LEARNING EXPERIENCE TWO

Guiding Question: How can agricultural environments contribute to sustainability?

This **Learning Source** provides starting points and information to investigate: • Nutrients in agricultural environments • Nutrients and biodiversity • Nutrient cycles • Life cycle assessments • Environmental footprinting • Wildlife habitats	**Build Competencies: Discover biotechnologies** Students analyze environmental footprints through life cycle assessments, create a cycle diagram of an agricultural ecosystem. This handout includes activities that support competencies and weblinks to online resources that students can explore.	**Assess** Look for evidence of understanding of the following concepts: • Human intervention in natural ecosystems • Artificial and natural factors • Nutrient cycles • Habitats For a formative assessment, have students use an online footprint calculator to assess their own **ecological footprint**. Have them write a reflection that identifies strategies that can reduce their footprint. How are some of these strategies being used in agriculture? Have students consult the environmental footprints of agricultural products that they identified in the activity for this guiding question.

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.

Environmental footprint calculators can be found at **www.footprintcalculator.org** and **https://calc.zerofootprint.net/**. Students may have to enter an email address or a nickname to use the calculators.

Alberta Agriculture and Forestry provides information on environmental footprinting initiatives, including a general overview of sustainability and Life Cycle Assessments conducted by some Alberta producer groups. Information bulletins can be found at **https://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/sag14158**.

The Alberta Biodiversity Monitoring Institute provides a comprehensive overview of the status of human footprint in Alberta, found at **www.abmi.ca/home/reports/2018/human-footprint**. Their mapping portal, accessed on the webpage at **www.abmi.ca/home/data-analytics**, allows you to select different datasets, including the human footprint for agriculture.

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

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

- Infographics that illustrate how farmers are **focusing on environmental footprinting**

Find **Science 9**, **Science 20** and **Biology 20** learning outcomes supported by this learning experience on the following pages.

Use this activity to have students focus on sustainability practices related to organic and inorganic substances in agricultural ecosystems, the use of chemicals in agricultural environments, agriculture's impact on biotic and abiotic factors and the flow of energy. Encourage students to consider the role that Life Cycle Assessments have in assessing the impact of human activities on environments.

After completing activities in this learning experience, have students reflect on the range of factors that farmers consider to implement sustainable practices. How are environmental factors like soil and water important to livestock farming? What contributions have farmers made to reductions in environmental footprints?

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

Find the article *Are Pesticides Safe for the Environment?* on the Best Food Facts website at **www.bestfoodfacts.org/are-pesticides-safe-for-the-environment/**.

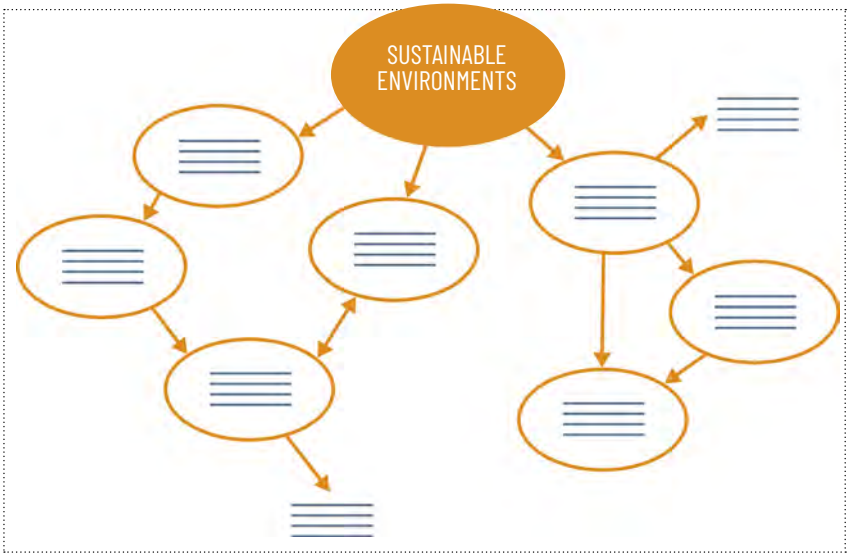
A full report on wildlife habitats and agriculture can be found on the Statistics Canada website at **https://www150.statcan.gc.ca/n1/pub/16-002-x/2015002/article/14133-eng.htm**.

An overview of sustainability initiatives is provided by the Dairy Farmers of Canada at **https://dairyfarmersofcanada.ca/en/how-canadian-dairy-farmers-are-improving-sustainability-farm**. Chicken Farmers of Canada provide a sustainability report at **www.chickenfarmers.ca/chicken-farmers-of-canadas-sustainability-report/**. Find a perspective on sustainability from the Egg Farmers of Canada at **www.eggfarmers.ca/2018/02/our-sustainability-story/**. Encourage students to look for examples from other livestock farmer groups, including those in Alberta. Encourage students to identify connections between these sustainability initiatives and practices and the Life Cycle Assessment process.

> EXTEND LEARNING

Create a **concept wall** based on concepts in the learning source and sustainability that is centred on the concept of "sustainable environments." Start, for example, with terms such as food nutrients, organic compounds, non-organic compounds, ecosystems, soil nutrients, water nutrients, air quality, farming, organic farming.

Have students work in groups to place these concepts in a hierarchy, using a **Mind Map**. Find this thinking map in **sustainability** MATTERS **Project Tools**. These concepts may not all belong in the first "level" of the pyramid — challenge students to come up with their own hierarchies. Have the students use connectors, arrows, and descriptions to show the relationships between these concepts. As a class, discuss each group's ideas and the reasons for their choices.



Learning Experience Two: LEARNING OUTCOMES AND COMPETENCY MAP

project AGRICULTURE Activity	GRADE 9 SCIENCE	SCIENCE 20	BIOLOGY 20
	CONCEPTUAL KNOWLEDGE	CONCEPTUAL KNOWLEDGE	CONCEPTUAL KNOWLEDGE
LEARNING SOURCE **How can agricultural environments contribute to sustainability?** [CONTINUED ON NEXT PAGE]	**Unit C: Environmental Chemistry** 1. Investigate and describe, in general terms, the role of different substances in the environment in supporting or harming humans and other living things • Identify common organic and inorganic substances that are essential to the health and growth of humans and other living things, and illustrate the roles served by these substances (e.g., identify calcium as an essential material for bones; identify minerals that are known to enhance plant growth but that limit growth if too little or too much is available) • Describe and illustrate processes by which chemicals are introduced to the environment or their concentrations are changed (e.g., dilution in streams, biomagnification through food chains) • Identify questions that may need to be addressed in deciding what substances – in what amounts – can be safely released into the environment (e.g., identify questions and considerations that may be important in determining how much phosphate can be released into river water without significant harm to living things) 2. Identify processes for measuring the quantity of different substances in the environment and for monitoring air and water quality • Identify chemical factors in an environment that might affect the health and distribution of living things in that environment (e.g., available oxygen, pH, dissolved nutrients in soil) 3. Analyze and evaluate mechanisms affecting the distribution of potentially harmful substances within an environment • Investigate and evaluate potential risks resulting from consumer practices and industrial processes, and identify processes used in providing information and setting standards to manage these risks (e.g., interpret and explain the significance of manufacturer's information on how wood preservatives can be safely applied; recognize that some individuals may have greater sensitivity to particular chemical substances than do others in the general population)	**Unit D: Changes in Living Systems** 20–D1.1k Investigate and analyze an aquatic or a terrestrial local ecosystem, distinguish between biotic and abiotic factors, describe how these factors affect population size and • Infer the abiotic effects on life; e.g., light, nutrients, water, temperature • Infer biotic interactions; e.g., predator-prey relationships, competition, symbiotic relationships • Infer the influence of biota on the local environment; e.g., microclimates, soil, nutrients 20–D1.2sts Explain that society and technology have both intended and unintended consequences for humans and the environment (SEC3) [ICT F2–4.8, F3–4.1] • Assess habitat loss and the responsibility of society to protect the environment for future generations • Analyze the need for habitat reclamation, such as recreating wetlands and swamps, forests, and prairie grasslands, and describe steps to ensure species diversity 20–D2.1k Outline the biogeochemical cycles of nitrogen, carbon, oxygen and water and, in general terms, describe their interconnectedness, building on knowledge of the hydrologic cycle from Science 10, Unit D 20–D2.1sts Explain that science and technology have both intended and unintended consequences for humans and the environment (SEC3) [ICT F2–4.8, F3–4.1] • Assess whether the efforts to reduce human impact on biogeochemical cycles are viable, taking into consideration a variety of perspectives (considerations for deep-well and deep-ocean injection of wastes, for example, include properties of waste, concentration, uncertainty, environmental concerns, risks and benefits to human health and organisms, costs)	**Unit A: Energy and Matter Exchange in the Biosphere** 20–A1.1k Explain, in general terms, the one-way flow of energy through the biosphere and how stored energy in the biosphere, as a system, is eventually "lost" as heat; e.g., • Photosynthesis/chemosynthesis • Cellular respiration (muscle-heat generation, decomposition 20–A2.1k Explain and summarize the biogeochemical cycling of carbon, oxygen, nitrogen and phosphorus and relate this to general reuse of all matter in the biosphere 20–A2.1sts Explain that science and technology have both intended and unintended consequences for humans and the environment (SEC3) [ICT F3–4.1] • Discuss the influence of human activities on the biogeochemical cycling of phosphorus, sulfur, iron and nitrogen: - fertilizer applications - waste and sewage disposal - acid deposition - persistent organic pollutants **Unit B: Ecosystems and Population Change** 20–B1.1k Define species, population, community and ecosystem and explain the interrelationships among them 20–B1.3k Identify biotic and abiotic characteristics and explain their influence in an aquatic and a terrestrial ecosystem in the local region; e.g., stream, lake, prairie, boreal forest, vacant lot, sports field 20–B1.1sts Explain how science and technology have both intended and unintended consequences for humans and the environment (SEC3) [ICT F3–4.1] • Evaluate the impact that human activity has had, or could have, on the biodiversity in an ecosystem: – wetlands management – land use – habitat fragmentation – monoculturing of forests, lawns, field crops

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[CONTINUED] **LEARNING SOURCE** **How can agricultural ecosystems contribute to sustainability?**	**Unit C: Environmental Chemistry** 3. Analyze and evaluate mechanisms affecting the distribution of potentially harmful substances within an environment • Identify and evaluate information and evidence related to an issue in which environmental chemistry plays a major role (e.g., evaluate evidence that the use of insecticides to control mosquitoes has an effect/has no effect on bird populations) Work collaboratively in carrying out investigations and in generating and evaluating ideas (e.g., assume responsibility for their share of work in preparing for investigations and in gathering and recording evidence; consider alternative ideas and approaches suggested by members of the group)	**Unit D: Changes in Living Systems** 20–D2.1sts Explain that science and technology have both intended and unintended consequences for humans and the environment (SEC3) [ICT F2–4.8, F3–4.1] • Evaluate the influence of society, and the impact of a variety of technologies, on the nitrogen cycle • Discuss the use of water by society, the impact such use has on water quality and quantity in ecosystems, and the need for water purification and conservation, considering such things as manufacturing, the oil industry, agricultural systems, the mining industry and domestic daily water consumption	
	PROCEDURAL KNOWLEDGE	**PROCEDURAL KNOWLEDGE**	**PROCEDURAL KNOWLEDGE**
BUILD COMPETENCIES **Sustainability practices**  [CONTINUED ON NEXT PAGE]	**Unit C: Environmental Chemistry** Ask questions about the relationships between and among observable variables, and plan investigations to address those questions • Identify science-related issues (e.g., identify issues regarding the use of soil fertilizers) • Identify questions arising from practical problems and issues (e.g., ask questions about the needs of different living things for nutrients and about the mechanisms by which these nutrients are obtained) Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data • Select and integrate information that is relevant to the issue (e.g., demonstrate proficiency in uploading and downloading text, image, audio and video files) • Organize data, using a format that is appropriate to the task or experiment	**Unit D: Changes in Living Systems** 20–D1.1s Formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues • Design an experiment and identify specific variables to investigate relationships between biotic and abiotic elements of a micro-ecosystem (IP–NS2) 20–D1.2s Conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information • Use library and electronic research tools to collect information on a given topic, such as: – protection of the environment as a priority over economic interest – sustainable development initiatives (PR–NS4) [ICT C1–4.1, C3–4.2] 20–D1.4s Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results • Prepare a visual display that explains initiatives undertaken by industry to protect the environment (CT–NS2) [ICT P4–4.2]	**Unit A: Energy and Matter Exchange in the Biosphere** 20–A1.2s Conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information • Draw, by hand or using technology, annotated diagrams of food chains, food webs and ecological pyramids (PR–NS4) 20–A2.1s Formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues • Predict disruptions in the nitrogen and phosphorus cycles that are caused by human activities (IP–NS3) [ICT C6–4.1] 20–A2.4s Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results • Work cooperatively in a group to investigate the influence of human activities on the biogeochemical cycles and use appropriate multimedia to present the information to a group (CT–SEC1, CT–SEC2, CT–SEC3) [ICT C1–4.2, F2–4.7, P3–4.1]

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	PROCEDURAL KNOWLEDGE	PROCEDURAL KNOWLEDGE	PROCEDURAL KNOWLEDGE
[CONTINUED] **BUILD COMPETENCIES** Sustainability practices 	**Unit C: Environmental Chemistry** Analyze qualitative and quantitative data, and develop and assess possible explanations • Apply given criteria for evaluating evidence and sources of information (e.g., use scatterplot data in evaluating how strong a relationship exists between two variables; evaluate claims of environmental impacts, based on the scope and relevance of supporting evidence)	**Unit D: Changes in Living Systems** 20–D2.1s Formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues • Predict disruptions in the nitrogen cycle that are caused by human activities (IP–NS3) 20–D2.2s Conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information • Draw, by hand or using technology, annotated diagrams of energy flow in food chains, webs and pyramids (PR–NS4). 20–D2.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results • Work cooperatively in a group to investigate the influence of human activities on the biogeochemical cycles and, using appropriate multimedia, present the findings (CT–SEC1, CT–SEC2) [ICT P3–4.1]	**Unit A: Energy and Matter Exchange in the Biosphere** 20–A3.4s Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results • Work cooperatively as a group to investigate, synthesize and present information on the effects of changes to stratospheric ozone levels on society, agriculture, plants and animals (CT–SEC1, CT–SEC2, CT–SEC3) [ICT C1–4.4, C7–4.2, F2–4.7] **Unit B: Ecosystems and Population Change** 20–B1.4s Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results • Work cooperatively to make clear and logical arguments to defend a decision on a given issue, such as human impact on ecosystems, land reclamation or wildlife habitat preservation (CT–SEC1, CT–SEC2, CT–SEC3) [ICT C1–4.4] • Develop, present and defend a strategy to improve wildlife habitats (CT–SEC3) [ICT C1–4.4]