

2015

Water Windmill Challenge



**4-H AG
INNOVATORS
EXPERIENCE**
PRESENTED BY MONSANTO



**NATIONAL 4-H
COUNCIL**



**THE OHIO STATE
UNIVERSITY**
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

MONSANTO



Teen Facilitator Guide

Welcome to the 4-H Ag Innovators Experience

Water Windmill Challenge!



As the Teen Facilitator for this activity, you will help youth learn that:

1. Water is critical to food production and every product we use.
2. Innovation and technology will enable agriculture to meet the food production needs of a growing population.
3. Efficiency in water usage and agriculture productivity requires the application of science, technology, engineering and math (STEM) skills.

Background

Millions of gallons of water go into every product we buy, use and throw away. It takes 24 gallons of water to make 1 pound of plastic . . . twice as much to make the plastic bottle as the water in the bottle. Whether it is the gas we put in our car, the hamburger we have for lunch or the t-shirt we put on for school, the important link is WATER! Only 1% of the water found on earth is considered safe for humans to drink and use. The rest is salty or frozen in the polar ice caps. We can't make more water, but we can all become better stewards of this important natural resource.

Agriculture innovation is increasing the efficiency of water usage needed to produce food while enabling fewer farmers to feed a growing population. Over the past 45 years, the human population has doubled. If current growth rates continue, in 80 years the U.S. population will be twice what it is now. Today, one U.S. farmer is able to feed 155 people and is the leading producer of more than 50 foods of importance to diets around the world. Technology and innovation drives agriculture's ability to feed more people on fewer acres while becoming more sustainable for future generations.

Every person and industry leaves a water footprint. The agriculture industry is reducing its water footprint through advancements in plant and animal genetics, engineering solutions, and adoption of alternative energy sources. The Water Windmill Challenge will enable youth to explore how to use innovation and technology to solve a water shortage problem created from limited rainfall and seasonal temperature fluctuations. Supplementing existing surface water sources is a real problem for livestock and crop farmers in the Midwest. Looking below the earth's surface to tap into ground water resources, allows farmers to continue to provide the water needed for their families, crops and livestock.

Advances in technology have made this easier. The traditional, mechanically powered windmills that dotted the land 150 years ago are being replaced by high-efficiency wind turbine generators. Sleek, aerodynamic designs with curved blades and heavy, gearless wind turbine motors generate power to pump water quickly and efficiently.

The notion of harnessing the wind as an energy source is not new. In fact, many early settlers used mechanically powered windmills for water pumping. Today, most windmills have transitioned from mechanical power to include a small turbine to generate electricity, which powers an electric water pump. Generally speaking, the higher the tower, the more power a wind system can produce (U.S. DOE, 2014). As a result, wind towers have evolved over time from traditional derrick style towers to modern tubular structures capable of reaching the more powerful winds at elevated heights. However, for the purposes of this learning activity we will utilize engineering principles to maximize the potential of the traditional derrick style tower.

Visit <http://energy.gov/eere/wind/frequently-asked-questions-small-wind-systems> for more info.

Human population
has grown from 2.5
billion people in 1950
to over 7.2 billion
today.



Track population growth at:
<http://www.census.gov/popclock>



The 4-H Water Windmill Challenge: Activity Preparation and Facilitation

PREPARING FOR THE ACTIVITY (1 hour)

STEP 1:

Familiarize yourself with the challenge (30 minutes - 1 hour)

- Watch the 4-H Water Windmill Challenge video: <http://4-h.org/about/partners/monsanto>
- Review the contents of the 4-H Water Windmill Challenge Kit.
- Read through this Guide, thinking through how you will facilitate each step of the activity.

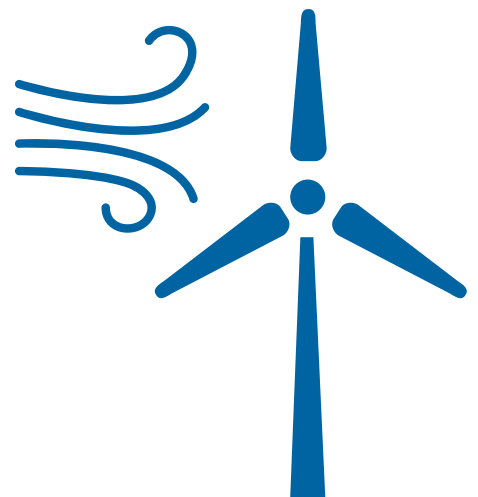
STEP 2:

Gather materials and set up the room (30 minutes - 1 hour)

- Sort contents of the 4-H Water Windmill Challenge Kit into the specified quantities for each team.
- Arrange the testing spot by placing two tables within 5 inches of each other.
- Make sure there is a water source in the room near the testing station sufficient for all teams to test their prototype.
- Get a mop, paper towels, or sponges to clean up any water spills.

Each 2 person team needs:

One 8 X 8 pegboard challenge pad
Access to the Crop-A-Dial Wood Punch provided with kit
Twenty craft sticks
Twenty cable ties
One pair of scissors
Ten 3/16 diameter dowel rods
Two pencils
Two push pins
Two pinwheel patterns
One lanyard





FACILITATING THE ACTIVITY (75 minutes)

STEP 1:

Present the challenge and hand out supplies (10 minutes)

- Using the Water Windmill Teaching Poster, tell the story of Happy Pastures Farm. Tell youth, “The farmer has hired your company, Wind Power Technologies, to engineer a derrick to support a high-efficiency, wind-powered generator for a new electric water pump.”
- Divide the group into teams of two, pairing younger participants with older participants.
- Describe the constraints of the challenge.
- Hand out supplies.

A derrick is a structure composed of a tower that holds and supports weight. It's typically seen on offshore drilling rigs.



The Problem

Happy Pastures is a 300-acre farm in the Midwest with 94 head of beef cattle. A hot, dry summer and low rainfall have slowed the farm's stream to a trickle. The old windmill that mechanically pumps water from the ground fails to keep up with demand. Happy Pastures barely has enough water for the cattle. The farmer wants to install a high-efficiency, wind-powered electric pumping system, but this requires replacing the existing derrick.

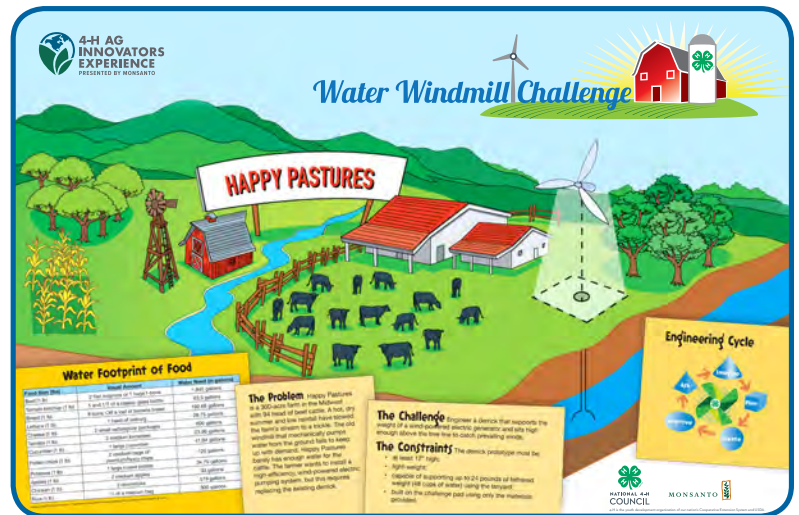
The Challenge

Engineer a derrick that supports the weight of a wind-powered electric generator and sits high enough above the tree line to catch prevailing winds.

The Constraints

The derrick prototype must be:

- At least 12" high;
- Light-weight;
- Capable of supporting up to 24 pounds of tethered weight (48 cups of water) using the lanyard;
- Built on the challenge pad using only the materials provided.





STEP 2:

Guide youth through the engineering task (45 minutes)

- Make sure the students understand the constraints of the challenge.
- Tell teams that for extra credit, they can attach the 4-H Water Windmill Challenge pinwheel.
- Remind youth of the Engineering Design Cycle.
- Invite teams to brainstorm solutions, sketch potential prototype designs, and discuss their merits.
- Direct teams to decide on a plan and begin building prototypes, using only the materials provided.
- Supervise teams as they test their prototypes and record their data. Teams may refine their designs and test them again if time allows.

ENGINEERING DESIGN CYCLE



EXTRA CREDIT:

Teams can assemble and attach the 4-H Water Windmill Challenge Pinwheel to their derrick prototypes.

QUESTIONS TO INSPIRE BRAINSTORMING:



How do engineers determine where to start when designing structures?

What structure shape would be strong enough to support 24 pounds (3 gallons) of water?

How can the weight of the prototype be minimized without compromising strength?

What are some possible ways to brace the structure using the available materials?

What are some ways to ensure that the structure is sturdy and won't break with the tethered weight?

Where on the derrick should the lanyard be attached so that the hanging water-weight will be evenly supported by the structure?



STEP 3:

Compare and Celebrate Results

- Call everyone to attention and discuss the teams' results. The highest final scores indicate the most successful designs.
- As a group, identify unique features of derricks with the highest scores.
- Discuss ideas for a final design to present to Happy Pastures Farm.
- Ask the group what they learned about the relationship between water and agriculture.
- Ask the group why it is important to conserve water.

STEP 4:

Wrap-up

- Recognize and thank Monsanto and the National 4-H Council, sponsors of the Water Windmill Challenge.
- Direct youth to complete the required student evaluations.
- Fill out the 4-H Water Windmill Challenge Participant Group Data Collection Sheet.
- Congratulate yourself on a job well done!

Created by:

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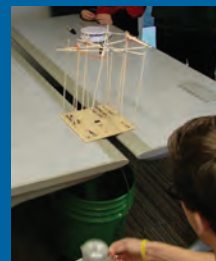
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AT THE TESTING STATION

- Remind teams to attach the lanyard to the derrick prototype with the metal clip passing through the hole on the challenge pad.
- Weigh each derrick with the challenge pad and lanyard attached. Using a marker, write this weight (in grams) along with the team number on each team's challenge pad.
- Position the challenge pad over the opening between the tables. Then attach the handle of the bucket to the lanyard's metal clip.
- Add water to the bucket one cup at a time to the bucket until you reach the maximum of 48 cups (3 gallons) or until the structure collapses.
- Note the number of cups the derrick was able to support. Multiply this number of cups by 237 to convert it to grams of water weight.
- Record the water weight in grams that each prototype was able to hold on the Challenge Results Score Sheet.
- Encourage teams to talk over what worked and what didn't in their design.



4-H Water Windmill Challenge

Dear Participant:

You are being given this survey because you are part of a 4-H program or project, and we are surveying young people like you to learn about your experiences.

This survey is voluntary. If you do not want to fill out the survey, you do not need to. However, we hope you will take a few minutes to fill it out because your answers are important.

This survey is private. No one at your school, home, or 4-H program or project will see your answers. Please answer all of the questions as honestly as you can. If you are uncomfortable answering a question, you may leave it blank.

This is NOT a test. There are no right or wrong answers, and your answers will not affect your participation or place in the program in any way.

Thank you for your help!

Section I: Water Windmill Challenge

Please indicate how much you agree or disagree with each statement (Select one response in each row by marking the appropriate box).

	Yes	Kind of	No
Did you think it was important to work in a group to accomplish the task during the Water Windmill Challenge?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I had to use communication skills with my team in order to accomplish the Water Windmill Challenge?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I think water windmills are a good way to increase food production for our world to have more food?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am more interested in science and agriculture after participating in the Water Windmill Challenge?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have a better understanding of how to design and create an object to solve a problem after participating in the Water Windmill Challenge?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Section II: Tell us about You

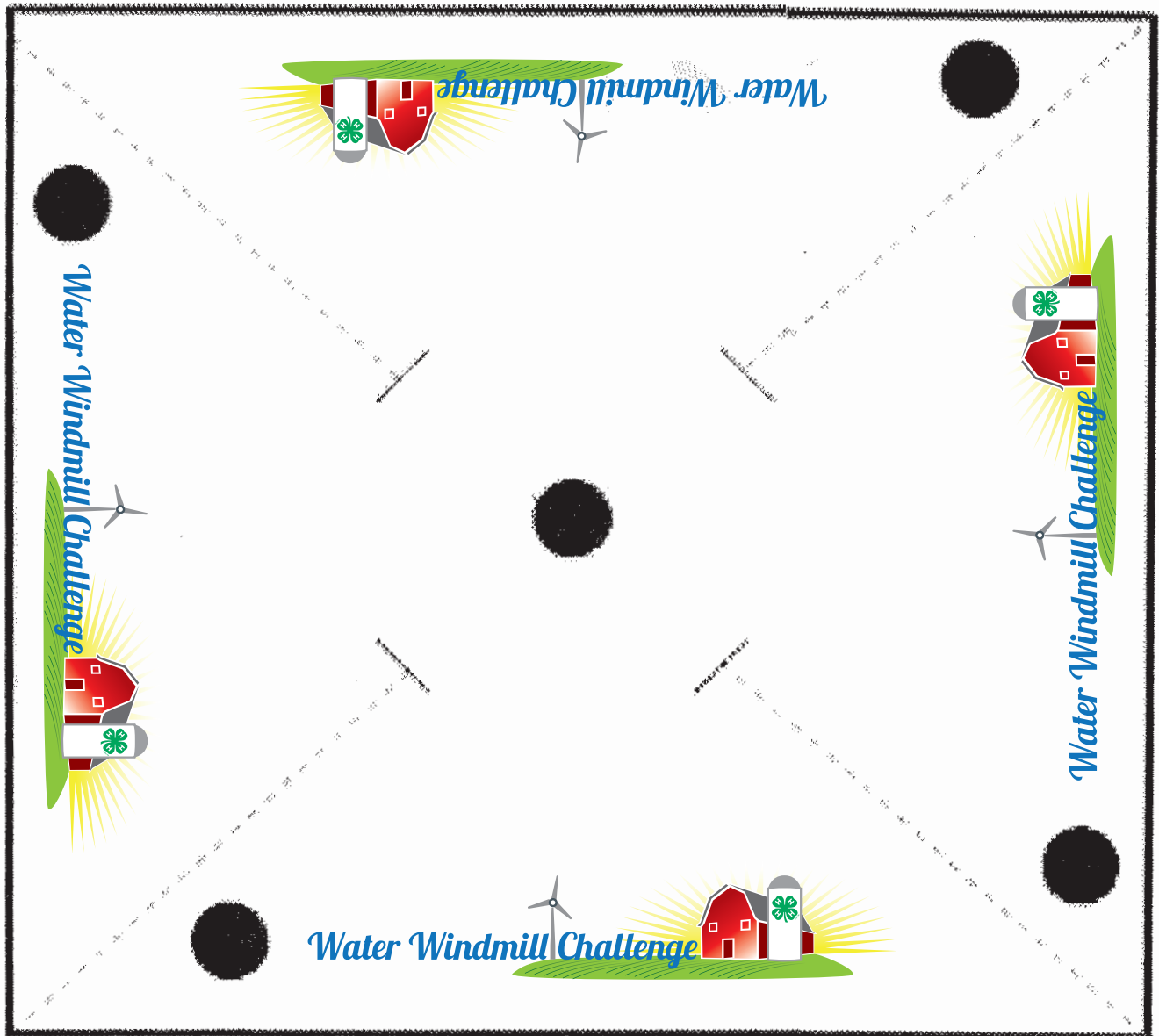
- How old are you? _____ Age (in years)
- Which of the following best describes your gender? (Mark **one** box). Female Male
- Which of the following best describe your race? (Mark **each** box that applies to you.)
 - American Indian or Alaskan Native
 - Asian
 - Black or African American
 - Native Hawaiian or Other Pacific Islander
 - White
- Which of the following best describe your ethnicity? (Mark **one** box).
 - Hispanic or Latino
 - Not Hispanic or Latino
- Which of the following best describes the primary place where you live? (Mark **one** box).
 - Farm
 - Rural (non-farm residence, pop. < 10,000)
 - Town or City (pop. 10,000 – 50,000)
 - Suburb of a City (pop. > 50,000)
 - City (pop. > 50,000)





Appendix: 4-H Water Windmill Challenge pinwheel pattern

Instructions: Cut out the 4-H Water Windmill Challenge pinwheel pattern along the black lines, then cut along the dotted lines. Next, gather the corners by aligning each corner dot with the center dot. Place a push-pin through all dots into the eraser end of a pencil. Attach the pinwheel to the top of the derrick prototype.





Monsanto is a sustainable agriculture company that delivers technology-based solutions and agricultural products that support farmers all around the world. As the population increases and access to land and water for agriculture decreases, Monsanto remains focused on enabling farmers to produce more from their land while conserving the world's natural resources. Monsanto is supporting the 4-H Ag Innovators Experience because today's participants will provide tomorrow's foundation for a prosperous, knowledgeable and innovative agricultural workforce. Visit <http://www.monsanto.com> for more information, read the company blog at <http://www.monsantoblog.com>, and follow us on Twitter: <https://twitter.com/MonsantoNews>.

Thank you notes should be addressed to:

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4-H is the youth development organization of our nation's Cooperative Extension System and USDA.