# Engineered Ecosystems and Modern Agriculture

As you read this text, you are probably surrounded by a human-designed environment. The room may be lit by fluorescent bulbs instead of the Sun. The floors, walls, and ceiling are not part of a natural environment. They are part of a constructed building. The building has its own energy and water supplies. There is a system for taking away human waste. Whether you are at school or at home, you will find supplies of food in the cafeteria or kitchen.

Unlike most species, humans spend little time in natural ecosystems. Even when you go outside, you are likely to be on a lawn or a sidewalk. Whether you live in a large urban centre or a rural community, the abiotic and biotic features around you have been changed. In some cases, such as a park, the features of an ecosystem are still recognizable. In others, such as a parking lot, most biotic features have been eliminated.

Examine the variety of environments in Figure 1. What do they have in common? What features suggest that they are not natural ecosystems?

In each photo, the work of humans is obvious. The natural vegetation has been removed and replaced with other plants or artificial surfaces. Recreational areas are often covered in gravel, wood chips, or fields of grass. Transportation routes are covered in asphalt. A massive mine has exposed Earth's lithosphere. In all of these examples, the abiotic and biotic features have been changed. Biogeochemical and water cycles have been changed as well.

Engineered ecosystems cover a large portion of Earth's land area. As the human population increases, we replace natural ecosystems with land uses to support our modern lifestyles: farms (or **agroecosystems**), urban centres, and roads.
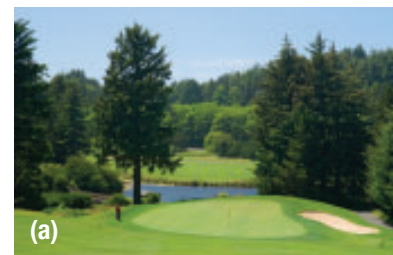
(a)

(b)

(c)

Figure 1 The biotic and abiotic features of this (a) golf course, (b) open-pit mine, and (c) neighbourhood have been changed.

agroecosystem an agricultural ecosystem

TRY THIS WATCH WHERE YOU STEP!

SKILLS: Observing, Analyzing

In this thinking activity, you will use your knowledge of land uses to obtain a qualitative sense of how Earth's surface has been altered for human use. Think of Earth's surface as a checkerboard or mosaic of different surfaces, some natural and some human-made, but each with distinct characteristics and potential uses.

1. Brainstorm a list of the different surfaces you have used during the last 24 hours, month, and year. Create a table similar to Table 1 at right, and classify the surfaces you have used as either manipulated or natural.

A. During your daily routine, do you make greater use of manipulated or natural surfaces? K/U

B. How many different surfaces have you used in the past year? K/U

Table 1

	Manipulated surfaces	Natural surfaces
24 hours		
Past month		
Past year		

C. How many of these surfaces have been altered by humans? K/U

D. Would it have been possible to do these same activities in a completely natural setting? Explain. A

The ability of humans to manipulate their environment comes from two innovations: tools and concentrated energy sources. Humans have been making tools for thousands of years, but those powered by hand or horse have done less to alter the natural landscape. The recent use of fossil fuels has given us the ability to literally move mountains.

Humans are able to dramatically alter the environment. However, we are not able to change the basic relationships that exist between the environment and ourselves. To live sustainably, we must not disrupt the biotic and abiotic conditions we need to survive. Actions that disrupt water and nutrient cycles, threaten biodiversity, or alter climate patterns jeopardize our ability to survive.

Modern Agriculture—Food for Thought

Eating is one of our fundamental biological activities. Like breathing and drinking, eating food is something we must do. With a population of close to 7 billion people on Earth, producing food is critical to our survival and must continue on a large scale.

Unlike other animals, humans obtain very little of their food from natural ecosystems. Instead, most of our food is produced on large agricultural farms. Most fruits and vegetable crops are grown in large fields. Our meat is provided by a few kinds of domesticated animals that are raised on farms.

Canadian Agriculture Is Based on Imported Species

If you are like most Canadian teenagers, you have probably enjoyed eating pizza. The Hawaiian-style pizza is a popular choice. It consists of tomato sauce, cheese, ham, and pineapple. You probably have not thought about the origin of the ingredients or how their production affects the environment. Even though most of the ingredients were grown in Canada, none of them come from species *native* to Canada (Figure 2).
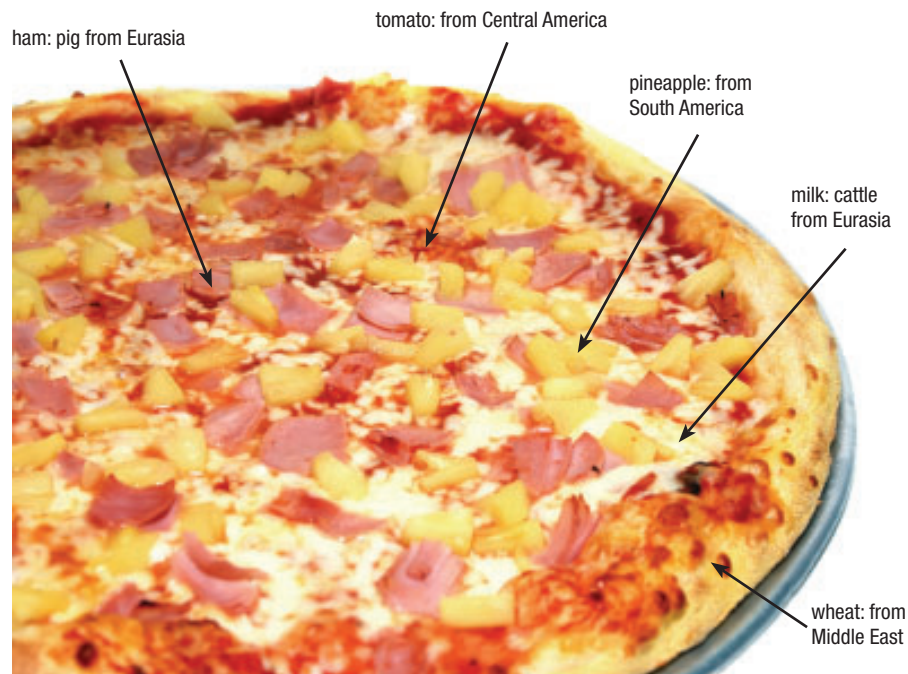
ham: pig from Eurasia

tomato: from Central America

pineapple: from South America

milk: cattle from Eurasia

wheat: from Middle East

Figure 2 Most of the ingredients in this pizza are derived from species that are not native to Canada.

Like the pizza ingredients, all the major foods we produce in Canada were introduced from other parts of the world. They are all "exotic" species (Table 2). These non-native plants and animals have been domesticated by humans over thousands of years. The results are easy to see. These food species are highly productive, nutritious, and relatively easy to produce in large quantities.

Table 2 Selected Native and Non-Native Crops and Livestock Species Grown and Raised in Canada

	Non-native species	Native species
plant crops	corn, wheat, potatoes, beans, barley, rye, oats, soybeans, canola, tomatoes, apples, squash, beans, peanuts, carrots	strawberries, maple sap, wild rice, blueberries
livestock species	cattle, pigs, chickens, sheep, goats	turkeys

Agroecosystems Differ from Natural Ecosystems

The presence of non-native rather than native species is just one way in which farmland differs from natural ecosystems. Figure 3 highlights some of the other major differences. In general, when compared to natural ecosystems, agroecosystems have more uniform abiotic features, have lower biodiversity, and are more intensively used by humans. Agroecosystems also require humans to maintain them.
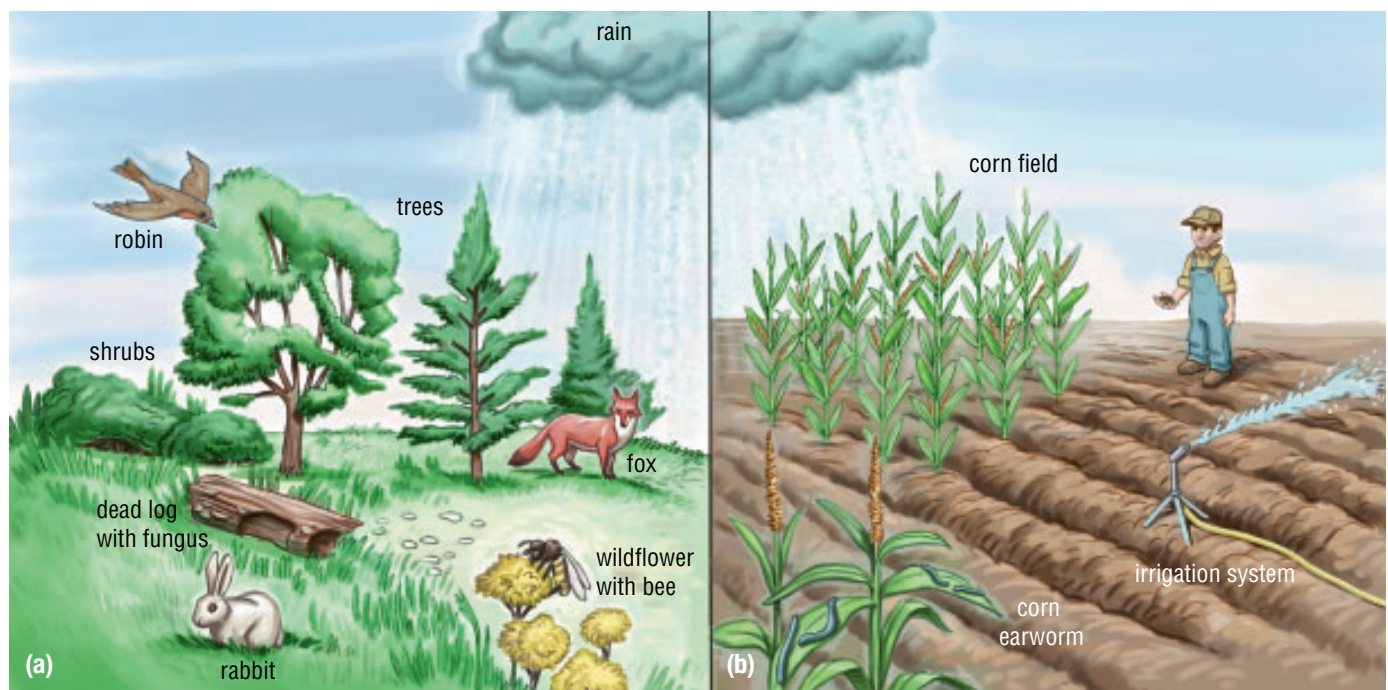

Figure 3 In (a) natural ecosystems, many species interact, participating in and maintaining natural cycles, whereas in (b) agricultural ecosystems, a very limited number of species interact, and most cycles are directly altered by human activity.

On agroecosystems, farmers grow crops in **monocultures** of non-native species where only one species is grown in a large field. In a monoculture, ecological cycles are altered, and biodiversity is reduced. Consumers that feed on crops are considered **pests**. You will learn more about pests and agroecosystems in Section 4.4.

monoculture the cultivation of a single crop in an area

pest any plant, animal, or other organism that causes illness, harm, or annoyance to humans

The differences outlined in Figure 3 raise concerns about our ability to produce food sustainably. While natural ecosystems sustain themselves over thousands of years, engineered ecosystems such as farmland must be managed. Farmers manage abiotic and biotic conditions to maximize the success of growing monocultures. They attempt to create ideal and uniform growing conditions and to eliminate competitors, diseases, and pests (Figure 4). Ploughing, weeding, fertilizing, irrigating, and the spraying of pesticides are examples of such management techniques.

Figure 4 Most crops in Canada, such as these sunflowers, are grown in monocultures. Farmers must manage monocultures carefully so that only the desired crops will grow.

Remember what you learned about biodiversity. Does the management of a monoculture result in a stable ecosystem? In the next sections, we will consider how these management practices influence our environment.

IN SUMMARY

- Engineered ecosystems, such as farmland and cities, make up a large portion of Earth's land area.
- Most of Canada's crop and livestock species are introduced, non-native species.
- Engineered ecosystems have uniform abiotic features and low biodiversity.
- Most monoculture crops consist of plants of uniform age and size.
- Farmers attempt to create ideal abiotic and biotic growing conditions for crops.

✔ CHECK YOUR LEARNING

1. List six examples where humans have replaced a natural ecosystem with an engineered ecosystem and describe its new purpose. K/U C

2. How do engineered ecosystems differ from natural ecosystems? Refer to both biotic and abiotic ecosystem characteristics. K/U

3. Describe how you use natural ecosystems. A C

4. Describe how you use engineered ecosystems. A C

5. Do Canadians rely on native plant and animal species for all their food? Explain using examples. K/U C

6. How do major human food sources differ from those of most animals? K/U

7. Do you always have to be physically located in an ecosystem to be making use of its services? Explain. K/U

8. Suggest some possible reasons why non-native species are so extensively used in agriculture. K/U A

9. Why do we not milk moose and grow fields of native plants for food? K/U A

10. Construct a table that compares the characteristics of natural ecosystems with the characteristics of agricultural ecosystems. K/U C

11. List some management techniques used by farmers to alter abiotic and biotic growing conditions. K/U