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water spouts

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Irrigation Tour July 30

Many industries are thriving as a result of irrigated agriculture. This tour will focus on irrigation and the facilities necessary to get water from the source to the field. Stops will include the Snake Creek Pumping Plant, Lake Audubon, an irrigated farm, the Mile Marker 7.5 Irrigation Project and Garrison Diversion's McClusky operation and maintenance office. The tour begins and ends in Bismarck.

Registration is \$20 per person and includes tour transportation, meals, refreshments, informational materials and a one-year subscription to North Dakota Water magazine. To register, go to www.ndwater.com/programs and click on "Summer Water Tours" on the left-hand menu or send a check to NDWEF, P.O. Box 2254, Bismarck, ND 58502. Please include the number of people who will attend the tour. For more information, give us a call or send an email.

North Dakota Water Education Foundation, (701) 223-8332
 Fax (701) 223-4645
ndwaterusers@btinet.net

Get Rid of Unused Pesticides: Project Safe Send

Farmers, ranchers, pesticide dealers and applicators, government agencies and homeowners with unusable pesticides can bring them to any of the Project Safe Send sites listed below.

Project Safe Send is a safe, simple and nonregulatory program that helps people safely and legally get rid of unusable pesticides free of charge.

NDSU EXTENSION SERVICE

County Commissions, NDSU and U.S. Department of Agriculture Cooperating.
 This publication will be made available in alternative formats for people with disabilities upon request. (701) 231-7881.

Since 1992, thousands of people have brought in more than 3 million pounds of pesticides to Project Safe Send. The program accepts old, unusable or banned pesticides, including herbicides, insecticides, rodenticides and fungicides. The collected pesticides are shipped out of state for incineration.

Project Safe Send is funded through product registration fees paid by pesticide manufacturers.

People are urged to check their storage areas for any unusable pesticides and safely set them aside for Project Safe Send. If the containers are deteriorating or leaking, pack them in larger containers with absorbent materials. Free heavy-duty plastic bags are available from the North Dakota Department of Agriculture.

People with more than 1,000 pounds of pesticides should preregister. No other preregistration is required. A maximum of 20,000 pounds of pesticides per participant will be accepted.

2015 Project Safe Send Sites

All collection sites are at North Dakota Department of Transportation (NDDOT) facilities. Open 9 a.m. to 3 p.m. (local time)

July 20	New England	11704 61st St. S.W.
July 21	Parshall	7198 38th St. N.W.
July 22	Kenmare	49501 422nd Ave. N.W.
July 23	Towner	401 Airport Road
July 28	Cando	7411 68th Ave. N.E.
July 29	Larimore	1524 Towner Ave.
July 30	Mayville	511 Highway 18 N.E.
July 31	Wyndmere	7775 Highway 18

To preregister and/or obtain plastic bags, please contact me for more information or visit the Project Safe Send website at www.nd.gov/ndda/program/project-safe-send.

Jeremiah Lien, (701) 328-1504 or (800) 242-7535
 Pesticide Outreach Specialist
 North Dakota Department of Agriculture
 600 E. Boulevard Ave., Dept. 602
 Bismarck, ND 58505
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GDCD Supports Agriculture Initiatives Throughout N.D.

Agriculture has been an important element of the Garrison Diversion Conservancy District's (GDCD) foundation since its 1960 inception. GDCD continues to develop, expand and enhance irrigation through its investment in agricultural initiatives. In particular, irrigation development near Turtle Lake is possible through utilization of the McClusky Canal.

McClusky Canal

The McClusky Canal, constructed as part of the authorized Garrison Diversion Unit, was designed to carry 1,950 cubic feet of water per second (cfs) to irrigate up to 250,000 acres, along with providing water for municipal and rural water systems. Through several reformulations, the authorized acres were decreased. Currently, 23,700 acres are authorized along the McClusky Canal through the Dakota Water Resources Act of 2000.

The McClusky Canal in central North Dakota has become a valuable resource to farmers looking to develop irrigation. The GDCD has assisted in developing nearly 4,000 irrigated acres within the McClusky Canal Irrigation Project, which is dedicated to utilizing Missouri River water from the canal. The GDCD provided the upfront investment for the project to determine irrigable land and complete initial design work for projects along or near the canal.

The largest portion of the irrigation project is the Mile Marker (MM) 7.5 Irrigation Project, which was completed in 2011. Five 250-horsepower pumps deliver water through the main transmission line, which consists of two 24-inch parallel lines, to irrigate approximately 3,500 acres near Turtle Lake.

Construction on the MM 49 Irrigation Project began in the fall of 2014 and was completed this spring. The project features a submersible pump station that can pump 1,700 gallons per minute. Two pivots will deliver water to approximately 270 acres.

The MM 10 Irrigation Project was constructed this year, with water deliveries commencing in early July. An 80-horsepower centrifugal pump on a floating structure will deliver water to approximately 158 acres in 2015, with a planned expansion to 225 acres in 2016.

In addition to new irrigation, an existing irrigation development, the MM 1.7 Irrigation Project, has transitioned from a temporary water service contract with the Bureau of Reclamation to a long-term water service contract with Garrison Diversion.

Benefits of the transition include access to lower-cost power for the “first lift” of the irrigation water and eligibility for a cost-share to expand the supply works. The project irrigates approximately 500 acres, with plans to expand to approximately 610 acres.

The GDCD is proud to support agricultural and irrigation research and development that helps provide widespread benefits to farmers while economically benefiting North Dakota.

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Soil Moisture Sensors: An Important Part of Irrigation Water Management

One of last month's articles, “Soil Water in the Root Zone,” reviewed fundamental concepts of soil moisture, including soil water content and soil water potential, measuring soil moisture by the gravimetric and feel methods, and where in the field to sample soil moisture. In this article, we discuss soil moisture measurement methods and sensors, and their application to irrigation water management.

Soil water **content** is the amount of water per unit weight or volume of soil and is a measure of the total amount of water present in a soil or available for crop use. Soil water **potential** is a measure of the energy status of the water in the soil, or how hard the plants must work to extract water from the soil. The relationship between soil water content and soil water potential is called the soil water retention curve, which is shown for three North Dakota soils in **Figure 1**.

Coarse-textured soils such as sands tend to have a lower soil water content than fine-textured soils such as loams and clays at the same soil water potential. For irrigation scheduling purposes, this means coarse-textured soils run out of crop-available water sooner than fine-textured soils.

Some soil moisture sensors measure soil water content, while others measure soil water potential. We will review a few types of sensors and discuss their advantages and disadvantages. Some example sensors are shown in **Figure 2**.

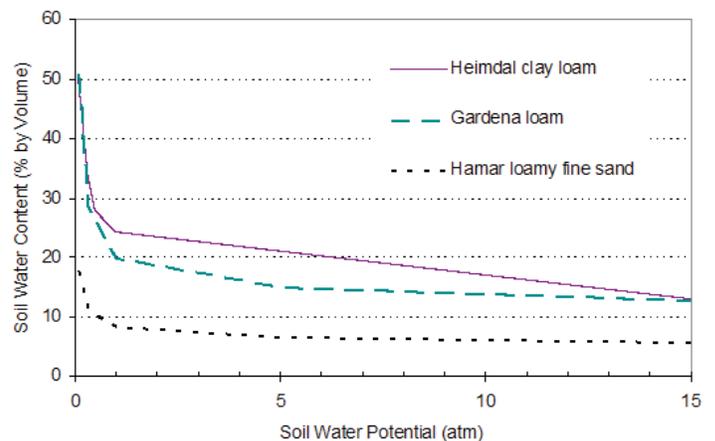


Figure 1. Soil water retention curves for three soils (from Cassel and Sweeney, 1976)

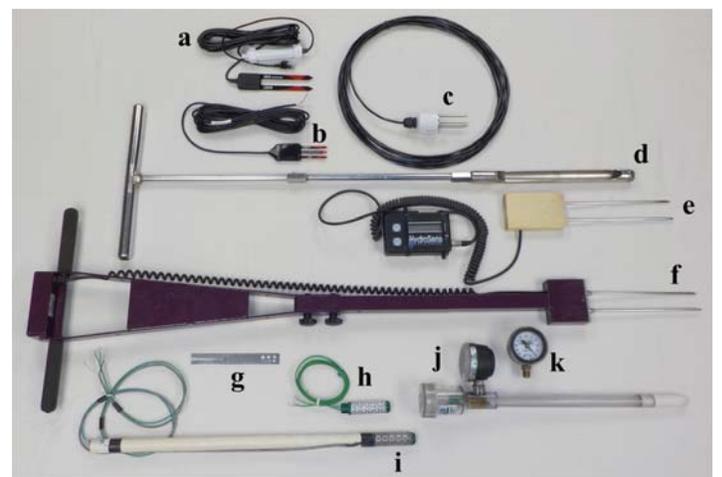


Figure 2. Examples of soil moisture sensors: a) Decagon 10HS; b) Decagon 5TE sensor for soil moisture, temperature and electrical conductivity; c) Stevens Hydra-Probe II for soil moisture, salinity and temperature; d) 3-foot soil probe; e) Campbell Scientific HydroSense; f) Spectrum Technologies FieldScout 300 TDR; g) 6-inch ruler to indicate sizes; h) Irrrometer Watermark block (a type of granular matrix sensor); i) Watermark block with PVC extension pipe and temperature sensor; j) Irrrometer tensiometer; and k) tensiometer vacuum gauge. (Disclaimer: Inclusion or exclusion of specific sensors does not imply endorsement or lack of endorsement by the author or NDSU. Trade names are the property of their respective owners.)

Soil water content methods and sensors

The "feel method" for estimating soil moisture was reviewed in last month's article. To obtain a sample from below the surface of the soil, a soil probe or shovel is required. A probe is useful because the soil core that is retrieved may indicate the depth to which irrigation or rain water moves into the soil. This boundary between wet soil on top and dry soil beneath it is called the wetting front.

In addition to **direct** measurements of soil water content such as gravimetric sampling, there are **indirect** measurements based on various physical properties of the soil-air-water mixture in which we grow crops. An example is the measurement of capacitance, an electrical property, by time domain reflectometry (TDR) or frequency domain reflectometry. The capacitances of soil, air and water all differ, enabling calibration of capacitance readings against gravimetric methods.

An example sensor consists of two parallel 8-inch-long stainless steel rods that are inserted into the soil. An electrical signal is sent into the rods or waveguides and reflected back into a sensing unit that measures the transmission time. This is converted into a soil water content value through a calibration provided by the manufacturer or developed by the user. Research-grade measurements with the TDR method can be quite accurate, but the equipment is expensive, typically costing several thousand dollars.

A hand-held sensor with a readout meter is a portable approach to capacitance measurements. Some of these sensors have stainless steel rods as part of the sensing unit that are inserted into the soil and a reading is obtained from the meter. The cost is about \$1,000 or somewhat more per unit. The units are easy to move from one location to another.

Other types of capacitance sensors have plastic sensing surfaces and are meant to be buried in the soil and used in fixed installations for the entire growing season. Often used for research, they range in cost from about \$140 to more than \$400 per sensor; additional costs are incurred for data-logging equipment.

A disadvantage is that while the manufacturer may provide a built-in calibration for direct readout of soil water content, the sensors may require a calibration for each soil type on which they are used.

Some capacitance-based systems monitor soil moisture at several depths in the profile at a single monitoring station. Several sensors are contained within a plastic pipe or tube installed in the soil profile. The sensors are left in place for continuous measurement of soil water content at multiple depths throughout the growing season.

An advantage of this type of sensor is that measurements deeper in the soil profile can be made without coring or digging every time you want to make a measurement. Another advantage is that these systems measure the total soil moisture in the profile and thus give good indications of the water available to the crop.

Neutron scattering is a soil water content measurement method commonly used in research, and to a limited extent, for very high-value crops. It is considered by many to be the best indirect method of soil moisture measurement.

It involves the installation of a vertical access tube – typically steel – in the soil, into which is placed a sensor-detector with a radioactive source of fast neutrons that are slowed or thermalized by hydrogen in the soil and detected by the unit. Because water contains hydrogen, a readout device can be calibrated against gravimetric methods to indicate soil water content.

Multiple access tubes often are installed in a field. This unit is lowered successively to various depths in each access tube, then removed for use at the next monitoring station or transported to a secure storage location. The cost may be several thousand dollars, and the unit's use and transport are regulated by the Nuclear Regulatory Commission.

Soil water potential methods and sensors

Tensiometers consist of a porous ceramic tip attached to the lower end of a tube that is inserted vertically into a hole bored into the soil. The top has a cap that can be removed to fill the tip, tube and reservoir with water.

When the soil dries, it pulls a small amount of water out of the tensiometer through the ceramic tip. This "pull" is registered on the vacuum gauge and is a direct indication of how hard the plant must work to extract water from the soil.

The cost is typically under \$100 per sensor. An advantage of tensiometers is that they directly measure soil water potential, while disadvantages include maintenance requirements, a limited operating range and damage to the unit in freezing conditions.

Granular matrix sensors and gypsum blocks use the principle of electrical resistance to measure soil water potential indirectly. Two electrodes are embedded in granular or gypsum material in the sensor head, which is buried in the soil at the desired depth. As the soil becomes wetter or drier, the electrical resistance of the material surrounding the electrodes changes. Lead wires to the surface are connected to a readout device for measurement.

Advantages include relatively low cost (\$35 to 39 per sensor and \$280 for a meter to read the sensors), simplicity and low maintenance. Limitations include sensitivity to changes in soil temperature, which may be accounted for in readout devices, and possible sensor degradation through time.

Irrigation trigger points

Irrigation scheduling consists of determining when and how much water to apply to the crop. The "when" question depends on the soil type and its water-holding capacity, the crop and the stage of growth.

From the standpoint of soil water content, checkbook irrigation scheduling recommendations for North Dakota are to avoid exceeding 50 percent depletion of the available soil water for corn and small grains, irrigating when depletions reach 35 to 40 percent of the available water for drought-sensitive crops such as potatoes, and allowing higher depletions for drought-tolerant crops such as sunflowers.

Using soil water tension as the basis for scheduling decisions, research in North Dakota has used a soil water tension of 50 centibars as a trigger point for corn and 30 centibars for potatoes (1 centibar = 1/100 of a bar, and 1 bar is slightly less than atmospheric pressure).



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this and other topics, see
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Additional considerations

Near-real-time access to sensor readings via cellphones and the Internet has been a big advance in recent years. Many companies have data-logging units, wireless capabilities or cellular communications that can be dedicated to measuring and recording soil water content or soil water potential data and provide features for transfer of the data to the Internet, mobile devices and computers.

The sensors and data loggers often have very low power requirements, which may enable the use of only a few batteries for the entire growing season. Users also may want to consider monitoring and logging rainfall and irrigation amounts, as well as soil temperature, all of which can be done at a relatively low cost.

Users of soil water sensors must consider location within a field and depth of installation when installing sensors. The user should recognize that the sensors mentioned here apply only to specific locations within the field rather than to large areas, so selecting representative locations, as discussed in last month's article, is important.

Sensors typically are placed between plants and in the crop row to avoid damage by wheel traffic and cultural operations. The sensors should be installed in the active rooting zone of the crop. For row crops, small grains and alfalfa, a sensor depth of 12 inches is common. A shallower depth may be used for drought-sensitive crops such as potatoes, for shallow-rooted

crops such as onions or early in the season when the crop's rooting depth is close to the surface.

If two sensors are used at a monitoring station, one may be placed 9 to 12 inches deep and another 18 to 24 inches deep. The shallow sensor will tend to change the most in response to crop water use and can be used to indicate when to irrigate, while the deeper sensor will help indicate whether irrigations and rainfall are sufficient to meet the needs of the crop.

What is important is to recognize the distinction between absolute measurements and relative changes in soil water content or soil water potential. The sensors described here may not provide a research-grade measurement of soil moisture without calibration, but with built-in memory, display screens or the ability to transfer data to the Internet and mobile devices, they allow the user to see recent data easily.

The ability of sensors and loggers to monitor trends in soil moisture is perhaps their most important feature for irrigation scheduling purposes. For example, if soil moisture readings indicate a drying trend, then recent irrigation and rainfall events have not been sufficient to meet the needs of the crop. If under- or overirrigation are indicated by soil moisture measurements, then adjustments can be made in irrigation scheduling decisions.

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