www.ag.ndsu.edu/extension-aben/irrigation/water-spouts

water spouts

No. 309 May 2020

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2020 NDSU Field Days

Due to the COVID-19 pandemic, the decision to conduct the fields days hasn't be made at this time.

Summer Water Tours – Canceled

The board of the North Dakota Water Education Foundation has decided to cancel all summer water tours for 2020. We hope the tours will resume in 2021.

North Dakota Water Education Foundation, 701-223-8332
jellingson@ndwater.net

Welcome to 2020: What a Year So Far!

Everyone has been on a wild, emotional ride as we enter the 2020 growing season. Last fall, we had above-average rain as seen in **Figure 1**, which shows the departure from normal rain amounts between Aug. 15 and Nov. 15, 2019.

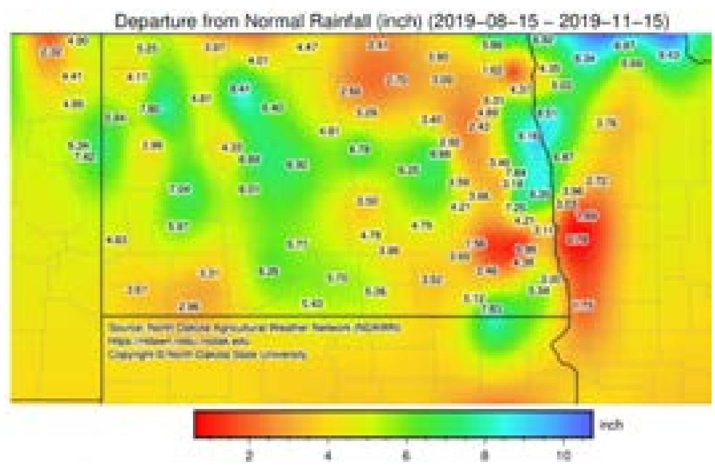

Figure 1. Departure from normal rain for Aug. 15 to Nov. 15, 2019.

Notice the entire state is above average. All this rain resulted in such wet conditions that many fields could not be harvested and crops were left standing all winter. A good result from the excess rain is that the subsoil has been recharged, which should be a benefit for the 2020 growing season.

In contrast, look at **Figure 2**, which shows the departure from normal rain amounts for the period from April 1 to May 14 of this year. Just about the whole state is below normal except for the central area around Jamestown. This area still is experiencing very wet fields.

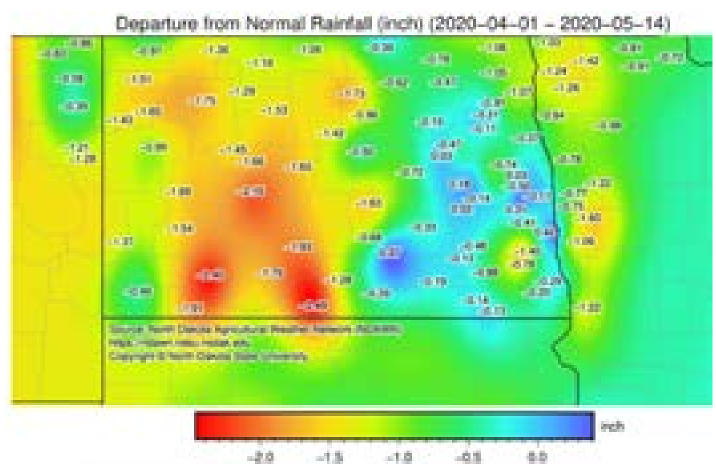

Figure 2. Departure from normal rain for April 1 to May 14, 2020.

In contrast to the area surrounding Jamestown, the western half of the state is classified by the U.S. Drought Monitor as abnormally dry, the lowest drought rating. Low crop prices and demand, shifting rainfall patterns and economic effects caused by the COVID-19 pandemic will require some innovative thinking by many farmers this growing season.

The 2019 Bismarck irrigation workshop was held the second week of December in conjunction with the North Dakota Water Users convention. If you were not able to attend, I have posted pdf copies of the presentations

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on my website at *www.ag.ndsu.edu/irrigation*. Look in the upper right-hand side for the yellow star.

Have a great growing season and remember to take care of your irrigation system. Getting it ready for the growing season now is better than waiting until it is needed.

Tom Scherer, 701-231-7239
NDSU Extension Agricultural Engineer
Thomas.Scherer@ndsu.edu

Soil Water in the Root Zone – The Basis of Irrigation Water Management

With all the rain last fall and lack of it this spring, the amount of soil water in the root zone may be highly variable, depending where your irrigation system is in the state. Lately a great deal of interest has developed about measuring soil water, sometimes called soil moisture, for irrigation water management.

Many manufacturers offer automated soil water monitoring units. Some of these units can measure soil water at several depths in the root zone. Many have communication packages that allow the user to check the soil water status any time of the day.

The difficulty for many irrigators is determining the soil water "trigger point(s)" for the soils and crops in their fields. To identify and understand when to "trigger" irrigation, you must understand basic soil water concepts.

The soil in the root zone provides storage for nutrients and water that plants need for growth and development. Measuring soil water accurately always has been difficult. The makeup of soil and the way it interacts with water poses many problems.

Soil is composed of grains of minerals that can vary in size from less than 8/10,000 inch (0.002 millimeter) to more than 1/32 inch (1 millimeter) and that are all mixed together. Mixed in with the grains are pieces of organic matter (old roots, crop residue, manure, etc.) that act like sponges and can make up from 0.5% to 6% of the soil volume in the root zone. Add water to this mixture, either in liquid or vapor form, and you can understand why measuring soil water is difficult.

Basic Soil Water Concepts

Soil water commonly is expressed as **soil water content** or **soil water potential**.

Soil water content

The amount of water in a volume of soil often is expressed as the percent of water by weight, percent of water by volume or by the inches of water per foot of soil. The percent of water by weight is determined by obtaining a soil sample and weighing it, then drying the sample in an oven (at 205 F) for 24 hours and weighing it again when it's dry.

The weight of water in the sample is the difference between the wet weight and the dry weight of the soil sample. Divide this amount by the dry weight and multiply by 100 to get the percent of water content by weight. This procedure often is called the "gravimetric method."

The percent of water by volume, a more useful value for irrigation design and management, is obtained by multiplying the percent of water content by weight by the bulk density of the soil. The bulk density of soil is the ratio between the dry weight and the volume of a soil sample with units of grams per cubic centimeter (g/cm3).

Agricultural soils can have bulk densities that range from 1.1 to 1.6 g/cm3. Generally, the top foot of soil will have low bulk densities and deeper soil will have higher bulk densities.

Soil water potential

How tightly water is held by soil particles and organic matter is a measure of the soil water potential. Soil tension is another term often used to describe soil water potential.

Soil tension is a measure of how hard pulling water away from the soil particles is for a plant's roots. Wet soil gives up water easily and has a low value of tension. Dry soil holds water very tightly because it's bound to the surface of the soil particles and has a high tension.

For irrigation purposes, the amount of water available for plant use is the difference between the soil "field capacity" and the "wilting point." Field capacity is the water content where soil holds water against the force of gravity.

This is the water content where many of the large-pore spaces between soil particles will drain but many of the small-pore spaces will be full of water. For most irrigated soils in North Dakota, field capacity is the water content at a soil water tension of one-fifth of a bar (1 bar is almost atmospheric pressure and is equal to 14.5 pounds per square inch, or psi, so one-fifth of a bar is approximately 3 psi of tension).

The wilting point is where most agricultural crops experience permanent wilting and will not recover. It is the soil water content at a soil water tension of 15 bars (almost 220 psi of tension). Subtracting the water content by volume at the wilting point from the water content by volume at field capacity and multiplying the difference by 12 will give you the "inches per foot" of available water for plants **(Table 1)**.

Table 1. Range of available water for plants for different soil textures.

Soil Texture	Inches of Water Per Foot of Soil
Coarse sand and gravel	0.2 to 0.7
Sands	0.5 to 1.1
Loamy sands	0.7 to 1.4
Sandy loams	1.3 to 1.8
Fine sandy loams	1.7 to 2.2
Loams and silt loams	2.0 to 2.8
Clay loams and silty clay loams	1.7 to 2.5
Silty clays and clays	1.6 to 2.2

However, not all the available water is obtained easily. For irrigation management, we don't want the available water to drop below 50% of the amount stored in the root zone. Available water above 50% is readily available for plant use.

If the amount of water is depleted to below 50%, the plants will experience water stress. If this happens for a couple of days during the critical growth stage of fruiting, research has shown that yield potential will be affected.

Measuring soil water

Many methods and devices have been developed to measure soil water. Some devices measure soil water content and some measure soil water potential. The gravimetric method is the **standard** that is used to calibrate soil water measurement devices.

Although a great deal of new technology related to soil water measurement has been developed, according to the latest National Agriculture Statistics Service (NASS) 2018 Irrigation Survey, the crop appearance and the soil feel method are still the most common methods for making irrigation decisions.

The "feel method" is the oldest and most common method of checking soil water for irrigation management. It involves obtaining a handful of soil from a desired depth and location in the field, then squeezing to see if it makes a ball. Based on how the soil reacts to the pressure, the water content can be determined.

For finer soils, an additional indicator is how the soil ribbons when pressed between the thumb and forefinger. Many crop consultants and experienced irrigators use the feel method, but it can be a challenge for new irrigators.

For those unfamiliar with the feel method, the Natural Resources Conservation Service (NRCS) has an excellent online publication titled "Estimating Soil Water by Appearance and Feel" *(www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_051845.pdf)*. It contains photos of the ball-forming process for several soil textures at different water contents.

Where to check soil water

Checking the soil water content at many locations in a field can be time-consuming, so the irrigator has to select representative locations. Selection of ideal locations for soil water checking should be based on ease of access, crop and soil types in the field.

An example of a field with a center pivot system and soil series superimposed is shown in **Figure 1**. Important soil parameters for the field are shown in **Table 2**.

The easiest access for soil sampling would be next to the roads or near the pivot access road (not shown). However, the location also should be selected based on the type of soil, topography and crop.

If potatoes were grown under the center pivot in **Figure 1**, four or more soil-sampling locations would be needed. Because they are moisture sensitive, potatoes

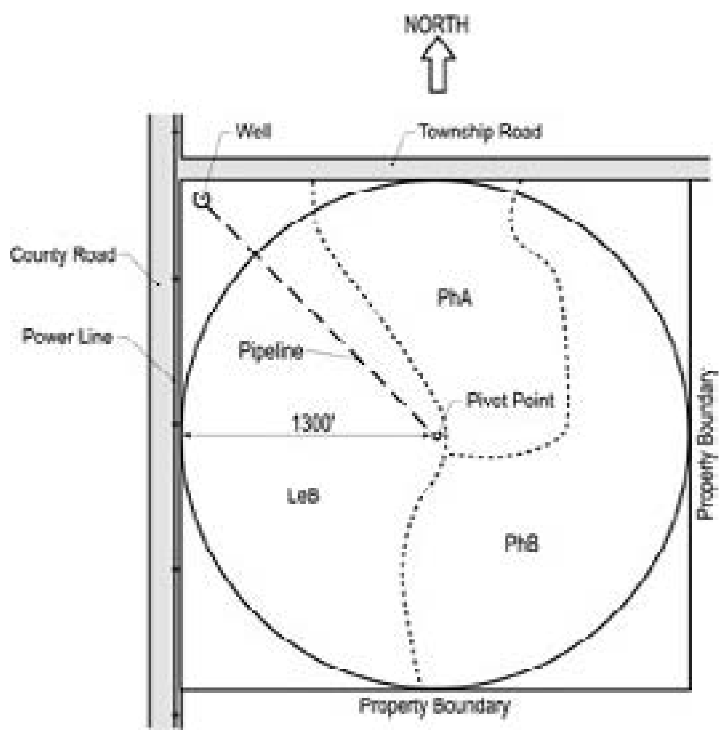

Figure 1. Example of the soil distribution under a center pivot.

Table 2. Important soil parameters for irrigation management of the center pivot shown in Figure 1.

Map ID	Soil Type	Slope	Water-holding Capacity	Field Area
		(%)		(%)
LeB	Lihen loamy fine sand	1 to 6	1.6 in/ft.	37
PhA	Parshall fine sandy loam	1 to 3	1.9 in/ft. (top 2 ft.) 1.4 in/ft. (2 to 5 ft.)	23
PhB	Parshall fine sandy loam	3 to 6	1.9 in/ft. (top 2 ft.) 1.4 in/ft. (2 to 5 ft.)	40

NDSU NORTH DAKOTA STATE UNIVERSITY

DEPARTMENT OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING
NDSU Dept 7620
PO Box 6050
Fargo ND 58108-6050

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on the Parshall soil with 3% to 6% slope (PhB) will show moisture stress first.

Therefore, at least two sample locations should be in part of the field, at least one should be in the Lihen soil and one should be in the Parshall soil with 0% to 3% slope. For most other crops, two sampling locations in the Lihen and two in the Parshall area would be sufficient.

Tom Scherer, 701-231-7239
NDSU Extension Agricultural Engineer
Thomas.Scherer@ndsu.edu

Starting the Irrigation System: A Checklist

- ☐ **Make sure the main breaker is turned off, then open and check all electrical control panels and motor openings for damage, especially from rodents, before starting the irrigation system.**
- ☐ Measure and record the static water level in all wells if possible.
- ☐ Replace broken or old pressure gauges.
- ☐ Visually inspect the above-ground piping system.
- ☐ Make sure all portable aluminum or PVC pipe sections have gaskets installed. Pipeline leaks can reduce the amount of water applied to the field significantly. Gaskets have a useful life of about five years, then they become brittle and crack.
- ☐ **Check to make sure the pivot point is grounded properly at the center pivot control panel. The copper ground line must be bolted securely to the ground rod.**
- ☐ Check gearboxes on center pivot towers for water accumulation. Drain water and replace with oil.
- ☐ Check the tire pressure on center pivots.
- ☐ Fill pipelines slowly; make sure all the air is out of the system and that all the air release valves are working properly.
- ☐ Visually check each sprinkler head with the center pivot running to make sure it is working properly and check for leaking boots on the tower joints.

Tom Scherer, 701-231-7239
NDSU Extension Agricultural Engineer
Thomas.Scherer@ndsu.edu