy loam	6 days after beginning dent	6 days after soft dough	3 days after full seed fill
Fine sands	1 day after full dent	10 days after soft dough	6 days after full seed fill

	Example	Same example but soil water balance method	Enter your field data here
Field	_____	_____	_____
Date	8-20	8-20	_____
Crop	<i>Corn</i>	<i>Corn</i>	_____
Soil Type	<i>Bottomland silt loam</i>	<i>Bottomland silt loam</i>	_____
1. Present stage of growth.	<i>Beginning Dent</i>	<i>Beginning Dent</i>	_____
2. Water required to crop maturity, inches (<i>Table II</i>).	5.0	5.0	_____
3. Allowable soil moisture deficit, inches, from <i>Table III</i> (current soil water balance for the water balance method).	6.0	9.5	_____
4. Current soil moisture deficit, inches (minimum allowable balance for water balance method, from <i>Table III</i>).	0.5	4.0	_____
5. Remaining usable moisture, inches (3 minus 4).	5.5	5.5	_____
6. Irrigation requirement assuming no rainfall, inches (2 minus 5)	<i>None</i>	<i>None</i>	_____

NOTE: If Item 5 is greater than or equal to Item 2, no more irrigation is needed.

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