CATTLE RANCH
RIDDLE

facilitator's guide

TABLE OF CONTENTS

Challenge Rationale

Challenge Rationale

There are multiple factors at play and many cattle ranchers must consider many things when running their operation. Today's beef is produced using fewer resources than ever before, but there is still more to be done. Through this challenge, students will become more aware of the intricacies of beef production. After thoughtful research to evaluate how these challenges exist globally, nationally, and locally, students will design, test, and demonstrate a solution that optimizes production as well as economic, environmental, and social needs.

Establishing the Challenge

Identify a Challenge

According to the United Nations, it's estimated there will be nearly 10 billion people on Earth by 2050.[1] That's three billion more mouths to feed than exists today, which means more food will need to be raised and grown to meet the food demands of a growing population. People around the world consume beef, particularly in the United States, because it has 10 essential nutrients, such as protein and iron, that are important requirements in our diets.[2] Cattle ranching families have to balance maintaining a profitable business that complies with current regulations with producing a safe and affordable product for a growing population, while at the same time, caring for the land and environment.

Challenge Question

How can we, as cattle ranchers, raise beef cows in a way that balances production as well as economic, environmental, and societal needs?

This solution must address the following needs:

- Production as well as economic, environmental, and societal needs

Success will be determined by

- Construction of a model of a cattle ranch (either cow-calf or stocker/backgrounder) that addresses best practices in the following areas:

  - Beef cattle health/welfare
  - Land and environmental management
  - Beef cattle nutrition
  - Costs of production

- Grazing plan

- Producing and sharing a presentation that communicates knowledge gained

- Sharing progress and results on social media by tagging @ThePurplePlow

Standards Addressed

Next Generation Science Standards

www.nextgenscience.org

- **5-LS2-1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

- **5-ESS3-1** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

- **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-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

- **MS-ETS1-4** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

- **MS-PS1-3** Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

- **MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

- **MS-LS2-3** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

- **MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

- **MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

- **MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

- **MS-ESS3-4** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

- **HS-ETS1-1** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

- **HS-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering

- **HS-ETS1-3** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

- **HS-LS2-7** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

- **HS-ESS3-1** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

- **HS-ESS3-2** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

- **HS-ESS3-4** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

- **RST.11-12.9** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Common Core Standards

- **CCSS.MATH.CONTENT.5.OA** Write and interpret numerical expressions.
- **CCSS.MATH.CONTENT.5.NBT** Perform operations with multi-digit whole numbers and with decimals to hundredths.
- **CCSS.MATH.PRACTICE.MP2** Reason abstractly and quantitatively.
- **CCSS.MATH.PRACTICE.MP4** Model with mathematics.

- **CCSS.ELA-LITERACY.W.5.7** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
- **CCSS.ELA-LITERACY.W.5.9** Draw evidence from literary or informational texts to support analysis, reflection, and research.
- **CCSS.ELA-LITERACY.W.6.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
- **CCSS.ELA-LITERACY.W.7.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content
- **CCSS.ELA-LITERACY.W.8.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
- **CCSS.ELA-LITERACY.SL.9-10.4** Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
- **CCSS.ELA-LITERACY.W.9-10.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- **CCSS.ELA-LITERACY.W.11-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Suggested Pacing Guides

Classroom Program

This sample pacing guide is created for a 90-day calendar with a 45-minute class.

Design Process Step	Timeline
Identify	5 days
Imagine	10 days
Design	10 days
Create	10 days
Test & Improve	50 days
Share	5 days

Summer School Program

This sample pacing guide is created for a 10-day calendar with a 3-hour block.

Design Process Step	Timeline
Identify	1 day
Imagine	1 day
Design	2 days
Create	2 days
Test & Improve	3 days
Share	1 day

AfterSchool Program

This sample pacing guide is created for two days a week for an 18-week semester.

Design Process Step	Timeline
Identify	2 days
Imagine	2 days
Design	2 days
Create	5 days
Test & Improve	21 days
Share	5 days

Materials List

Cattle Ranch Riddle
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.).

Materials Required	Suggested Material Options
Computer with internet access	Printer
	Variety of paper (e.g., poster board, presentation board, construction paper, etc.)
	Creative materials (e.g., scissors, glue, etc.)
	Coloring supplies
	Calculator
	Microsoft PowerPoint

Facilitating The Challenge

Facilitating The Challenge

Each Purple Plow Challenge can be implemented in a variety of methods, timeframes, and programs. Follow the steps below to help determine how this challenge will best fit the current situation and educational environment.

1. Review the Purple Plow "Design Process" and the "Lesson Packet" documents. Note that the lessons are encouraged, but not required.

2. Examine the suggested pacing guides to determine ways to integrate the challenge and lessons into your specific program.

3. With the timeframe 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.

1. IDENTIFY

PURPOSE OF STEP

Define the need and how it affects life globally, nationally, and locally. Research and consider how others have approached solving the need including how people have addressed this need historically. Describe why this challenge needs a solution and determine constraints (e.g., time, space, resources, etc.).

STUDENT PROMPTS AND GUIDING QUESTIONS

- Why is ranching an important occupation?
- What would happen if we ran out of food?
- Why is it important for food sources to be sustainable?
- What are the benefits of eating meat, and in particular, beef?
- How do we balance having affordable beef and having responsibly run cattle ranches?
- What are cattle ranching families already doing to balance the production as well as economic, environmental, and societal needs?

SIGNS OF STEP COMPLETION

Students will present a description of the challenge to the facilitator. The description should include how this challenge affects communities globally, nationally, and locally. The description should also include ways in which others have addressed finding a solution and constraints to be considered (e.g., time, space, resources, etc.).

At the completion of this step, direct students to the reflection questions in the "Cattle Ranch Riddle" student guide.

2: Imagine

PURPOSE OF STEP

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

STUDENT PROMPTS AND GUIDING QUESTIONS

- How much room do cattle need?
- Where do cattle sleep?
- What do cows eat?
- How much water is needed on a ranch?
- Can well-managed pasture systems improve soil quality?
- How can cattle ranchers prevent soil erosion?
- How can wildlife and cattle coexist on a farm?
- What can cattle ranchers do to maintain a profitable business?
- How can cattle ranchers take care of their sick animals and what can they do to prevent diseases?
- What are ways to manage herd health?
- How much does it cost to operate a cattle ranching business?
- How can we provide for beef cattle welfare?

SIGNS OF STEP COMPLETION

Students will present a list of possible solutions to the identified challenge to the facilitator.

At the completion of this step, direct students to the reflection questions in the "Cattle Ranch Riddle" student guide.

3: DESIGN

PURPOSE OF STEP

Diagram the model and identify the materials needed to build the model. Write out the steps to take and describe the expected outcomes.

STUDENT PROMPTS AND GUIDING QUESTIONS

- Where is the cattle ranch located and how many acres or hectares is it?
- Where and what will the cows eat?
- How will all of the cow's nutrition requirements be met?
- Where can the cattle access water?
- If the water source for the cows is a steam or pond, how can that water resource be protected?
- Do the cows have a place to get out of the elements?
- Where will the fencing be and what will it be made of?
- Who will help you run your cattle ranch?
- How often will your cows rotate through different fields?

SIGNS OF STEP COMPLETION

The students will present a detailed diagram of the prototype as well as a written plan of how it will be built. Look for the following in the plan: a materials list with budget (if building a physical model), detailed directions, and expected outcomes.

At the completion of this step, direct students to the reflection questions in the "Cattle Ranch Riddle" student guide.

4: CREATE

PURPOSE OF STEP

Follow the design plan and build the model or prototype.

STUDENT PROMPTS AND GUIDING QUESTIONS

- Use all research, knowledge gained, and the design plan to create the model.
- Repeat any of the previous steps should issues arise during the building process
- Consider the parameters of the challenge and what needs to be accomplished for a successful challenge.

SIGNS OF STEP COMPLETION

The students will build the model and share with the facilitator.

At the completion of this step, direct students to the reflections questions in the "Cattle Ranch Riddle" student guide.

5: TEST & IMPROVE

PURPOSE OF STEP

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

STUDENT PROMPTS AND GUIDING QUESTIONS

- How successful was your cattle ranch model in addressing the Cattle Ranch Riddle requirements?
- Were there any missing project components from your model?
- In what ways were local ingredients used to develop the menu?
- Were the sources of the one menu item ingredient identified accurately?
- Was the ranch budget calculated accurately?
- Based on their plan, would you feel comfortable buying beef from this ranch?
- What suggestions do you have for improvements to the model/plan?
- What changes will you make to your design based on feedback from your peer reviewers?

SIGNS OF STEP COMPLETION

The students will keep records of all test trials and share data with the facilitator. Entries should include both qualitative and quantitative data. The students will also share recordings of any improvements made to the design prototype and the effect they had on the outcome.

At the completion of this step, direct students to the reflections questions in the "Cattle Ranch Riddle" student guide.

6: SHARE

PURPOSE OF STEP

Communicate what was learned throughout the challenge. Share the design process, data, and conclusions on how the model answers the challenge question.

STUDENT PROMPTS AND GUIDING QUESTIONS

- How is your design approach an appropriate, innovative solution that realistically responds to the precise design competition problem?
- How does your design address budgetary constraints, timeline issues or other challenges?
- Describe and/or demonstrate what you learned from this challenge.

SIGNS OF STEP COMPLETION

The students will present what was learned through the design process including sharing how the prototype addresses the problem, key aspects of design, data from test trials, and end results.

Additional Resources

The resources listed below are links to additional information to help you and your students complete the Cattle Ranch Riddle Challenge.

CURRICULUM

Global Rangelands – *Rangeland Curriculum*
https://globalrangelands.org/k-12

Ag in the Classroom – *Beef Basics Curriculum*
https://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=284

Illinois Ag in the Classsroom – *All About Beef Curriculum*
http://www.agintheclassroom.org/TeacherResources/Lesson%20Booklets/AllAboutBeef_.pdf

Oklahoma Ag in the Clasroom – *Oklahoma Beef Cattle*
http://aitc.okstate.edu/lessons/beef/beef.html

GRAZING & PASTURE MANAGEMENT

National Resources Conservation Service – *Balancing Your Animals with Your Forage*
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1097070.pdf

Cattlemen's Beef Board and National Cattlemen's Beef Association – *Raising Beef*
https://www.beefitswhatsfordinner.com/raising-beef

The Pasture Project – *Develop a Grazing Plan*
http://pastureproject.org/pasture-management/developing-a-grazing-plan/

The Pasture Project – *Rotational Grazing Systems*
http://pastureproject.org/pasture-management/rotational-grazing-systems/

University of Wisconsin Extension Service – *Pastures for Profit: A Guide to Rotational Grazing*
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1097378.pdf

Additional Resources

ENVIRONMENT

Tiffany Nicole – *28 Ways Arizona Ranchers Care for the Environment*
https://arizonabeefblog.com/2017/04/21/28-ways-arizona-ranchers-care-for-the-environment/

Cattlemen's Beef Board and National Cattlemen's Beef Association – *Cattlemen and the Environment: Leading the way in Conservation and Preservation*
https://www.beefitswhatsfordinner.com/raising-beef/environment

Cattlemen's Beef Board and National Cattlemen's Beef Association – *Beef Sustainability: Balancing Environmental, Social and Economic Impacts*
https://www.beefitswhatsfordinner.com/raising-beef/beef-sustainability

HERD MANAGEMENT

Cattlemen's Beef Board and National Cattlemen's Beef Association – *Animal Care and the Modern Rancher*
https://www.beefitswhatsfordinner.com/raising-beef/animal-care

Kansas Beef Council – *Caring for Cattle on the Pasture*
https://www.kansasbeef.org/on-the-farm/caring-for-cattle-on-the-pasture

The Pennsylvania State University – *Common Diseases of Grazing Beef Cattle*
https://extension.psu.edu/common-diseases-of-grazing-beef-cattle

The Pennsylvania State University – *Beef Herd Health*
https://extension.psu.edu/beef-herd-health

The Pennsylvania State University – *Beef Cow-Calf Production*
https://extension.psu.edu/beef-cow-calf-production#section-6

The Pennsylvania State University – *Beef Background Production*
https://extension.psu.edu/beef-background-production

THIS RESOURCE IS BROUGHT TO YOU BY

AMERICAN FARM BUREAU
FOUNDATION FOR AGRICULTURE®

THANKS TO GENEROUS SUPPORT FROM

DU PONT

PIONEER

REFERENCES

[1]United Nations, Department of Economic and Social Affairs. (2017, June 21). *World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100.* Retrieved from https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html

[2]Cattlemen's Beef Board and National Cattlmen's Beef Association. (2018). *The nutrients you need with a taste you love.* Retrieved from https://www.beefitswhatsfordinner.com/nutrition/beef-nutrients