LEARNING source **sustainable** PRACTICES

How are **natural** and **agricultural ecosystems** connected?

agricultural and natural ecosystems

An agricultural ecosystem is a type of ecosystem. Agricultural ecosystems have the same needs that natural ecosystems have for sources of nutrients and energy, moisture and the exchange of gases. In other words, all ecosystems need food, water and air.

Plants use soil nutrients like nitrogen, potassium and phosphorus, water, carbon dioxide from the air, and the sun's energy to produce food for animals and humans. Animals depend on the plants in an ecosystem for food and sometimes shelter.

For ecosystems to be sustainable, more processes are involved. These processes all need to work together.

In a sustainable ecosystem, wastes and other organic materials are broken down and recycled by microbes and organisms like worms and insects. **Microbes** are living organisms that are too small to be seen without a microscope. They include single-celled organisms like bacteria and fungi. This organic matter nourishes the soil and provides nutrients for plants.

The flowcharts on this page show the basic processes of natural ecosystems and how ecosystems can be sustainable. How could you use these two flowcharts to help you write your own description of an agricultural ecosystem?

.....

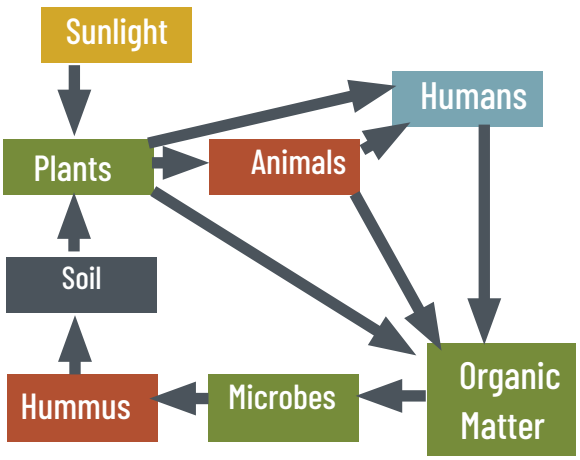
.....

.....

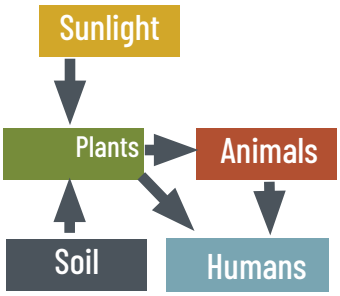
.....

.....

Elements of a Sustainable Ecosystem



Relationships in an Agricultural Ecosystem



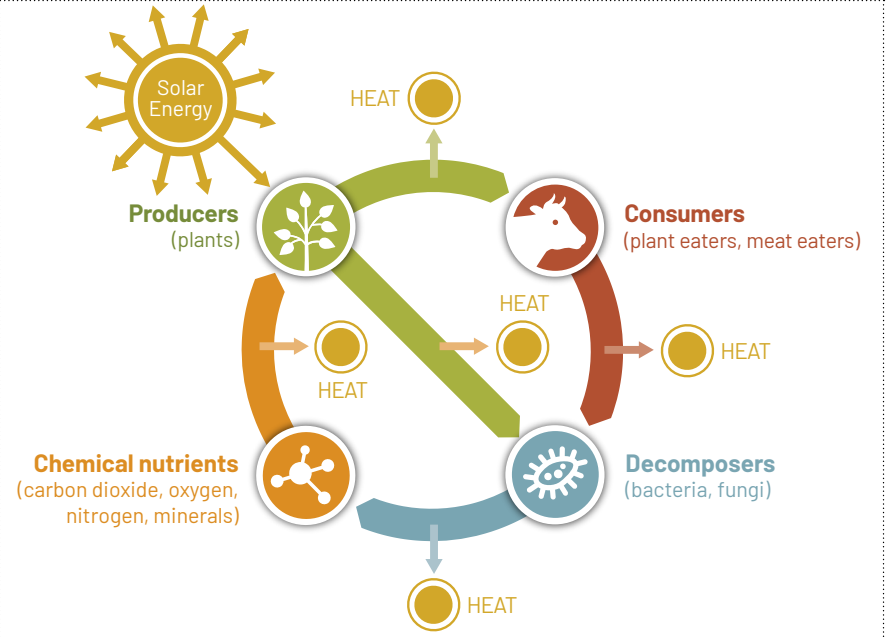
Agricultural ecosystems are designed and managed by humans for the purpose of growing crops and/or raising animals.

They are simpler in some ways than natural ecosystems, because there are more limited types of plants or animals grown or raised in the ecosystem by the farmer. Other plants or animals that come into the ecosystem – like weeds or pests – are controlled or eliminated.

Natural ecosystems, on the other hand, exist without humans. They are composed of a great diversity of **biotic** (living) and **abiotic** (non-living) components.

Natural ecosystems are naturally sustainable. **Ecosystem sustainability** refers to the ecosystem's ability to maintain its functions and structures over a long period of time, even if that ecosystem experiences external stresses, like droughts or extreme rainfall.

How can you use the diagram on this page to describe what you know about natural ecosystems?



meeting needs in ecosystems

Agricultural ecosystems have the same needs that natural ecosystems have for nutrients, energy sources, moisture, suitable habitat, and exchange of gases. They have the same interactions between the biotic and abiotic elements of an ecosystem. The combination of biotic and abiotic interactions affects the sustainability of the agricultural ecosystem.

The competition that can occur between crops and other plants and pests is also a biotic factor in agricultural ecosystems. For example, crop plants and weeds both compete for nutrients in the soil. What can you learn about ecosystem competition in the story that follows?

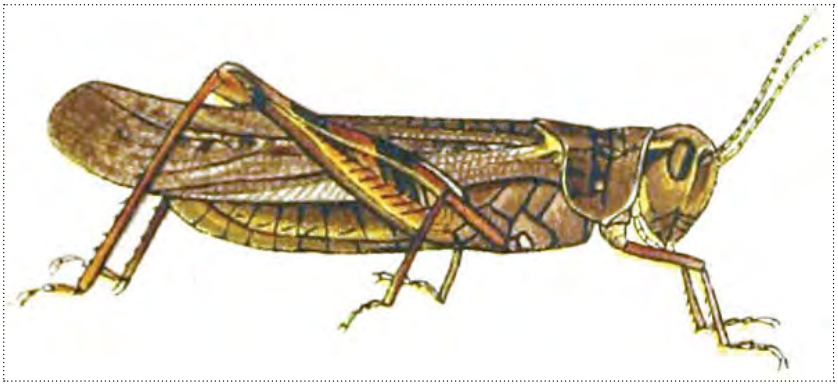
BIOTIC AND ABIOTIC ELEMENTS IN AN AGRICULTURAL ECOSYSTEM

In an agricultural ecosystem, the **biotic elements** consist of the living organisms as well as the interactions between them. For example, biotic elements include pollinators and organisms that are decomposers.

The farmers who manage the land, soil nutrition, pest control and crop planting are also biotic elements.

Abiotic elements in an agricultural ecosystem are non-living environmental factors that include temperature, abiotic elements of soil like minerals, water, relative humidity, sunlight and wind.

Attack of the legendary locusts



A [large plague] of locusts an estimated 500 000 square kilometres in size swept across the U.S. Midwest and into parts of Western Canada in 1875. The ravenous insects ate virtually everything in their path from crops to cloth.

Described as a living eclipse of the sun, it is believed to have been the largest insect swarm in recorded history. Perhaps even more extraordinary, within 25 to 30 years of this legendary natural event, the Rocky Mountain locust (Melanoplus spretus) was declared extinct.

American author and entomologist Jeffrey Alan Lockwood noted several eyewitness accounts of the 1875 swarm.

..."The farmers tried desperately to save their crops and to drive the locusts off, but with little success because of the huge numbers of insects. Many families had to abandon their homesteads and thousands more were threatened by famine, and virtually no food left for themselves or livestock."

In Manitoba, the locust appeared in 1874 and its attack intensified in 1875, according to writer and historian Bruce Cherney who examined the story of the locust in a May 2012 column in the Winnipeg Regional Real Estate News.

Thanksgiving Day 1875 was cancelled in Manitoba. "The locust had killed off any justification for declaring a day of giving thanks for the harvest," wrote Cherney. "The locust plague destroyed so many crops of fresh vegetables north of Winnipeg that scurvy broke out. Dr. David Young, who practiced near present-day Selkirk, laboured day and night to alleviate the sufferings of those afflicted by the disease caused by vitamin C deficiency." By 1876 the plague had abated.

Among many theories on the rapid decline of the pest, Lockwood suggested cool, wet conditions that did not favour the locust coincided with increased farming activities in the fertile valleys near the Rocky Mountains. This disturbed the soils in which the locust laid its eggs.

?

Locusts have a role in natural ecosystems. They can act as pollinators, eat other plant-eating insects and provide food for wildlife. In what ways did the 1875 locust swarm compete with crops in agricultural ecosystems?

Story and image excerpted from Wilson, T. (March 19, 2021). Attack of the Legendary Locust. Grains West: Online. https://grainswest.com/2021/03/attack-of-the-legendary-locust/

- Ecosystems provide fresh and clean air and sources of water.
- They provide pollinators, which are essential to produce food. Insects and wind pollinate plants and trees, which are essential for the development of fruits, vegetables and seeds.
- Ecosystems can also provide control of plant pests and diseases by their natural enemies.

The benefits that people receive from ecosystems are known as **ecosystem services**. Ecosystem services also contribute to agriculture. The processes that take place in ecosystems are essential for the production of crops and livestock.

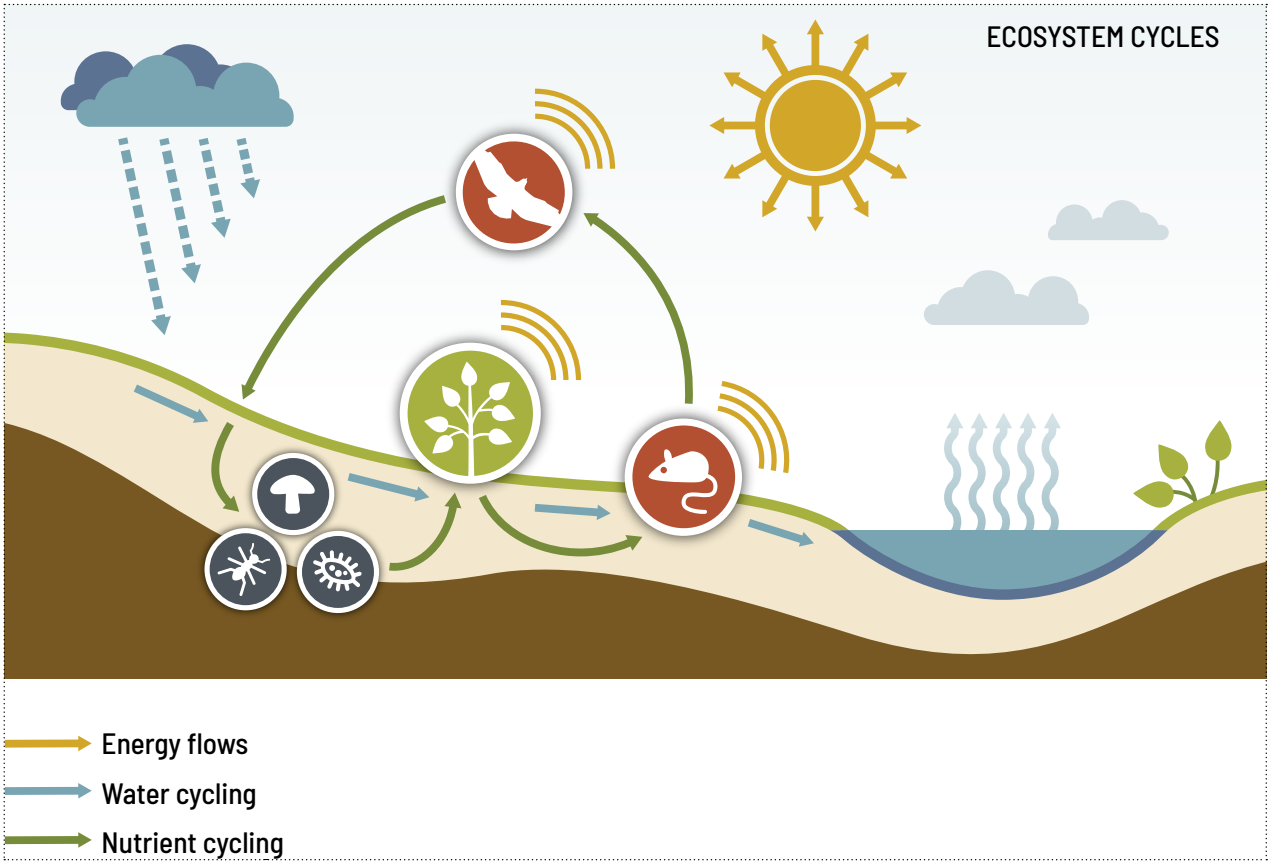
What do you think each of these three ecosystem processes – energy flows, water cycle and nutrient cycles – provide on farms that grow crops or raise livestock?

ecosystem cycles

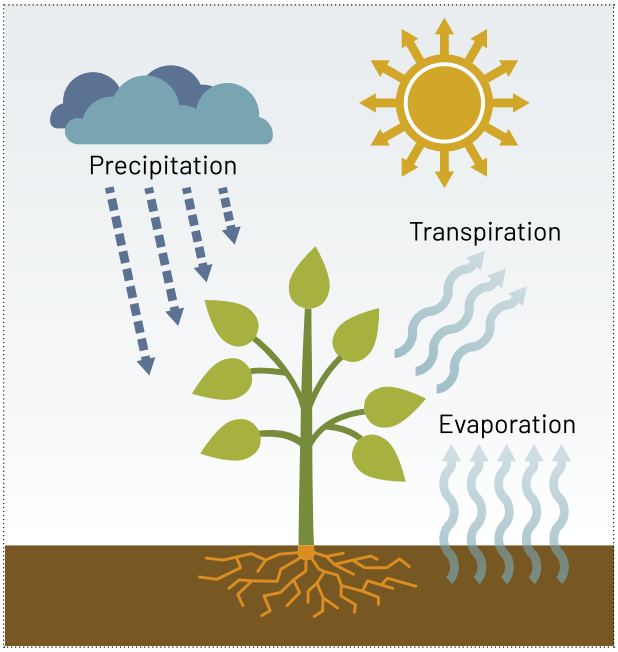
There are three main types of processes involved in natural and agricultural ecosystems:

- Energy flows
- Water cycling
- Nutrient cycling

These processes are shown in the illustration below. Can you trace each process in the illustration?



The **water cycle** involves the movement of water on, in and above the earth's surface. The water cycle includes precipitation, evaporation and **transpiration** – the release of water from plant leaves.

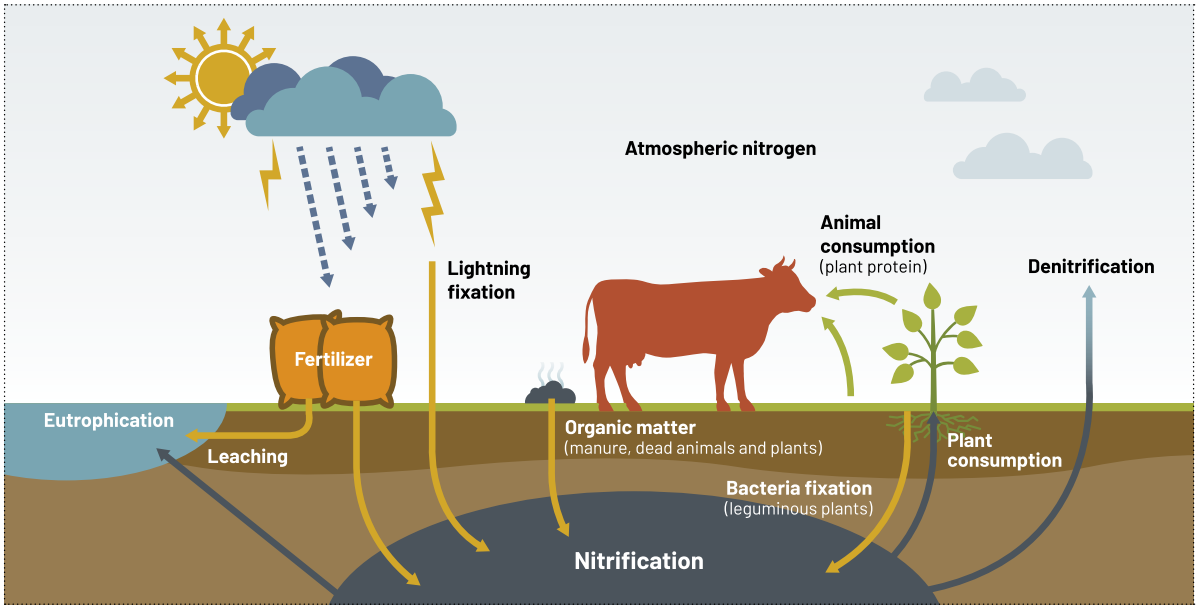


The flow of ground and surface water is also part of the water cycle. Water is purified naturally through **evaporation**, which occurs when water absorbs enough heat to become a gas, called water vapor. When water evaporates, the pollutants and sediments in it are left behind.

Nutrients are used and reused by all living organisms in an ecosystem. These nutrients include nitrogen, phosphorous, sulfur and carbon. The movement of these nutrients through plants and the soil is referred to as the **nutrient cycle**. Each nutrient can also be described on its own as a cycle.

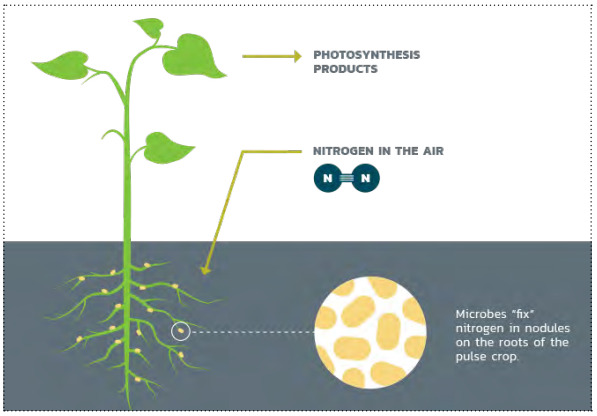
Focus on the nitrogen cycle

- Nitrogen is in the atmosphere and cannot be used by living organisms on its own. Nitrogen makes up about 78 percent of Earth's atmosphere by volume, far more than the oxygen we often think of as "air," which makes up 21 percent.
- Nitrogen is needed for photosynthesis and is an essential nutrient for all plants – including crop plants.



- Plants and animals cannot convert the nitrogen in the atmosphere into a usable form on their own, even through they – and human bodies – contain quite a lot of it.

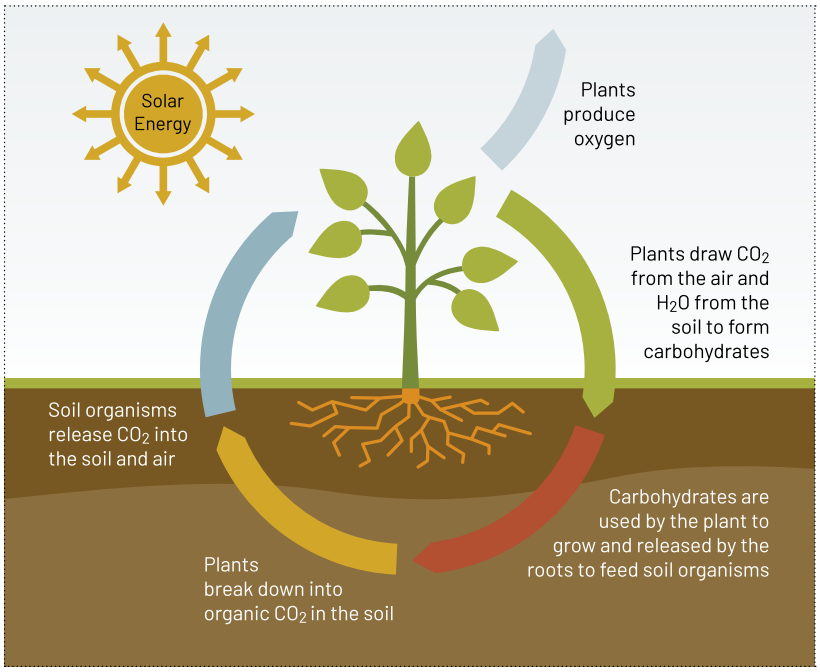
- Therefore, nitrogen has to be **fixed** – this means it has to be combined with other elements like hydrogen, carbon or oxygen before plants can use it. Lightning, algae and some types of bacteria can convert nitrogen into nitrates or ammonia. Pulses in the legume family like beans and peas can then use the nitrates or ammonia for food.



- In the natural world, nitrogen comes from bacteria. Some species of nitrogen-fixing bacteria live on their own in soil or water, while others are beneficial **symbionts** – organisms that lives inside of a larger host plant.
- Nitrogen continuously enters the air from **denitrifying bacteria**, which are organisms that convert nitrates in the soil to nitrogen in the air. This decreases the fertility of soil.

Focus on the carbon cycle

- Energy also flows through ecosystems. This flow of energy is called the **carbon cycle** because carbon is involved in all storage and transfer of energy. Plants, including agricultural crops, play a role in the carbon cycle.
- Carbon dioxide – CO_2 – from the atmosphere is absorbed by plants and trees – including crop plants. These plants use carbon dioxide to make their own food. This process is called **photosynthesis**. Most carbon dioxide enters the living world through photosynthesis.
- During photosynthesis, carbon dioxide from the atmosphere is converted into a usable form of chemical energy (used to build carbohydrates), and the carbon is separated from the oxygen. Oxygen gets released back into the air and some of the carbon gets stored in the soil.



- As the plants use the energy they get from the carbohydrates, some of the carbon is released back into the atmosphere as carbon dioxide. The rest of the carbon is used by the plant to grow.
- Carbon is also added to soil through the decomposition of fallen leaves or dead plants.

farms in Alberta grassland ecosystems

In all farm ecosystems, biotic and abiotic elements interact with each other in many ways. Insects live in the soil, on the land and in the air. Vegetation uses the moisture and nutrients found in the soil and air. Sun energy is used by plants, animals and humans. Weather affects the plants and water supply.

These interactions include decisions that farmers make. For example, fertilizer interacts with grass by increasing its rate of growth. However, farmers are provided with and use information about the proper application of fertilizers to help eliminate harmful effects on wildlife.

Grasslands biome and ecosystems

Since European settlement, domestic cattle have replaced wild bison and cropland has replaced native prairie plants. Ducks Unlimited Canada is working to secure what is left of the original prairies. But we also recognize that wildlife can still thrive in certain types of agricultural landscapes. That's why we work with landowners to promote wildlife-friendly farming practices such as winter wheat and properly managed pastures.

Ducks Unlimited works with farmers across Canada, including in Alberta, to protect natural environments, including grassland ecosystems.

Environmental Benefits

Grasslands improve the quality of our soil, air and water. Grasses have deep roots that stabilize slopes and protect soil from erosion. These root systems also store carbon from the atmosphere to help [reduce] climate change impacts, including extreme weather events.

Diverse Wildlife

Grasslands are habitat for a range of wildlife, from mice to mule deer. They provide essential nursery cover for smaller animals, including waterfowl like pintails, blue-winged teal and shovellers. Many species of songbirds, like meadowlarks and bobolinks, are found in grasslands, as are grazing species like antelope, deer and jackrabbits. Predators like as swift foxes, hawks and badgers depend on many of the species that feed in grasslands.

Agricultural Integrity

Grasslands maintain soil stability, prevent soil erosion and feed our livestock. They also provide habitat and food for the pollinators that fertilize our crops. Grassland-dependent insects like wasps and ground beetles act as a natural pest control for crops because they feast on aphids and grasshoppers.

What connections could you describe between Alberta's grassland biome and crop farms?

.....

.....

.....

.....

.....

From Our Work: Grasslands. Ducks Unlimited Canada: Online. www.ducks.ca/our-work/grasslands/