

LEARNING EXPERIENCE SIX

Guiding Question: How is innovation making agriculture smarter?

<p>This Learning Source provides starting points and information to investigate:</p> <ul style="list-style-type: none"> • Modern farms • Environment • Innovation • Precision agriculture 	<p>Build Competencies: Global food security</p> <p>Students investigate connections between technology and climate-smart practices and investigate pros and cons of smart agriculture.</p> <p>This handout includes activities that support competencies, and weblinks to online resources that can support student learning.</p> 	 <p>Assess</p> <p>Look for evidence of understanding of the following concepts:</p> <ul style="list-style-type: none"> • Impact of modern agricultural practices • Impact of human activity <p>For a formative assessment, have students identify and investigate infographics about agriculture, selecting from those provided on the Agriculture and Agri-Food Canada, Statistics Canada or Agriculture More Than Ever websites. Ask students to identify facts that are presented on the infographic and select from questions such as the following to have students analyze its messages:</p> <ul style="list-style-type: none"> • What conclusions, if any, can be drawn from these facts? What messages are these infographics communicating? • How would you update or add to these facts with examples of innovation and agricultural technologies? • How are the messages in these infographics connected to the concept of smart agriculture?
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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 Agricultural Institute of Canada provides *An Overview of the Canadian Agricultural Innovation System* at http://aic.ca/pdf/AIC20170825_DC_CFL_Contextpiece_Short_version_FINAL_11.2.pdf. This paper is suitable as teacher background information, but some sections could be used with students.

The wild west of agricultural data, a background article on privacy concerns related to the use of computer technologies in agriculture, is found at www.producer.com/2018/12/the-wild-west-of-agricultural-data/.



A YouTube video on *Smart Farming: Data Enabling the Future of Agriculture* can be accessed at www.youtube.com/watch?v=LaMvMgdJC58. Note that this video is produced by 3M but offers some general information on data and technology.



An additional YouTube video on *The Future of Farming & Agriculture* provides a discussion on agricultural innovations at www.youtube.com/watch?v=Qmla9NLFBvU. This video comes from The Daily Conversation and is American but provides some global perspectives.



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

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

- A perspective and example of what **smart farms** can look like



Find **Science 9, Science 10** and **Science 14** learning outcomes supported by this learning experience on the following page.

Use this activity to focus on the concept of innovation and encourage students to dig deeper into the science and research that informs the uses of technologies and practices in agriculture. What is the role of innovation in addressing global challenges with loss of species diversity, climate change and food production? Have students investigate and compare examples of innovation in local, national and global contexts. Challenge students to assess the costs and benefits of technologies that mitigate climate change and food or agricultural waste.

After completing activities in this learning experience, have students reflect on the balance between technological innovation and the costs involved for both farmers and consumers. Encourage them to identify questions for further research and predict issues that can affect future applications of different technologies.



Look on the **VIEW** webpage for video interviews with Alberta farmers about technology and innovation. As students watch the video, ask them to identify perspectives shared by farmers.

Agriculture and Agri-Food Canada provides a series of infographics on agriculture at www.agr.gc.ca/eng/about-us/publications/discover-agriculture/infographics-agricultural-products-and-their-impacts/?id=1530198199592. Statistics Canada also provides some infographics focused on agriculture at <https://www150.statcan.gc.ca/n1/pub/11-627-m/index-eng.htm>.

Agriculture More than Ever also provides some infographics at www.agriculturemorethanever.ca/resources/infographics/.

Find an article that discusses insights into consumer perceptions of innovation in agriculture, based on a study carried out in eleven countries globally by Enough Movement. *Separating myths from facts: Understanding food labels and innovation in food production* can be accessed at www.bizcommunity.com/Article/196/358/168914.html. Some of the issues identified are similar to those faced by Canadians. The Enough Movement website focuses on food security and can be found at www.enoughmovement.com.

> EXTEND LEARNING

Challenge students to investigate and predict what the future of agriculture could look like. Ask them to identify examples of innovation and technologies currently used in agriculture or predict those that they envision could be used in the future.

Use a **Four Row Chart** for each example. Find this graphic organizer in **smart AGRICULTURE Project Tools**. For each example, have students describe the following:

- ◆ What it is
- ◆ What the benefits are
- ◆ What the limitations or challenges involved in its use
- ◆ What it looks like in action

Have students focus their examples around questions such as:

- ◆ How is the demand for different food products affected by the use of automated technologies?
- ◆ What implications for farmers and food production with the use of precision agriculture?
- ◆ How can technologies like GPS and drones increase the efficiency of food production and farming?
- ◆ What would a fitness monitor look like and do if it was used with livestock?
- ◆ How can genetic technologies assist with the protection of biodiversity or address climate change?




LEARNING EXPERIENCE SIX: LEARNING OUTCOMES AND COMPETENCY MAP

project AGRICULTURE Activity	GRADE 9 SCIENCE	SCIENCE 10	SCIENCE 14
	CONCEPTUAL KNOWLEDGE	CONCEPTUAL KNOWLEDGE	CONCEPTUAL KNOWLEDGE
LEARNING SOURCE How is innovation making agriculture smarter? [CONTINUED ON NEXT PAGE]	Unit A Biological Diversity 1. Investigate and interpret diversity among species and within species, and describe how diversity contributes to species survival <ul style="list-style-type: none"> Identify the role of variation in species survival under changing environmental conditions (e.g., resistance to disease, ability to survive in severe environments) 3. Describe, in general terms, the role of genetic materials in the continuity and variation of species characteristics; and investigate and interpret related technologies <ul style="list-style-type: none"> Describe, in simple terms, some genetic technologies (e.g., cloning and genetic engineering); and identify questions and issues related to their application 4. Identify impacts of human action on species survival and variation within species, and analyze related issues for personal and public decision making <ul style="list-style-type: none"> Evaluate the success and limitations of various local and global strategies for minimizing loss of species diversity (e.g., breeding of endangered populations in zoos, development of seed banks, designating protected areas, development of international treaties regulating trade of protected species and animal parts) Investigate and describe the use of biotechnology in environmental, agricultural or forest management; and identify potential impacts and issues (e.g., investigate issues related to the development of patented crop varieties and varieties that require extensive chemical treatments; identify issues related to selective breeding in game farming and in the rearing of fish stocks) Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues (e.g., strive to assess a problem accurately by careful analysis of evidence gathered; critically consider ideas and perceptions, recognizing that the obvious is not always right)	Unit D: Energy Flow in Global Systems 1. Describe how the relationships among input solar energy, output terrestrial energy and energy flow within the biosphere affect the lives of humans and other species <ul style="list-style-type: none"> Explain how climate affects the lives of people and other species, and explain the need to investigate climate change (e.g., describe the responses of human and other species to extreme climatic conditions; describe housing designs, animal habitats, clothing and fur in conditions of extreme heat, cold, dryness or humidity, wind) 4. Investigate and interpret the role of environmental factors on global energy transfer and climate change <ul style="list-style-type: none"> Describe the role of technology in measuring, modelling and interpreting climate and climate change (e.g., computer models, devices to take measurements of greenhouse gases, satellite imaging technology) Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues (e.g., view a situation from different perspectives, propose options and compare them when making decisions or taking action; evaluate inferences and conclusions with a critical mind and without bias, being cognizant of the many factors involved in experimentation) Work collaboratively in carrying out investigations and in generating and evaluating ideas (e.g., choose a variety of strategies, such as active listening, paraphrasing and questioning, in order to understand other points of view; consider a variety of perspectives and seek consensus before making decisions) Demonstrate sensitivity and responsibility in pursuing a balance between the needs of humans and a sustainable environment (e.g., recognize that human actions today may affect the sustainability of biomes for future generations; identify, without bias, potential conflicts between responding to human wants and needs and protecting the environment)	Unit D: Investigating Matter and Energy in the Environment 1. Describe how the flow of matter in the biosphere is cyclical along characteristic pathways and can be disrupted by human activity <ul style="list-style-type: none"> Assess the costs and benefits of technological developments that produce materials the ecosystem cannot recycle (e.g., disposable plastics, heavy metals) Identify and assess the needs and interests of society that have led to technologies with unforeseen environmental consequences (e.g., fishing technologies that result in harvesting more than the rate of reproduction, use of pesticides such as DDT, impact of driving a car on atmospheric compositions) 2. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium <ul style="list-style-type: none"> Trace the development of a technological application that has altered an ecosystem (e.g., power generation, fishing, logging, oil and gas exploration, agricultural practices) Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues (e.g., insist on evidence before accepting a new idea or explanation for waste reduction; insist that the critical assumptions behind any line of reasoning be made explicit, so that the validity of the position taken can be judged) Work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas (e.g., be attentive when others speak; suspend personal views when evaluating suggestions made by a group; be nonjudgemental in the discussion of ideas and plans) Demonstrate sensitivity and responsibility in pursuing a balance between the needs of humans and a sustainable environment (e.g., examine their personal role in the preservation of the environment; make personal decisions based on feelings of responsibility toward less privileged parts of the global community and toward future generations; participate in the social and political systems that influence environmental policy in their community)



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<p>[CONTINUED]</p> <p>LEARNING SOURCE</p> <p>How is innovation making agriculture smarter?</p>	<p>Unit A Biological Diversity</p> <p>Work collaboratively in carrying out investigations and in generating and evaluating ideas (e.g., choose a variety of strategies, such as active listening, paraphrasing and questioning, in order to understand other points of view; accept various roles within a group, including that of leader)</p> <p>Demonstrate sensitivity and responsibility in pursuing a balance between the needs of humans and a sustainable environment (e.g., consider implications of changing land use on the welfare and survival of living things; identify potential conflicts between attempting to meet the wants and needs of humans and, at the same time, providing life-supporting environments for all living things; minimize environmental impact during studies by avoiding sampling that will affect an animal or plant population)</p>		
	PROCEDURAL KNOWLEDGE	PROCEDURAL KNOWLEDGE	PROCEDURAL KNOWLEDGE
<p>BUILD COMPETENCIES</p> <p>Innovative science</p>  <p>[CONTINUED ON NEXT PAGE]</p>	<p>Unit A Biological Diversity</p> <p>Ask questions about the relationships between and among observable variables, and plan investigations to address those questions</p> <ul style="list-style-type: none"> Identify science-related issues (e.g., identify issues related to loss of species diversity) <p>Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data</p> <ul style="list-style-type: none"> Observe and record data, and prepare simple line drawings (e.g., compare two related plants by measuring, describing and drawing them) Research information related to a given issue (e.g., conduct an electronic search for information on factors that affect the reproduction and survival of wood frogs) <p>Analyze qualitative and quantitative data, and develop and assess possible explanations</p> <ul style="list-style-type: none"> Interpret patterns and trends in data, and infer and explain relationships among the variables (e.g., interpret data on changing animal populations, and infer possible causes) 	<p>Unit D: Energy Flow in Global Systems</p> <p>Ask questions about observed relationships, and plan investigations of questions, ideas, problems and issues</p> <ul style="list-style-type: none"> Identify questions to investigate that arise from practical problems and issues (e.g., develop questions related to climate change, such as “How will global warming affect Canada’s northern biomes?”; “How will a species be affected by an increase or decrease in average temperature?”) <p>Conduct investigations into relationships between and among observable variables, and use a broad range of tools and techniques to gather and record data and information</p> <ul style="list-style-type: none"> Select and integrate information from various print and electronic sources or from several parts of the same source (e.g., collect weather and climate data, both historic and current, from the Internet) 	<p>Unit D: Investigating Matter and Energy in the Environment</p> <p>Ask questions about relationships between and among observable variables, and plan investigations to address those questions</p> <ul style="list-style-type: none"> Identify questions to investigate arising from practical problems and issues (e.g., develop questions related to recycling, ozone depletion or introduction of exotic species) Select appropriate methods and tools for collecting data and information to solve problems (e.g., plan and conduct a search for environmental projects, using a wide variety of electronic sources) <p>Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data</p> <ul style="list-style-type: none"> Select and integrate information from various print and electronic sources (e.g., research the influence of a specific living organism— nitrogen bacteria, sulfur bacteria, sea birds, mollusks— on the cycling of matter through the biosphere, and communicate information in the form of a clearly written report; create a database or use spreadsheets to convey information on populations)



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	PROCEDURAL KNOWLEDGE	PROCEDURAL KNOWLEDGE	PROCEDURAL KNOWLEDGE
<p>[CONTINUED]</p> <p>BUILD COMPETENCIES</p> <p>Innovative science</p> 	<p>Unit A Biological Diversity</p> <p>Apply given criteria for evaluating evidence and sources of information (e.g., evaluate sources based on their currency, credibility and the extent to which claims are supported by data)</p> <p>Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results</p> <ul style="list-style-type: none"> Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means (e.g., illustrate and compare methods of reproduction in sample organisms studied) 	<p>Unit D: Energy Flow in Global Systems</p> <p>Analyze data and apply mathematical and conceptual models to develop and assess possible solutions</p> <ul style="list-style-type: none"> Compile and display, by hand or computer, evidence and information in a variety of formats, including diagrams, flow charts, tables, graphs and scatterplots (e.g., construct climate graphs to compare any two of the following biomes: grassland, desert, tundra, taiga, deciduous forest, rain forest) Identify and apply criteria for evaluating evidence and sources of information, including identifying bias (e.g., investigate the issue of global climate change) State a conclusion based on experimental data, and explain how evidence gathered supports or refutes the initial hypothesis (e.g., summarize an analysis of the relationship between human activity and changing biomes) Explain how data support or refute a hypothesis or a prediction (e.g., provide evidence for or against the hypothesis that human activity is responsible for climate change) <p>Work as members of a team in addressing problems, and apply the skills and conventions of science in communicating information and ideas and in assessing results</p> <ul style="list-style-type: none"> Synthesize information from multiple sources or from complex and lengthy texts, and make inferences based on this information (e.g., use integrated software effectively and efficiently to produce work that incorporates data, graphics and text) Identify multiple perspectives that influence a science-related decision or issue (e.g., consult a wide variety of electronic sources that reflect varied viewpoints and economic, social, scientific and other perspectives on global warming and climate change) Develop, present and defend a position or course of action, based on findings (e.g., a strategy to reduce greenhouse gas emissions caused by the transportation of people and goods) 	<p>Unit D: Investigating Matter and Energy in the Environment</p> <p>Analyze qualitative and quantitative data, and develop and assess possible explanations</p> <ul style="list-style-type: none"> Compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs and scatterplots (e.g., analyze population growth curve graphs; communicate information on the flow of energy through the biosphere, using a diagram or flow chart) State a conclusion, based on experimental data; and explain how evidence gathered supports or refutes an initial idea (e.g., explain, on the basis of experimental evidence, how energy is stored in the form of starch in photosynthetic organisms) Identify and evaluate potential applications of findings (e.g., experimentally determine the biodegradability of various forms of organic matter, and relate findings to composting and recycling) <p>Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results</p> <ul style="list-style-type: none"> Communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means (e.g., represent the movement of matter and energy in an ecosystem, using food chains, webs or pyramids, and communicate this information in the form of a graphic illustration; describe the biogeochemical cycles of carbon, nitrogen or oxygen, and communicate this information in clearly labelled charts, models or diagrams) Defend a given position on an issue or problem, based on their findings (e.g., investigate reduction of household wastes, or investigate ways to prevent the introduction of exotic species into Alberta or Canada)