FARM FORECAST

Multi-Week Challenge Guide

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Challenge Rationale

Farmers rely on the weather every single day. Rainfall, temperature, wind speed, and air pressure determine when seeds go in the ground, how crops grow, and when to harvest. A sudden storm or an unexpected drought can mean the difference between a healthy crop and a devastating loss. In 2023 alone, the United States' droughts, excessive heat, and flooding accounted for more than $16.6 billion in agricultural losses.

By building and testing simple weather instruments, students explore how atmospheric conditions shape local weather and why monitoring them is vital for agriculture. Like professional meteorologists, students will collect data, track patterns, and make decisions that protect crops, conserve resources, and ensure food security. Small, homemade tools such as barometers, rain gauges, anemometers, hygrometers, and thermometers mirror data collection strategies used on farms worldwide and connect science to real agricultural challenges.

Establishing The Challenge

Identify a Challenge

In this challenge, students will design, build, and calibrate one or more simple weather instruments (e.g., air pressure, wind speed, rainfall, temperature, or humidity). Over a set period, they will monitor and record local weather, analyze patterns, compare their measurements with trusted sources, and explain how farmers could use those data (e.g., timing field work, adjusting irrigation, protecting seedlings). The final product should demonstrate both the instrument's functionality and the value of weather monitoring for farming.

CHALLENGE QUESTION

How can we build a simple, accurate weather tool, prove it works, and use its data to make a real recommendation a farmer would trust?

THIS SOLUTION MUST ADDRESS THE FOLLOWING NEEDS:

To meet the challenge, students must create functional instruments that measure a specific atmospheric condition or variable. They are expected to record, organize, and analyze consistent, usable, and collected data over time. Their findings must demonstrate how their data could inform agricultural decision-making.

SUCCESS WILL BE DETERMINED BY:

Success in this challenge will be demonstrated by students' ability to build an instrument that accurately and reliably measures the intended atmospheric condition. Students analyze and interpret their data, showing patterns and making short-term predictions. In addition, the final presentation connects weather monitoring to farming practices such as irrigation scheduling, field preparation, or planting decisions. Student designs are durable, practical, and realistic for potential field use. Their final poster product and presentation should clearly connect the scientific principles of weather to agricultural challenges and show how this understanding can guide responsible farming decisions that impact crop growth.

Standards Addressed

Next Generation Science Standards

nextgenscience.org

– MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

– MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

– MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

Standards Addressed

COMMON CORE STANDARDS

corestandards.org/mathematics-standards

- CCSS.MATH.CONTENT.6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that expressions in different forms can represent the same number.
- CCSS.MATH.CONTENT.6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.
- CCSS.MATH.CONTENT.6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
- CCSS.MATH.CONTENT.6.SP.C.5 Summarize numerical data sets in relation to their context, such as by:
  - Reporting the number of observations.
  - Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.
  - Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation).
  - Describing any overall pattern and any striking deviations from the overall pattern with reference to the context.
  - Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.

Standards Addressed

corestandards.org/english-language-arts-standards

- CCSS.ELA-LITERACY.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.
- CCSS.ELA-LITERACY.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- CCSS.ELA-LITERACY.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
- CCSS.ELA-LITERACY.WHST.6-8.1 Write arguments focused on discipline-specific content.
  - Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
  - Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.
  - Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
  - Establish and maintain a formal style.
  - Provide a concluding statement or section that follows from and supports the argument presented.
- CCSS.ELA-LITERACY.WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
  a. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories.
  - Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
  - Use appropriate transitions to clarify relationships among ideas and concepts.
  - Use precise language and domain-specific vocabulary to inform about or explain the topic.
  - Establish and maintain a formal style and objective tone.
  - Provide a concluding statement or section that follows from and supports the information or explanation presented.
- CCSS.ELA-LITERACY.SL.8.4 Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

Guiding The Challenge

Each Purple Plow Challenge can be implemented using various methods, time frames, and programs. Follow the steps below to help determine how this challenge best fits the current situation and educational environment.

1. REVIEW the Purple Plow "Design Process" (next page) and the "Lesson Packet" documents.
   Note that the lessons are encouraged but not required.

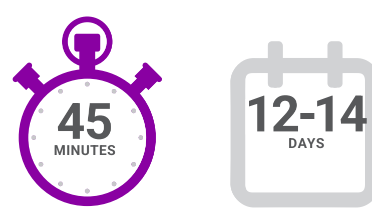
2. EXAMINE the suggested timeline to determine ways to integrate the challenge and lessons to fit your needs.

3. With the time frame in mind, USE THE GUIDANCE PROVIDED in this section to help students progress through the challenge. This guidance includes suggested student prompts, guiding questions for students, signs of step completion, and journaling opportunities. The student prompts, guiding questions, and journal prompts are found in the "Student Guide." Facilitators or students may determine the method by which they record their research and discoveries found for these prompts and journal reflection questions.

SUGGESTED TIMELINE

This sample pacing guide is created for a 90-day calendar with a 45-minute class. It is important to remember that timing may vary on student's pace, as well as how much time you dedicate to each of the steps listed below. Your students may return to certain steps and repeat the process, no journey is the same!

DESIGN PROCESS STEP	TIMELINE
Identify	2 days
Imagine	2 days
Design	2- 3 days
Create	2-3 days
Test & Improve	2 days
Share	2 days



You may need time beyond the allotted program time estimates above to fulfill the challenge's requirements. Possible options for competing include:

- Sending the related materials home with students wishing to compete (participating in regular progress monitoring of the project with the facilitator).
- Developing continuation options in an after-school or extra-curricular club with the facilitator.
- Including parents in the process of continuing the investigation (with an option of providing space at school to keep project materials).

Guiding The Challenge

Week-by-Week Breakdown

WEEK 1: EXPLORE WEATHER

- Introduction to weather and its importance in farming.
- Guided simulation using online resources, or classroom tools, to explore weather variables.
- Students use digital resources (e.g., local weather apps or data sets) to observe how rainfall, temperature, and wind impact farms and crops.
- **Deliverable:** Data table showing local weather observations and initial reflections on how weather affects farming decisions.

WEEK 2: DATA ANALYSIS AND SCIENTIFIC APPLICATION

- Construct and test simple models of weather instruments (e.g., rain gauges, thermometers, barometers, anemometers, hygrometers).
- Calibrate and begin collecting local weather data.
- Compare student-collected data with trusted professional sources.
- **Deliverable:** Working weather instruments and an initial data set with graphs showing early patterns or comparisons.

WEEK 3: APPLY TO AGRICULTURE

- Research how farmers use weather to make decisions about planting, irrigation, and harvest timing.
- Students brainstorm and sketch improvements to their instruments or data systems to better meet agricultural needs.
- Build refined or adapted weather models that simulate real farm decision-making tools.
- **Deliverable:** Revised instrument or data model and design sketch connecting weather data to a specific agricultural use.

WEEK 4: TEST, IMPROVE, PRESENT

- Test improved weather instruments for accuracy and consistency.
- Analyze final data for trends, predictions, and implications for farm management.
- Prepare and deliver a presentation including:
  - Key weather data and patterns
  - Explanation of how farmers could use this data
  - Demonstration or display of the final weather model/tool
  - Deliverable: Final presentation and functional weather instrument showing agricultural impact.

Challenge Design Process

STEP ONE

IDENTIFY

Define the problem and how it is affecting life globally, nationally, and locally. Research and consider how others have approached solving the problem. Describe why this problem needs a solution. Determine constraints (e.g., time, space, resources, etc.).

STEP TWO

IMAGINE

Brainstorm solutions to the problem. List all ideas – don't hold back! Discuss and select the best possible solution.

STEP THREE

DESIGN

Diagram the prototype. Identify the materials needed to build the prototype. Write out the steps to take. Describe the expected outcomes.

STEP FOUR

CREATE

Follow the design plan and build the prototype.

STEP FIVE

TEST & IMPROVE

Test the design and collect quantitative and qualitative data. Discuss results and compare with the expected outcomes. Seek areas of improvement and make changes where needed.

STEP SIX

SHARE

Communicate what was learned. Share the design, data, and conclusions. Present results.

Materials List

Suggested Materials List

The items listed below are suggested materials needed to conduct the challenge. Facilitators and students are encouraged to be creative and inventive in acquiring the materials needed to complete the challenge (e.g., purchased, recycled, donated, etc.).

FOR INSTRUMENTS OR MODELS:

- Rain Gauge: Clear cylindrical bottle/jar, ruler (mm), zip ties/stake, stones (stability), funnel (optional).
- Anemometer: 4-6 small cups, two straws, pencil/rod with eraser (pivot), pushpin, tape, stopwatch.
- Barometer: jar, balloon/latex, rubber band, index card, straw, tape (for pointer), reference scale.
- Thermometer (validation): standard liquid/digital thermometer (for comparison).
- Hygrometer (simple): human – hair or paper strip, pointer, scale (optional extension).

GENERAL AND DATA TOOLS:

- Scissors/craft knife, hot glue/tape, waterproof marker/labels, ruler/protractor
- Notebook or printed data sheets, or a spreadsheet for digital logs/graphs
- Access to a trusted reference (local weather station, extension/university network, or app) for validation.

FOR ENHANCED PRESENTATIONS:

- Poster board or trifold boards (for presenting findings)
- Colored paper, glue sticks, scissors (for visuals and models)
- Digital presentation tools (e.g., Canva, Google Slides)
- Stopwatches (for timing water flow if testing physical models)

Safety and Field Use Notes:

- Use caution with cutting tools/hot glue, and wear eye protection outdoors.
- Secure instruments to stakes/fences away from heavy traffic and livestock.
- Avoid metal objects and lightning; check wind chill/heat advisories.

STEP ONE

1 | IDENTIFY

Purpose of Step

Understanding the challenge question, why local weather data is essential for farming, and defining the challenge of building simple, accurate, durable instruments. Research to build background knowledge on weather and its agricultural applications. Describe why this problem needs a solution. Determine constraints (e.g., time, space, resources, etc.).

Student Prompts and Guiding Questions:

- Which weather variables most affect planting, irrigation, or harvest in our area?
- Why do farmers track rainfall, wind, and air pressure?
- How can local weather data guide planting and irrigation decisions?
- What instruments do professionals use, and what do they care about (accuracy, placement, consistency)?
- What limitations might farmers face without accurate data?
- Without good data, what risks do farmers take?
- What constraints do we face (time, cost, materials, location, safety)?
- What instruments do professional meteorologists and farmers use?

Signs of Step Completion

Students can explain how the weather affects farming and identify at least one condition (e.g., rainfall, wind speed) or variable they want to measure. Students can identify the ways weather can influence farming practices. They should generate a list of questions they want to investigate and create a hypothesis about the impact of weather on farming practices.

AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE STUDENT GUIDE.

STEP TWO

2 | IMAGINE

Purpose of Step

Brainstorm possible creative, low-cost design instruments/models that measure weather conditions using household or recycled materials to provide potential solutions to the challenge. Discuss the tools available and how they might be the best solution.

Student Prompts and Guiding Questions:

- What materials could reliably measure rainfall, wind speed, air pressure, temperature, or humidity?
- How does your homemade instrument compare to professional tools regarding accuracy, consistency, and design?
- How might we weatherproof and stabilize the device?
- What challenges might we face in designing these instruments?
- How can we make sure our tools are both accurate and durable?
- Which condition will be most valuable to measure for farmers?

Signs of Step Completion

Students sketch or describe at least two possible instrument designs and decide which to build first. They select an instrument to create (e.g., anemometers for wind speed, rain gauges for precipitation, thermometers for temperature, hygrometers for humidity, and barometers for atmospheric pressure).

AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE STUDENT GUIDE.

STEP THREE

3 | DESIGN

Purpose of Step

Develop a detailed blueprint of instruments, including data collection methods and success criteria. The plan includes variables, controls, data collection, and visual data representation.

Student Prompts and Guiding Questions:

- What is our measurement scale and unit (mm of rain, rpm to mph, rising/falling pressure)?
- What variables will you measure, and how will you record them?
- How will we calibrate (e.g., compare with a known thermometer, use a measured cylinder to check rain gauge marks, count revolutions vs. a timed wind speed chart, or test your instrument for accuracy)?
- How can you ensure your data can be collected consistently over time?

Signs of Step Completion

Students create a written plan or blueprint for their experiment or model. They define independent and dependent variables, prepare a data collection system, and define success indicators. They also make initial predictions about the expected results.

AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE STUDENT GUIDE.

STEP FOUR

4 | CREATE

Purpose of Step

Students build the instruments, calibrate, collect, and organize data.

Student Prompts and Guiding Questions:

- – Do repeated measurements match within our tolerance (e.g., +/- 1 0C Temp)?
- – What adjustments improve consistency (re-marking scales, leveling gauges, smoothing pivots)?
- – How does placement affect readings (wind shadow, splash in/out)?
- – Does your instrument give consistent readings?
- – What patterns have you seen in your data so far?
- – How does this tool compare to professional instruments?
- – If a farmer used this data, what decision/action could they make?

Signs of Step Completion

Physical models are built, tested, and refined based on usable data. With annotations or labels on their models/simulations, initial trends demonstrate evidence to support or disprove physical models.

AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE STUDENT GUIDE.

STEP FIVE

5 | TEST & IMPROVE

Purpose of Step

Students review their findings, refine their instruments, improve their model, and deepen their analysis of weather interactions and agricultural implications.

Student Prompts and Guiding Questions:

– What do your graphs show about changes over time?
– When you compare your data to a trusted source, how close is it? What explains the difference?
– How can you improve your design for more precise measurements?
– What design improvements would reduce error (shielding, leveling, sturdier mounts)?
– What patterns do your graphs reveal?
– Can your data predict a change in the weather?
– If a farmer used this data, what decision/action could they make?

Signs of Step Completion

Students revise their model or instrument setup and retest; a second data set is collected and compared to the first. They begin analyzing results to support a claim with evidence and reasoning and generate mathematical representations (e.g., line graphs, bar charts) to show weather patterns over time.

AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE STUDENT GUIDE.

STEP SIX

6 | SHARE

Purpose of Step

Students present their findings in a format explaining the relationship between weather and agricultural decision-making.

Student Prompts and Guiding Questions:

- How does the instrument measure your variable (mechanism and scale)?
- What patterns did you observe, and what do they suggest about local weather?
- How does your instrument work, and what condition does it measure?
- What patterns did you see in your data?
- How could a farmer use this information to better understand the impact of weather conditions on their crops or livestock?
- What improvements would you recommend for the next iteration of this instrument?

Signs of Step Completion

Students complete their poster presentation to explain their findings, including graphs, tables, claims, and real-world connections. Their explanation clearly ties weather to agricultural decision-making and explains the impact of weather on agricultural and farming practices. Compare data collected with professional weather apps or local stations.

AT THE COMPLETION OF THIS STEP, DIRECT STUDENTS TO THE REFLECTION QUESTIONS IN THE STUDENT GUIDE.

References

– **FAO.** (2019). Handbook on Climate Information for Farming Communities: What farmers need and what is available. Rome: Food and Agriculture Organization of the United Nations. Retrieved from: https://openknowledge.fao.org/server/api/core/bitstreams/9794a931-d49c-494e-82d5-577aec8fbab0/content

– **American Farm Bureau Federation.** (2025). Major Disasters and Severe Weather Caused Over $21 Billion in Crop Losses in 2023. Washington, DC: AFBF. Retrieved from: https://www.fb.org/market-intel/major-disasters-and-severe-weather-caused-over-21-billion-in-crop-losses-in-2023#:~:text=Updated%20crop%20and%20rangeland%20damage,NOAA's%20total%20economic%20impact%20figure.

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