## *Guiding Question: How do biodiversity and climate change shape smart agriculture solutions?*

This **Learning Source** provides starting points and information to investigate:

- Climate change
- Biodiversity
- Genetic diversity
- Climate and the food supply
- Greenhouse gas emissions
- Climate smart agriculture practices
- Food transportation

**Build Competencies: Policy influences**

Students use biodiversity data to assess risk and use climate data to make conclusions about climate change in a local area, predict its effect on biodiversity and explore farmer's perspectives on monitoring climate change.

This handout includes activities that support competencies and numeracy, and weblinks to online resources that can support student learning.

**Assess**

Look for evidence of understanding of the following concepts:

- Biodiversity risk
- Contexts for climate change
- Best biodiversity and climate-smart agriculture practices for animal health, food waste and transportation

For a formative assessment, ask students to identify a **case study example**, such as food waste, transportation or animal care and health. Use the **Cause and Effect Chart** to analyze and assess the impact of farming practices that result in risks or protect biodiversity and/or climate change.

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.

- Information on the goals of **climate-smart in Alberta** initiatives
- Perspectives about environmental farm management plans, addressing how egg farmers are **making a peep** and **thinking net zero**
- Insights into how dairy farmers are **keeping the environment in mind**, including a video explaining research on greenhouse gas emissions
- **Food movement**, including potential impact on climate change

## *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.

Initiate student discussion and thinking with a video and exploration of some issues related to smart agriculture and future technologies, such as in The Future of Livestock Farming from National Geographic at **www.nationalgeographic.com/science/2019/03/partner-content-livestock-farming-future/**. This video webpage provides information on issues and questions around livestock farming and explores the use of technologies.

The Alberta Environmental Farm Plan website at **www.albertaefp.com** provides resources that explain how farmers implement environmental farm plans. The Species at Risk webpage provides information on this biodiversity initiative at **www.albertaefp.com/species-at-risk**.

The Government of Alberta provides information and an assessment of biodiversity risk and agriculture on their Biodiversity Risk webpage at **www. alberta.ca/biodiversity-risk.aspx**. Data in different formats can also be accessed at **https://open.alberta.ca/opendata/93d539b5-e651-47eb-83f1-eef9eab460a4#summary**.

The Alberta Biodiversity Management and Climate Change website provides information and resources that focus on biodiversity and climate change resilience at **http://biodiversityandclimate.abmi.ca/**. An additional webpage on Biodiversity and Climate Change can be found at **www.abmi.ca/home/biodiversity/biodiversity-climate-change.html**. Encourage students to make connections to farming and food.

Find a thorough background report on biodiversity and climate change in the *Adaptation State of Play Report* at **www.ouranos.ca/publication-scientifique/Biodiversity-Adaptation-Working-Group-State-of-Play-Report.pdf**. This report provides some information specific to agriculture, including implementation of environmental farm plans in the context of biodiversity and climate change.

Find *Canada's Changing Climate*, a Government of Canada website and report about how and why Canada's climate has changed and what changes are projected for the future. Led by Environment and Climate Change Canada, it is the first report to be released as part of Canada in a Changing Climate: Advancing our Knowledge for Action. Access this resource at **https://changingclimate.ca/CCCR2019/**.

The article *Climate change and livestock: Impacts, adaptation, and mitigation*, found at **www.sciencedirect.com/science/article/pii/S221209631730027X** provides information about the impact of climate change on livestock farming as well as possible actions and is more suitable as a teacher background resource.

Agriculture in the Classroom Canada provides a resource on Food Waste, found at **https://aitc-canada.ca/en-ca/learn-about-agriculture/category/food/food-waste**.

Alberta Agriculture and Forestry's 2017 study and report on food waste can be accessed at **https://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/bt14879/$FILE/FWS2017.pdf**.

National Geographic provides the article *How Reducing Food Waste Could Ease Climate Change* at **www.nationalgeographic.com/news/2015/1/150122-food-waste-climate-change-hunger/**. This article includes information on reduction of greenhouse gas emissions.

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

Use this activity to explore the connections between biodiversity and climate change. Encourage students to focus on the concept of risks and risk management and to identify the practices and technologies that farmers are using to monitor risk and address sustainability.

Encourage students to explore conflicting points of view as well as the science and research involved in issues connected to biodiversity, climate change, food waste and animal health. How do these issues inform decisions about the types of "smart" agriculture practices that farmers implement. Compare these issues to information on environmental farm plans, increasingly implemented by many farmers.

After completing activities in this learning experience, have students reflect on the balance between the use of technologies and protection of the environment. What are the perspectives that shape different opinions about what this balance should be?

> **EXTEND LEARNING**

Ask students to discuss the decisions that they think farmers have to make on a daily basis to raise healthy animals, protect environmental resources and make a living. Have students focus on the conflicting points of view involved in balancing these types of elements, such as animal health, food safety, environmental impacts and economics, like food costs and farmer's ability to make a living.

Identify questions that are involved in this type of decision making, such as examples like the following:

◆ Should farm sizes be smaller to reduce the risk of disease, but potentially use more land and increase emissions?

◆ Should food transportation be limited to reduce emissions, at the risk of increasing food prices and making fewer foods available?

◆ Should more waste management practices be implemented on farms, at higher costs for farmers?

Group students and have them plan and prepare for a **horseshoe debate** focused on a question that students select. Have students prepare an argument for both sides of the debate and be prepared to present either side. Randomly arrange students in a horseshoe circle, identify which side each section of the circle will debate and provide each student with the opportunity to present their arguments and ask questions of the other side. Track participation and question/answer responses.

Students can use a **Triple T-Chart** or **Retrieval Chart** to collect and compare their data. Find these graphic organizers in **smart** AGRICULTURE **Project Tools**.

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

| project AGRICULTURE Activity | GRADE 9 SCIENCE | SCIENCE 10 | SCIENCE 14 |
|---|---|---|---|
| | **CONCEPTUAL KNOWLEDGE** | **CONCEPTUAL KNOWLEDGE** | **CONCEPTUAL KNOWLEDGE** |
| **LEARNING SOURCE**<br><br>How do biodiversity and climate change affect smart agriculture solutions?<br><br>[CONTINUED ON NEXT PAGE] | **Unit A Biological Diversity**<br><br>1. Investigate and interpret diversity among species and within species, and describe how diversity contributes to species survival<br><br>• Observe variation in living things, and describe examples of variation among species and within species (e.g., observe and describe characteristics that distinguish two closely related species)<br><br>• Identify examples of niches, and describe the role of variation in enabling closely related living things to survive in the same ecosystem (e.g., investigate different bird species found in a local park ecosystem, and infer how each is adapted to life within that ecosystem)<br><br>• Identify the role of variation in species survival under changing environmental conditions (e.g., resistance to disease, ability to survive in severe environments)<br><br>4. Identify impacts of human action on species survival and variation within species, and analyze related issues for personal and public decision making<br><br>• Describe ongoing changes in biological diversity through extinction and extirpation of native species, and investigate the role of environmental factors in causing these changes (e.g., investigate the effect of changing river characteristics on the variety of species living in the river; investigate the effect of changing land use on the survival of wolf or grizzly bear populations)<br><br>• 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) | **Unit D: Energy Flow in Global Systems**<br><br>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<br><br>• 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)<br><br>• Describe and explain the greenhouse effect, and the role of various gases—including methane, carbon dioxide and water vapour—in determining the scope of the greenhouse effect<br><br>3. Relate climate to the characteristics of the world's major biomes, and compare biomes in different regions of the world<br><br>• Identify the potential effects of climate change on environmentally sensitive biomes (e.g., impact of a reduction in the Arctic ice pack on local species and on Aboriginal societies that rely on traditional lifestyles)<br><br>4. Investigate and interpret the role of environmental factors on global energy transfer and climate change<br><br>• Investigate and identify human actions affecting biomes that have a potential to change climate (e.g., emission of greenhouse gases, draining of wetlands, forest fires, deforestation) and critically examine the evidence that these factors play a role in climate change (e.g., global warming, rising sea level(s))<br><br>• 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)<br><br>• Describe the limitations of scientific knowledge and technology in making predictions related to climate and weather (e.g., predicting the direct and indirect impacts on Canada's agriculture, forestry and oceans of climate change, or from changes in energy transfer systems, such as ocean currents and global wind patterns) | **Unit D: Investigating Matter and Energy in the Environment**<br><br>1. Describe how the flow of matter in the biosphere is cyclical along characteristic pathways and can be disrupted by human activity<br><br>• Compare the recycling of matter by society with the natural cycling of matter through ecosystems<br><br>• Assess the impact of modern agricultural technology on the natural pathways of recycling matter<br><br>• 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)<br><br>2. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors of the equilibrium<br><br>• Describe how various abiotic factors influence biodiversity in an ecosystem (e.g., climate, substrate, temperature, elevation)<br><br>• Explain how various factors influence the size of populations; i.e., immigration and emigration, birth and death rates, food supply, predation, disease, reproductive rate, number of offspring produced, and climate change<br><br>• Describe the relationship between land use practices and altering ecosystems (e.g., swamp drainage, slash and burn forestry, agriculture) |

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| **[CONTINUED]**<br><br>**LEARNING SOURCE**<br><br>How do biodiversity and climate change affect smart agriculture solutions? | **Unit A Biological Diversity**<br><br>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)<br><br>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) | **Unit D: Energy Flow in Global Systems**<br><br>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)<br><br>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**<br>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)<br><br>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) |
| | **PROCEDURAL KNOWLEDGE** | **PROCEDURAL KNOWLEDGE** | **PROCEDURAL KNOWLEDGE** |
| **BUILD COMPETENCIES**<br><br>**Smart data**<br><br>[CONTINUED ON NEXT PAGE] | **Unit A Biological Diversity**<br><br>Ask questions about the relationships between and among observable variables, and plan investigations to address those questions<br><br>• Identify science-related issues (e.g., identify issues related to loss of species diversity)<br>• State a prediction and a hypothesis based on background information or an observed pattern of events (e.g., predict changes to an area of local parkland that is subject to intense use; hypothesize means of impact, such as soil compaction and disturbance of nest sites)<br><br>Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data<br><br>• Observe and record data, and prepare simple line drawings (e.g., compare two related plants by measuring, describing and drawing them)<br>• 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) | **Unit D: Energy Flow in Global Systems**<br><br>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<br><br>• Use library and electronic research tools to collect information on a given topic (e.g., research sources of greenhouse gases; research protocols to control human sources of greenhouse gases)<br>• 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) | **Unit D: Investigating Matter and Energy in the Environment**<br><br>Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data<br><br>• Carry out procedures, controlling the major variables (e.g., perform quantitative experiments to demonstrate that cellular respiration releases some thermal energy)<br>• Organize data, using a format that is appropriate to the task or experiment (e.g., analyze the biotic and abiotic data collected in an ecosystem study, and present this information in a written or graphic format or in an oral presentation to peers)<br>• 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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| [CONTINUED]<br><br>**BUILD COMPETENCIES**<br><br>Smart data | **Unit A Biological Diversity**<br><br>Analyze qualitative and quantitative data, and develop and assess possible explanations<br><br>• Identify strengths and weaknesses of different ways of displaying data (e.g., compare different ways of recording and displaying data on plant variation in a study plot)<br>• 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) | **Unit D: Energy Flow in Global Systems**<br><br>Analyze data and apply mathematical and conceptual models to develop and assess possible solutions<br><br>• 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)<br>• Interpret patterns and trends in data, and infer or calculate linear and nonlinear relationships among variables (e.g., analyze a graph of mean monthly temperatures for cities that are at similar latitudes but have different climates)<br>• 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)<br>• 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) | **Unit D: Investigating Matter and Energy in the Environment**<br><br>Analyze qualitative and quantitative data, and develop and assess possible explanations<br><br>• 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)<br>• 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)<br>• 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) |