Crop Science Investigation Workshop Series Lesson Plans

Subject: Agricultural Irrigation Management **Grade Level(s):** 4th – 12th grades
Lesson Title: When and how much should I irrigate?
Time period: 1-3 hours (depending on activities conducted)
This lesson can easily be adapted to address as few as one learning objective or all. Objectives and corresponding learning activities are numbered accordingly.

These lessons can be adapted for youth of any age depending on level of technical content taught. When working with youth of varying ages, it is suggested to have older youth help the younger ones.

Lesson Objectives:

1. Define and understand basic irrigation terminology.
2. Become familiar with problems associated with under or over-irrigating crops.
3. Understand & demonstrate how to use irrigation equipment for effective (corn and soybean) irrigation management.

Materials, audio-visual aids:	**Resources Used & Handouts**
3-4 corn/soybean plants in containers (if not available, use a potted plant of some kind that you don't mind if it dies) -1 healthy plant, 1 over-watered for about 3-4 days, 1 under-watered and starting to die Paper towels Pocket knife to cut plants ET gage Soil probe Watermark sensors & meter *Optional*: Powerpoint and equipment to supplement this lesson *Suggested*: Whiteboard, flipchart, something to write on so all youth can see or to illustrate any points ** Should start several activities for this lesson ahead of time!	Resources: Neb Guides/Circulars: C1904, EC783, G05-1579 Nebraska Irrigation Facts Sheet ET Gage NebGuide Watermark Sensors NebGuide Crops Growth Stage Charts (with ET) Soil Moisture Sensor Worksheet *Optional*: Youth Crops Power point

Solving the Problem

Interest Approach	*(PREP REQUIRED AHEAD OF TIME)*
Effects of Over Irrigation & Under Irrigation Activity	-Show youth three potted plants (healthy, flooded, drought) Try to not let youth see soil conditions. -What are the differences between these plants? -What types of conditions do you think were present for each type of plant? -What can we learn from these three plants? (Plants require a certain amount of water to thrive.)

Problem statement When and how much should I irrigate? 1. **Objective 1**: Define and understand basic irrigation terminology. Terms Used: - Irrigation - Irrigation management - Crop ET - Atmometer or ETgage - Soil Water Status - Watermark Sensors	By the end of this lesson, you should be able to answer the following problem statement and more. 1.1 Why did irrigation first start? (supplement the crop with needed water so it wouldn't die) 1.2 What is the economic impact irrigation has on Nebraska? (The University of Nebraska's Bureau of Business Research conducted an Economic Impact Study* in 2003, a drought year, to determine the impact of irrigated agriculture on Nebraska's economy. The actual net total economic impact was computed as more than $4.5 billion; adjusted to $3.6 billion for normal precipitation conditions.) 1.3 How do most producers decide when to irrigate? 1.4 What tools are they using to decide when to irrigate? Do you think those are pretty accurate? 1.5 Let's define some key irrigation terms to first understand how and what irrigation does. 1.6 **Irrigation**, (defined by Britannica) is the artificial supply of water to land, to maintain or increase yields of food crops, a critical element of modern agriculture. Irrigation can compensate for the naturally variable rate and volume of rain. 1.7 Proper **irrigation management** is required to maintain adequate soil moisture in the crop root zone for healthy plant growth and optimum yield. The objective of irrigation management is to establish proper timing and amount of irrigation for greatest effectiveness. It also helps reduce the potential for runoff and reduce soil erosion and pesticide movement into the surface and groundwater. 1.8 In order to understand irrigation management, there are two important concepts to understand in regards to crops: 1) Crop Water Use, also called Evapotranspiration and 2) Soil Water Status. 1.9 **Crop Water Use** (Evapotranspiration)The evapotranspiration (ET) process is a key variable in many disciplines including, • irrigation management, • crop growth, • hydrologic cycle,

	• plant physiology, • soil-plant-water-atmosphere relationships, • microclimate and surface interactions, and • drainage studies. • ET can be defined in a broad definition as the combined process of both evaporation from soil and plant surfaces and transpiration from plant canopies through the stomates to the atmosphere. • In the ET process, water is transferred from the soil and plant surfaces into the atmosphere in the form of water vapor. • Crop ET can be measured directly using advanced techniques. However, in practice, the most commonly used method of estimating the ET rate for a specific crop requires first calculating reference ET and then applying the proper crop coefficients to estimate actual crop ET. • In order to measure a crop's ET, an **atmometer** or **ETgage** can be used. • *(If available, show youth the ETgage and explain the basics of how it works.)* 1.10 **Soil water status** is an indication of the amount of water present in the soil profile and can be described in two ways: 1. Soil water content and 2. Soil water potential. Soil water potential determines availability of water to plants is is a direct indication of the energy required for plants to obtain water from the soil. • As water is removed from the soil, the remaining water molecules are bonded to soil particles and to other water molecules, and are not readily and easily removed from the soil by plants. Matric potential indicates the energy that must be available in the plants to extract water from the soil. • In general, more clay content in a soil, the greater the water content at any given matric potential. • **Watermark sensors** are used to measure soil moisture to determine irrigation timing and amount • One of the simple, economical, durable, and accurate sensors to monitor soil water status is the Watermark Granular Matrix sensor. The sensor operates on the same principles as other electrical resistance sensors. Water conditions inside the Watermark sensor change with corresponding variations in water conditions in

	the soil. These changes within the sensor are reflected by differences in electrical resistance between two electrodes imbedded in the sensor. Resistance between the electrodes decreases with increasing soil water. The new transmission material used in the sensor was designed to respond more quickly to soil wetting and drying cycles. 1.11 The Watermark sensors and ETgages can be used together quite well for irrigation management. If both tools are used together, the Watermark sensors can be used to determine when to initiate the first irrigation, based on the suggested trigger points in the Watermark EC for a given soil texture. • After the first irrigation, an ETgage can be used to estimate actual crop water use (ETa) since the last irrigation, using the reference ET (ETref) and crop coefficient (Kc) approach (i.e., ETa = ETref x Kc), to replenish the crop water needs on a weekly basis. For example, let's say the 35% depletion trigger point is reached by using the Watermark Sensors and the irrigation system is turned on to apply 1" of water. You will then go to the ET gage and move the second red ring 1" below where the current water line is. When the water level depletes in the ETgage to where the second red line is, then you know it's time to irrigate again. If you receive a rainfall event before the water level reaches the second red ring, simply move the ring down for the amount of what you feel the effective rainfall was. For example, if you received 0.5 inches, move the ring down another 0.5 inches so your new trigger is set on the ETgage. • The Watermark sensors can be used again to determine the timing of the last irrigation. Between the first and the last irrigation, ETgages can be used alone to make irrigation management decisions. Using the ETgage irrigation management between the first and last irrigations can have an advantage since a producer does not have to make a trip to the field to read the Watermark sensors on a weekly basis. • *(If available, show youth the Watermark Sensors and explain the basics of how it works.)* • (Depending on age of youth, can go into more detail using NebGuides, etc.)

2. **Objective 2:** Become familiar with problems associated with under or over-irrigating crops.	2.1 Ask youth if too much of a good thing can happen, whether its that they eat too much of a healthy food. i.e. apple, etc. (Everything needs to be in balance; think back to the demonstration at the beginning of lesson with over water, underwater, etc. plants) 2.2 The impact of excess water on crop growth and yield is influenced by crop type, soil characteristics, duration of excess water or flooding, initial soil water and nitrogen status of the soil before flooding, crop stage, air temperature, etc. 2.3 What happens to crops that receive excess water? (they will "drown" out b/c they need oxygen to survive) 2.4 Adopting proper irrigation management strategies can reduce negative impacts of over-irrigation and provide a balance between the crop water requirements and available water. Over-irrigation leads to water loss, increases energy use for pumping, causes leaching of nitrogen and other micronutrients and wastes time.
3. **Objective 3**: Understand & demonstrate how to use irrigation equipment for effective (corn and soybean) irrigation management.	**PREP AHEAD OF TIME:** 3.1 If possible, have youth install an ETgage and Watermark Sensors (or have some already installed), and have youth take readings. AND/OR Have a bucket(s) of soil with varying moisture levels. Have youth read the watermark sensors and interpret if they would irrigate or not based on those readings. 3.2 Interpret what those readings mean for the crop. Is it wet/dry? Is irrigation needed? 3.3 Go to the water.unl.edu website; check out what the most recent ET readings were. **Additional Activity:** Encourage youth to keep track of rainfall with the "crop rainfall worksheet" on pg. 41 of ISU Crops 1 manual. How did the amount rainfall affect the crops growth?

Summary (Closure) – Conclusion to the Problem:

What is the importance of irrigation in Nebraska and when should I irrigate?

Review:

1. What is a definition of irrigation management?
2. Why is it important to irrigate efficiently and how can you be effective?
3. Define and understand basic irrigation terminology.
4. What are problems associated with under or over-irrigating crop?
5. What are two tools used to irrigate crops/soybeans?

References:

Irmak, S., & Rathje, W. R. (2008). *Plant Growth and Yield as Affected by Wet Soil Conditions Due to Flooding or Over-Irrigation*. Extension NebGuide, G1904. University of Nebraska-Lincoln Extension.

Irmak, S., J.O. Payero, D.E. Eisenhauer, W.L. Kranz, D.L. Martin, G.L. Zoubek, J.M. Rees, B.S. VanDeWalle, A.P. Christiansen, and D. Leininger. 2006. *Watermark granular matrix sensor to measure soil matric potential for irrigation management*. Univ. of Nebraska Extension Circular

Irmak, S., J.O. Payero, and D.L. Martin. 2005b. *Modified Atmometers (ETgage) for irrigation management.* University of Nebraska-Lincoln Extension NebGuide, G05-1579.