LEARNING EXPERIENCE FIVE

Guiding Question: When is farm mechanization considered efficient and sustainable?

This **Learning Source** and accompanying **Build Competencies** activities explore examples of innovation through precision agriculture and developments in tillage and irrigation. Students are encouraged to make connections between innovation and advancements to efficiency as well as impact on the environment. This **Learning Source** and **Build Competencies** activity can be introduced with **LEARNING EXPERIENCE FOUR** on **pages 49 to 51**.

This Learning Source provides starting points and information to investigate: • Machines and sustainability • How precision machinery works • Robotic crop farming • Irrigation technologies • Irrigation with precision agriculture Ask students to consider what they think the process involved in innovation involves – for example, designing and engineering agricultural machines and/or technology. Start with the "why" and what the motivation was for continued efforts to improve the way that machines and technology were used in agriculture. Share examples of the basic steps involved in an engineering design process: • Ask (identify a need or problem) • Research (research the problem, background) • Imagine (develop possible solutions and ideas) • Plan (develop the concept) • Create (create a prototype) • Improve (test and evaluate; redesign and test again) Have students propose what details and considerations go into each of these steps. How do they think farmers apply these steps? How do engineers who create agricultural technologies apply these steps? How are these steps similar to the scientific method? As students explore the Learning Source, challenge them to identify examples of the engineering design process.	Build Competencies: Connecting Precision Agriculture and Sustainability Students identify examples of sustainable mechanization, construct a device that models variable rate irrigation. This handout includes activities that support competencies, literacy and numeracy, and weblinks to online resources that can support student learning. ABC	Assess Look for evidence of understanding of the following concepts: • Sustainable mechanization • Precision agriculture • Systems and subsystems • Force and motion For a formative assessment, assess students' ability to analyze qualitative and quantitative data and develop explanations in the **variable rate irrigation lab** they complete in the Build Competencies lab activities.

Lab Preparation

This learning source provides instructions for a lab that simulates variable irrigation practices. Start by asking students to share what they know or have learned about the use of irrigation for any type of food production.

This lab was adapted from Increasing Food Production with Precision Agriculture Lesson Plan. National Agriculture in the Classroom: Online. https://agclassroom.org/matrix/lesson/513/. The lab adaptation was created and contributed by Matt Gunderson.

Preview the labs and gather the following lab supplies. Note that quantities of each of these supplies can vary across the four different labs in the **Build Competencies** handout.

- Biodegradeable foam or paper cups
- 250 ml beaker
- 100 ml beaker
- 100 ml graduated cylinder
- Water
- Regular size straws
- Jumbo straws
- Hollow coffee straws
- Slurpee straws
- Ruler
- Scissors
- Sharpie

Additional Research or Background Sources

Consult teacher or student background sources such as the examples that follow to further explore, enrich or expand activities for this guiding question. Student research sources are also provided in **Build Competencies** handouts.

The Policy Options website provides an article titled Sustainable agriculture and innovation at https://policyoptions.irpp.org/magazines/may-2017/sustainable-agriculture-and-innovation/ that can provide some perspectives and background on the scope of technological innovation, including irrigation practices, reduction of greenhouse gases and advanced digital technologies.

Another Policy Options article titled Look twice at the digital agricultural revolution, found at https://policyoptions.irpp.org/magazines/september-2017/look-twice-at-the-digital-agricultural-revolution/, can offer some social and ethical considerations connected to sustainable mechanization that can be shared and discussed with students.

Olds College shows how computers will revolutionize the way modern prairie agriculture is about to be carried out in the Western Producer article Smart Farm Helps Make High Tech Agriculture a Reality, found at www.producer.com/news/smart-farm-helps-make-high-tech-agriculture-a-reality/.

Resources on the Alberta Water Portal Society can support students in making the connection between the characteristics of a healthy ecosystem and the science that is applied to make decisions about water use; find them at https://albertawater.com/resources/. The Water Nexus, Energy, Food and People project. This website includes a case study that focuses on water sources for agriculture at http://albertawater.com/nexus-food/case-study-agriculture.

Additional information and discussion questions are provided in the carousel slide for this guiding question in the **sustainable** PRACTICES section of the **LEARN** webpage.

Click on the carousel slide to open and explore the following content.

- New technologies
- Changing tillage practices
- Irrigation practices

Find **Science 8** learning outcomes supported by this learning experience on the following page.

Use this activity to apply understandings of design and function, as well as force and motion to machines that are used in agriculture. Encourage students to consider the extent to which developing technologies in agriculture have improved efficiency - and through this - sustainability.

A Government of Canada article titled Managing crops sustainability with RADARSAT data is available at www.asc-csa.gc.ca/eng/satellites/radarsat/managing-crops-sustainably.asp.

Look on the **MEET A FARMER** webpage for video interviews with Alberta farmers. As students watch the videos, ask them to identify irrigation practices shared by Alberta farmers.

> ACCOMMODATE AND/OR EXTEND LEARNING

Challenge students to work in small groups to create a prototype of a machine that is used in agriculture. For example, students could design:

- A machine that includes a type of lever - see Simple Machines: Levers from Let's Talk Science at https://letstalkscience.ca/educational-resources/backgrounders/simple-machines-levers for some ideas and background
- A machine based on a hydraulic system - see Hydraulics 101 from Let's Talk Science at https://letstalkscience.ca/educational-resources/stem-in-context/hydraulics-101 for some ideas and background

Groups can also be encouraged to develop their own challenges. Organize students to allow their choice of machine and provide opportunities for them to share with each other or with the **project** AGRICULTURE community.

Learning Experience Five: LEARNING OUTCOMES AND COMPETENCY MAP

project AGRICULTURE Activity	**GRADE 8 SCIENCE**	
	CONCEPTUAL KNOWLEDGE	**PROCEDURAL KNOWLEDGE**
LEARNING SOURCES When is farm mechanization considered efficient and sustainable? **BUILD COMPETENCIES** Connecting Precision Agriculture and Sustainability	**Grade 8 Science Unit D: Mechanical Systems** 1. Illustrate the development of science and technology by describing, comparing and interpreting mechanical devices that have been improved over time • illustrate how a common need has been met in different ways over time (e.g., development of different kinds of lifting devices) 2. Analyze machines by describing the structures and functions of the overall system, the subsystems and the component parts • analyze a mechanical device, by: – describing the overall function of the device – describing the contribution of individual components or subsystems to the overall function of the device – identifying components that operate as simple machines 3. Investigate and describe the transmission of force and energy between parts of a mechanical system • build or modify a model mechanical system to provide for different turning ratios between a driving and driven shaft, or to achieve a given force ratio • describe fluid pressure qualitatively and quantitatively, by: - explaining how forces are transferred in all directions - describing pressure in units of force per unit area 4. Analyze the social and environmental contexts of science and technology, as they apply to the development of mechanical devices • illustrate how technological development is influenced by advances in science, and by changes in society and the environment Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., recognize that varied solutions to similar problems have been developed by different cultures throughout history; appreciate that different approaches to problems lead to different solutions, and that each may have merits for particular applications)	**Grade 8 Science Unit D: Mechanical Systems** Ask questions about the relationships between and among observable variables, and plan investigations to address those questions • identify practical problems (e.g., identify problems related to the effectiveness or efficiency of a mechanical device) • identify questions to investigate arising from practical problems (e.g., "What is the efficiency of this device?") • propose alternative solutions to a practical problem, select one, and develop a plan • select appropriate methods and tools for collecting data to solve problems (e.g., develop or apply appropriate methods for measuring speed ratios and force ratios; plan and conduct a search, using a wide variety of electronic sources) Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • select and integrate information from various print and electronic sources or from several parts of the same source • construct and test prototype designs and systems Analyze qualitative and quantitative data, and develop and assess possible explanations • evaluate designs and prototypes in terms of function, reliability, safety, efficiency, use of materials and impact on the environment (e.g., test and evaluate the efficiency and reliability of a prototype device to lift a given mass from the floor to a tabletop) • identify and evaluate potential applications of findings (e.g., identify possible applications of a simple machine or mechanical system they have studied) Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results • use specific language that is scientifically and technologically appropriate (e.g., use such terms as "system," "subsystem," "component" and "function" in describing a mechanical system) • communicate practical problems, plans and results in a variety of ways, using written and oral language, data tables, graphs, drawings and other means (e.g., describe, using pictures and words, the transmission of a force through a mechanical system)