water spouts

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Upcoming Irrigation Workshops

- **Dec. 10, 2009 – Bismarck Best Western Ramkota Inn**
  This workshop is held in conjunction with the North Dakota Water Users Association's annual convention. The Missouri Slope Irrigation Development Association (MSIDA), NDSU Extension Service and North Dakota Water Users Association are sponsors. The convention will include an irrigation exposition where suppliers display their products and services.

- **Dec. 15, 2009 – Grand Forks**
  Contact Willie Huot, (701) 780-8229,
  Willie.Huot@ndsu.edu

- **Dec. 16, 2009 – Turtle Lake**
  Contact Mike Liane, (701) 652-2951,
  Mike.Liane@ndsu.edu

- **Dec. 17, 2009 – Ernie French Building**
  Williston Research Extension Center.
  Contact Chet Hill, (701) 774-4315, *Chet.Hill@ndsu.edu*

More information about the workshops will be in next month's issue of *Water Spouts* and workshop information will be mailed in November. If you have any suggestions for topics to cover at any of these workshops, please give me a call or send an e-mail.

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How to Estimate the Amount of Pumped Water

If you have an irrigation water permit, sometime this winter you will receive a notice from the North Dakota State Water Commission requesting a report of the amount of water you pumped for irrigation this past growing season. Here are three methods you can use to determine the volume of water pumped for irrigation, depending on your equipment:

1. **Do you have a working flow meter?**
   A working flow meter with a volume totalizer makes filling out the postcard easy. The volume totalizer is a counter similar to the odometer in a car. Some meters record the volume in either hundreds or thousands of gallons. Determining which one usually is easy because the manufacturer will show zeros to the right of the counter. If hundreds of gallons are recorded, the meter will have two extra zeros; it will have three zeros if it records thousands of gallons. If you wrote down the numbers on the volume totalizer at the start of the season, then all you need to do is read the meter again and subtract the numbers to obtain the volume pumped. You can report water use in either gallons or acre-feet. Just remember that an acre-foot of water covers an acre 1 foot deep and is equal to 325,800 gallons. An acre-inch is equal to 27,150 gallons.

2. **Do you have an hour meter on a center pivot or pump?**
   For a center pivot system, you can calculate an estimate of the amount of water pumped using the hour meter in the pivot control panel. However, you need to have written down the hour-meter reading at the beginning of the growing season. Subtract the current reading from the previous reading to get the number of hours the pivot operated this year. You then need to know your center pivot's approximate flow rate. This can be obtained from the center pivot sprinkler chart. Now that you know the flow rate, use the following formula to calculate the acre-feet of water that was pumped:

   Volume pumped = (hours of operation) x (gallons per minute) / 5,430

   For example, if your center pivot ran for 895 hours and the sprinkler flow rate is 800 gallons per minute, then the volume pumped is approximately:

   (895 x 800) / 5,430 = 131.9 acre-feet

   You also can use this method if you have a diesel or gasoline engine with an hour meter or an hour meter in the pump electrical control panel and know the average flow rate being pumped.

3. **You do not have a water meter or hour meter**
   If this is the case, estimating the volume pumped will be difficult. However, for electrically driven water pumps, you can obtain an estimate of the number of hours of operation using the electric meter. Modern electric meters not only record the total energy use in kilowatt-hours (kwh) but also other parameters such as peak kwh and average kwh use. You can estimate the total hours the pump was operated by dividing the total kwh used during the growing season by the average kwh. The seasonal total and average electric draw for each meter can be obtained from your electrical

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supplier. For instance, if your pumping plant used a total of 43,937 kwh and the average draw was 43 kwh, dividing 43,937 by 43 shows that the pump operated for 1,021.8 hours. Again, you need an estimate of the flow rate to calculate the total volume used. The calculated hours will be correct even if the electrical meter is recording the electricity used by the pump and a center pivot or if it is recording electrical use of just the pump. The extra electrical load of the center pivot is recorded in both the average draw and the total, so it doesn't affect the calculated hours of operation.

Estimating the volume of pumped water becomes very difficult where irrigation systems have one pump that supplies multiple pivots or multiple wells that supply a single or multiple center pivots. If you have difficulty estimating pumped water volume, consider installing a flow meter, or if you have a center pivot, recording the reading on the hour meter. You have other ways of estimating the volume of pumped water from electrical use, but they involve a few more calculations. Contact me if you have questions.

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2009 Postharvest Tips for Later Maturing Corn

Check corn maturity to estimate corn harvest and drying needs. Progression to maturity is very slow in October, even if a killing frost does not occur. The average growing degree days (GDD) during the first two weeks of October is about 100. In 2008, the first two weeks had 70 to 80 GDD.

The table at bottom summarizes information from various sources on corn development.

Standing corn in the field may dry about 0.3 to 0.4 percentage point per day during October and 0.15 to 0.2 or less per day during November. Corn at 35 percent moisture content on Oct. 1 might be expected to dry to about 24 percent by Nov. 1 and about 20 percent by Dec. 1. Immature corn dries more slowly in the field than mature corn. Frosted high-moisture corn can mold on the stalk.

Estimated Corn Field Drying

Month	EMC	GDD	PET	Estimate Drying (percentage points) Month	Week
	(%)		(in)		
Sept.	15	250-350	4.0-5.0	18	4.5
Oct.	16	100-125	2.8-3.5	11-12	2.5
Nov.	19	20-30	0.8-1.2	4-5	1
Dec.	20	0	0.5-0.8	2	0.5
Jan.	21	0	0.5-0.8	2	0.5
Feb.	21	0	0.5-0.9	3	0.8
March	19	0	1.3-1.6	5	1
April	16	50-90	3.2-4.5	16	4
May	14	200-300	6.5-8.5	30	7

PET = Potential Evapotranspiration, NDAWN, Weather, Total PET, Estimate: 1 inch = 4 percent drying

EMC = equilibrium moisture content

GDD = growing degree days

Field drying is extremely slow during winter months and corn will dry to only about 20 percent to 21 percent moisture content, based on the equilibrium moisture content for average monthly air temperature and relative humidity. Corn in the field through winter in 2008-09 dried from 25 percent to 30 percent moisture in November to 17 percent to 20 percent when harvested in February and early March. Corn losses generally were small if the corn stalk was strong in November.

Corn at moisture contents exceeding about 23 percent should not be stored in a grain bin because the kernels may freeze together and may deform and bind together. The corn may not flow from the bin for unloading. Corn above this moisture content should be placed so it can be removed with a front-end loader or some other machine that can dislodge the corn mechanically.

Providing aeration to keep the corn cool is critical. Wet corn will deteriorate rapidly unless kept cool. Corn will deteriorate even with airflow, but without airflow through the corn, it will increase in temperature, resulting in rapid deterioration. Condensation and icing occur on bin vents at temperatures near or below freezing, so leave bin covers open to serve as a safety opening when operating fans near or below freezing temperature.

Stage	Days to Maturity	GDD until Mature	Yield Loss	Test Weight	Grain Moisture Content
			(%)	(lbs/bu)	(%)
Dough	30-40	600-700	50-60	35-40	60-80
Early Dent	20-25	500-550	30-35	45-50	50-55
Full Dent	12-17	250-400	15-25	50-53	35-45
Half Milk Line	10-15	150-300	5-10	54-55	35-40
Mature	0	0	0	56	25-35

*GDD needed varies with corn RM and hybrid

Approximate Allowable Storage Time (Days) for Cereal Grains

M.C.	Temperature (F) 30	40	50	60	70	80
(%)						
14	*	*	*	*	200	140
15	*	*	*	240	125	701
16	*	*	230	120	70	40
17	*	280	130	75	45	20
18	*	200	90	50	30	15
19	*	140	70	35	20	10
20	*	90	50	25	14	7
22	190	60	30	15	8	3
24	130	40	15	10	6	2
26	90	35	12	8	5	2
28	70	30	10	7	4	2
30	60	25	5	5	3	1

Based on composite of 0.5 percent maximum dry-matter loss calculated on the basis of USDA research at Iowa State University; Transactions of ASAE 3330337, 1972; and "Unheated Air Drying," Manitoba Agriculture Agdex 732-1, rev. 1986.

* Approximate allowable storage time exceeds 300 days.

Corn above 21 percent moisture should not be dried using natural-air and low-temperature drying to minimize corn spoilage during drying. An airflow rate of 1.0 to 1.25 cubic feet per minute per bushel (cfm/bu) is recommended to reduce drying time. Because the drying capacity is extremely poor at temperatures below 35 to 40 degrees, little drying may be possible during the fall using a natural-air system. Cool the corn to 20 to 25 degrees for winter storage and start drying in early April. Adding heat does not permit drying wetter corn and only slightly increases drying speed. The primary effect of adding heat is to reduce the corn moisture content. Natural air drying in the spring is the most energy- and cost-effective method of drying. Corn depth should be limited to about 20 to 22 feet to obtain the desired airflow rate for drying. Turn fans off during extended rain, fog or snow to minimize the amount of moisture moved into the bin by the fan.

Using the maximum drying temperature that will not damage the corn increases the dryer capacity and can reduce energy consumption. The amount of energy required to remove a pound of water is about 20 percent less using a drying air temperature of 200 F rather than 150 F. Be aware that high drying temperatures may result in a lower final test weight and increased breakage susceptibility. In addition, as the drying time increases with high-moisture corn, the corn becomes more susceptible to browning. Dryer temperatures needed to be reduced below 200 F in 2008 to minimize the corn kernel damage.

Housekeeping during drying was critical during 2008 due to condensation occurring on the dryer, creating a wet surface for debris to accumulate. The debris sometimes reduced airflow through the dryer, reducing drying capacity and creating a fire hazard.

Use in-storage cooling instead of in-dryer cooling to boost capacity of high-temperature dryers. Cooling corn slowly in a bin rather than in the high-temperature dryer also will reduce the potential for stress cracks in the kernels.

In-storage cooling requires a positive pressure airflow rate of about 0.20 cfm/bu or 12 cfm/bu-hour of fill rate. Cooling should be started immediately after corn is placed in the bin from the dryer. Dryer capacity is increased 20 percent to 40 percent and about 1 percentage point of moisture is removed during corn cooling. Cooling the corn in the dryer to about 90 degrees before placing it in storage can reduce condensation problems.

A dryer that captures the heat from cooling the dry corn and a portion of the air from the final drying portion of the dryer can reduce the energy used to dry the corn by about 20 percent or more, depending on outdoor temperature. Newer dryers typically have incorporated features to make them more energy efficient than previous dryers.

The propane cost for high-temperature drying corn can be estimated using the following formula: cost/bushel-points = 0.022 x propane price/gallon. For example, the drying cost is $0.022/ bu-pt if the cost of propane is $1 (0.022 x $1). Propane will cost about $2 to remove 10 percentage points of moisture from 120 bushels of corn using $1 propane.

The estimated quantity of propane needed to dry is 0.02 gallon per bushel per point of moisture removed. For example, 24 gallons of propane is needed to dry 120 bushels of corn from 25 percent to 15 percent (0.02 x 120 bu x 10 pt) This is based on 0.72 pound of water being removed per point of moisture per bushel, 2,500 British thermal units (Btu) of heat required to remove a pound of water in a high-temperature dryer and a propane heat content of 91,500 Btu/gallon.

Moisture shrink is the reduction in weight as the grain is dried 1 percentage point. Moisture shrink factor = 100 ÷ (100 – final moisture content). The shrink factor of drying corn to 15.5 percent is 1.1834. The shrink factor of drying corn from 20.5 percent to 15.5 percent would be 5 x 1.1834 = 5.92 percent.

Moisture meters will not provide accurate readings on corn coming from a high-temperature dryer. The error will vary depending on the amount of moisture removed and the drying temperature, but the meter reading may be about 2 percent lower than true moisture. Check the moisture of a sample and place the sample in a closed container for about 12 hours, then check the moisture content again to determine the amount of error. Moisture meter errors increase as corn moisture contents increase, so readings above 25 percent should be considered only estimates.

In addition, moisture meters are affected by grain temperature. If the meter does not measure the grain temperature and adjust the value automatically, then the adjustment must be done manually. Even if the meter does it automatically, cooling a sample in a sealed container to room temperature before measuring the moisture content is recommended. Then compare the moisture content of the room temperature sample to the initial sample to verify that the adjustment was done accurately.

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Moisture meters normally are not accurate when grain temperatures are below about 40 degrees. Place the corn sample in a plastic bag or other sealed container, warm it to room temperature and then measure the moisture content.

Normally, corn test weight increases about 0.25 pound for each point of moisture removed during high-temperature drying. However, the increase in test weight is affected by the amount of mechanical damage during harvest and the gentleness of the drying. Due to the high mechanical damage involved with harvesting 25 percent to 30 percent moisture corn and high drying temperatures used in 2008, test weight frequently did not increase during drying. Little or no increase in test weight will occur in immature or frost-damaged corn.

More fines are produced when corn is wet because more aggressive shelling is required, which causes more kernel cracking and breaking. The potential for stress cracks in kernels also increases during drying, which leads to more breakage potential during handling. In addition, immature corn contains more small and shriveled kernels. Fines cause storage problems because they spoil faster than whole kernels, have high airflow resistance and accumulate in high concentrations under the fill hole unless a spreader or distributor is used. Preferably, the corn should be screen-cleaned before binning to remove fine material, cob pieces and broken kernels.

Corn with damage to the seed coat and immature corn have a shorter storage life than mature corn. Therefore, cooling the damaged or immature grain in storage to about 20 to 25 degrees for winter storage is more important than for mature corn. Drying the corn a percentage point lower in moisture content is recommended. Checking the stored corn more frequently also is recommended, and immature or damaged corn is not recommended for long-term storage.

Ice accumulation on fans leads to imbalance and vibration. Fans disintegrated in 2008-09 due to this problem. Monitor fans for ice accumulation and remove the ice if it is observed.

Bridging of corn in a bin transfers more of the load to the bin wall, which may lead to bin failure. Follow recommended storage management to minimize the potential for crusting or bridging and watch for the grain flow when unloading.

Never enter a bin while unloading grain. Also, do not enter a bin to break up grain bridging. Two people lost their lives in 2008-09 due to grain entrapment, and several more narrowly escaped.

For more information, do an Internet search for NDSU corn drying.

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