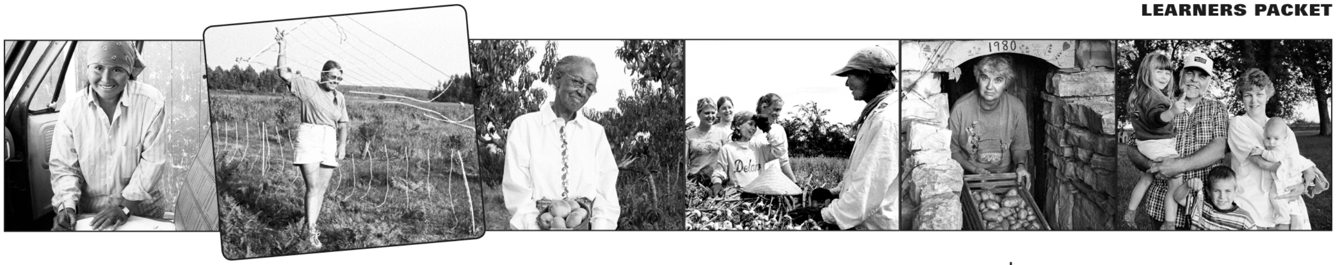


PHOTOS BY CYNTHIA VAGNETTI

3 | THE FOOD FOOTPRINT

Summary

Where does our food come from, and why does this matter? This session examines materials and energy used in food production as well as the wastes produced. As you explore the environmental impacts of these processes, you will gain an understanding of the food "footprint." Hands-on activities and multiple diagrams will help clarify the science behind the concepts.

Guiding Questions

- What steps do foods take from farm to table?
- What is a food "footprint"?
- What are the environmental impacts of growing, producing, transporting, processing and disposing of food? Are these impacts positive or negative?
- What are ways to reduce our personal food footprint?

Activities

1) Feeding Yourself for a Year (group map activity)

2) Inputs and Outputs: An introduction to the "food footprint" (reading/presentation)

3) Do Our Choices Matter? Comparing the footprints of three potatoes (group activity)

4) Reducing Our Food Footprint (reading/presentation/discussion)

5) Before the next session (To complete on your own.)

Activity 1) Feeding yourself for a year

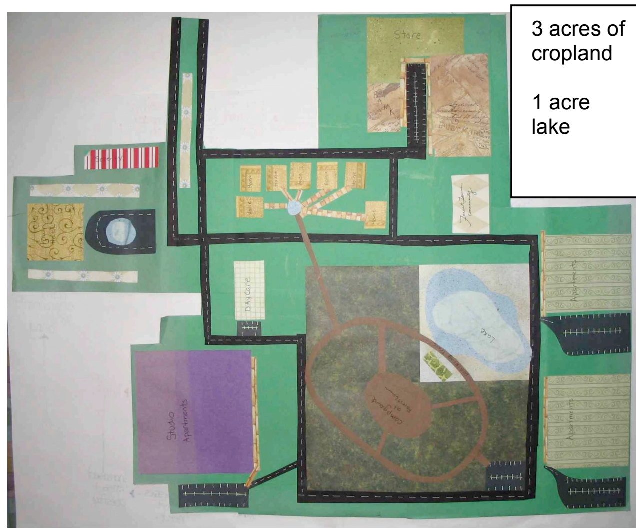
Introduction

Imagine that for the next year, you will be responsible for producing all of your own food. You will grow all the grains and vegetables you eat, catch all the fish, and raise animals if you want meat or dairy. (You also have to grow whatever the animals eat, or have enough pastureland for them to graze). Finally, you need space to store and prepare the food, as well as a method for managing all the wastes produced. *What would this farm look like?* In this activity, you will design and map a farm that can support your family for a year. For the purposes of the activity, imagine your group is your family.

Directions

1. Brainstorm the types of foods you would want, considering everything from grain for bread to animals for meat or bees for honey. Also consider how much of everything your family will consume in a year.

2. Identify the types of land you would need. Consider:
- cropland
- pasture lands for grazing animals
- ocean access and/or rivers for fish
- forests for wood or forage (nuts, greens, mushrooms, berries)
- sources for water
- land with buildings on it
- waste storage, processing, or re-use



3 acres of cropland

1 acre lake

3. Now, draw map that shows the layout of your self-contained farm. (An acre is about the size of a football field.) Guidelines:
- Include a scale that shows how big the overall farm would be in acres.
- Use labels and/or different colors to show the types of land listed above.
- Indicate sources of water.
- On the side, write an estimate of the number of acres of each type of land your farm has.

4. When your map is done, write an explanation of how you developed it and calculated the land uses. Specifically,
   - How did you calculate the amount of food you would consume?
   - How did you decide how much land it would take to grow it?
   - What other aspects did you consider?

Reflection questions

- Which tasks or calculations were easiest? Why?
- What aspects of the activity were more difficult? Why?
- What does this activity tell us about the relationship between food systems and the environment?

Activity 2) Inputs and Outputs: An introduction to the Food "Footprint"

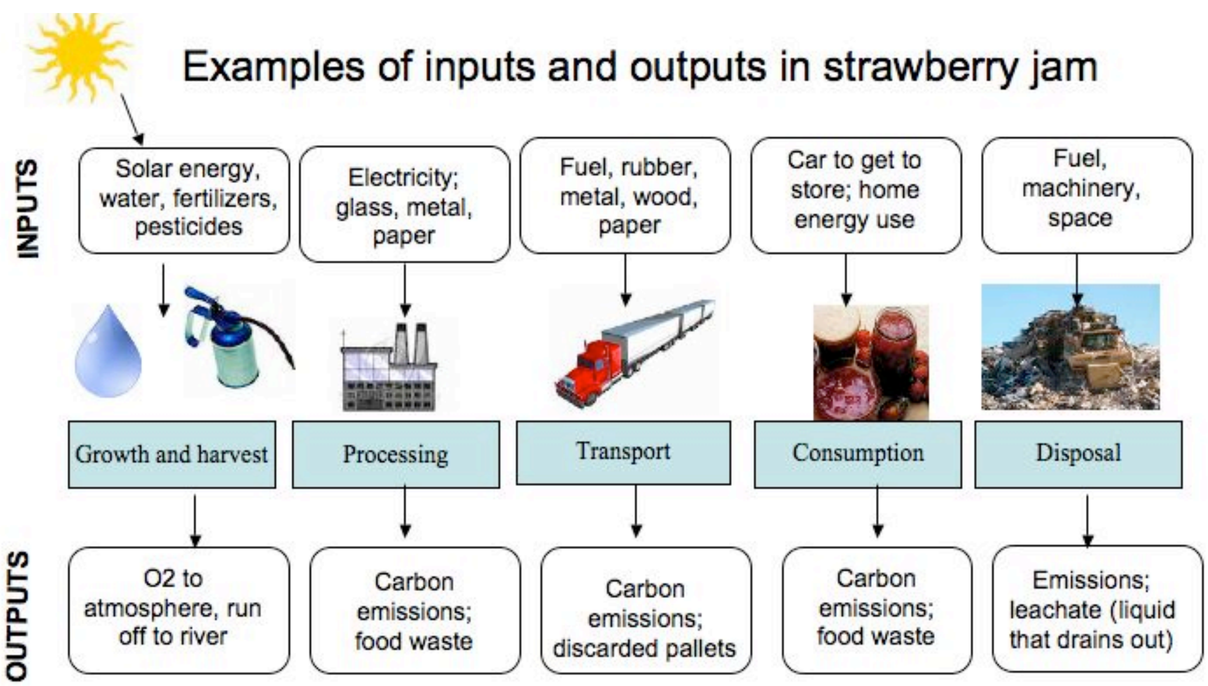
All the elements of a food system—from production to disposal--require natural materials, energy, and labor. Growing grains or vegetables requires productive soil. The soil requires nutrients, which can be provided by manure or synthetic fertilizers. Crops need clean water, which may come from rainfall or irrigation systems. Processing the food requires refrigeration, transportation, and labor. The machines and vehicles need fuel, which may come from petroleum or coal. All of the resources, materials, and energy needed to produce something are called **inputs.**

Food production activities also produce **wastes**. Burning fossil fuels produces carbon emissions, among other things. Excess nutrients from fertilizers can run off into waterways. Packaging gets discarded. All of these wastes are called **outputs**.

These inputs and outputs have environmental impacts. Some impacts are positive and nourishing, such as food scraps that become compost. But many impacts are negative, such as the carbon emissions created when fuels are used to fly in produce from other continents. Together, the negative environmental impacts are called a "footprint." The greater a food's negative environmental impact, the bigger its "footprint."

Foods that are highly processed and grown far away generally require more energy and packaging than fresh, locally produced foods. For example, strawberry jam made with strawberries grown in another country requires more fertilizers, fuel, and packaging to produce than does growing a fresh, local strawberry. Thus, the jam has a larger "footprint."

Review the diagram below. How would the diagram be different for a fresh, local strawberry? What steps would be eliminated? What inputs and outputs would be eliminated?



What about your last meal?

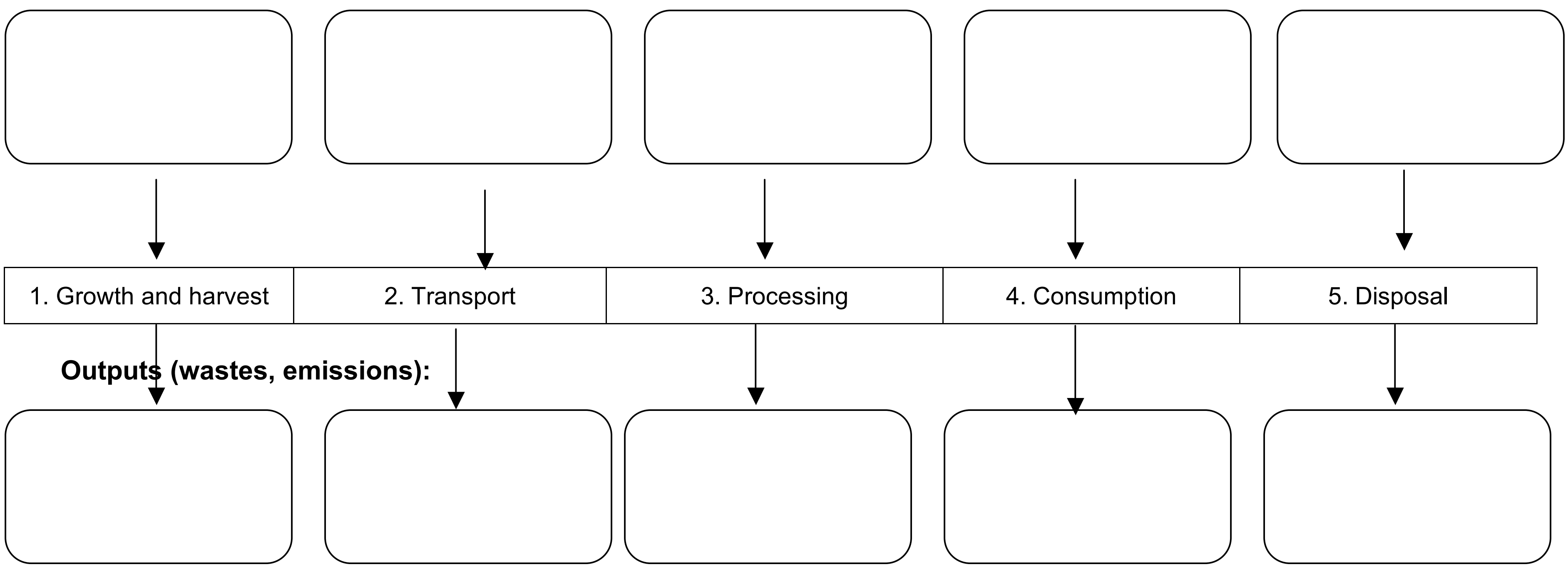
Choose one food that you ate at your last meal and consider the inputs and outputs that were used to produce it. On the following page is a diagram where you can record some of the inputs and outputs. (If you have already written down answers to these questions ahead of time, enter your responses into the diagram.)

Food : ____________________________________

On its way to your table, this food experienced some or all of these stages as shown below: growth and harvest, transport, processing, consumption, disposal.

- Identify as many of the materials, energy, and labor used at each stage. Write these in the ‘input’ ovals.
- List as many wastes as you can think of that occurred at all stages. Write these in the ‘output’ ovals.

Inputs (materials, energy, labor):



Activity 3) Do Our Choices Matter? Comparing the footprints of three potatoes

Note: This activity is adapted from "Introduction to the Ecological Footprint," developed by Redefining Progress in partnership with Creative Change Educational Solutions (2006). Used with permission.

Introduction

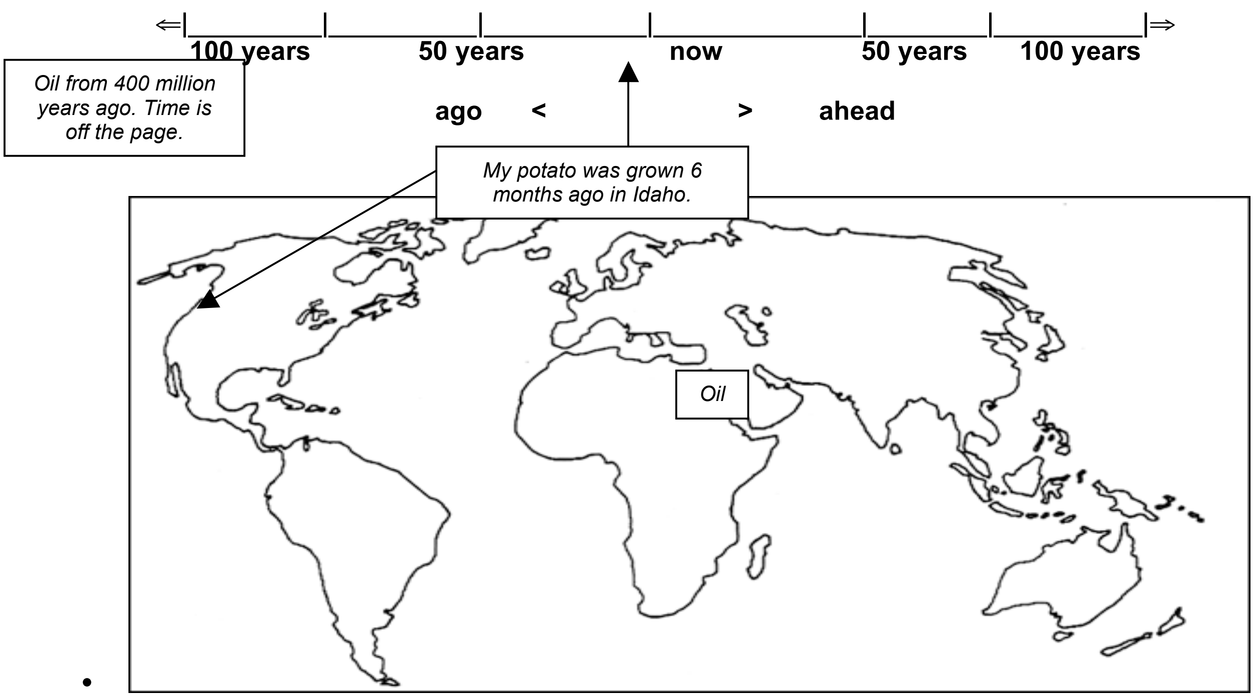
Do our food choices matter in terms of the footprint they create? This activity will help you find out. To do so, you will compare the stories of three types of potatoes: a French fry, a potato grown using traditional Peruvian methods, or a potato grown locally (assuming potatoes can grow in your climate). Reading selection on each of these follow.

Directions

1. Select one of the three potato stories; your facilitator may assign one.
2. Read your selection, paying attention to the inputs and outputs at each stage of the potato's "life." (Suggestion: Circle portions of the text that describe the inputs, and underline portions of the text that describe the wastes, or outputs.)
3. Document the inputs and outputs using one of the following methods:
   - Use the input-output diagram that follows the last reading selection.
   - Fill in information in the table provided (after the input-output diagram).
4. When you are done, you will compare your findings with people who read the other stories. What major similarities and differences are there in how the potatoes are produced?

Extensions:

- Create a diagram showing the inputs and outputs involved in preparing potatoes your favorite way.
- On the timeline below, identify significant dates in the life cycle of your potato. Then use the map to identify where major steps of your potato's life cycle took place. Examples are provided.



Potato Story 1: French fries

Growth:

- *Cultivating and harvesting:* The potato is a russet Burbank--a kind perfect for French fries because they stay stiff. The potato was grown on a farm that in Idaho, in sandy soil of the upper Snake River valley. The farm was a monoculture, meaning only one crop grew there. A harvesting machine, powered by petroleum-based diesel fuel, dug up my potato. The oil from the fuel was from Venezuela or perhaps Saudi Arabia, and was made from the fossilized remains of plants or animals that were alive about 400 million years ago.
- *Fertilizer and pest control:* Without a diversity of species to provide natural pest and disease control, a one-crop farm (a monoculture) is more susceptible to these problems. To avoid blight, the potato was treated with fertilizers and pesticides; these chemicals accounted for 38% of the farmer's expenses. The pesticides were made with petroleum. Nitrogen—a key element of the fertilizer--was obtained by using fossil fuels (primary natural gas) to extract nitrogen gas from the air.
- Some of the fertilizers and pesticides washed into streams when rain fell. The Environmental Protection Agency's tests of waters in the Columbia Basin found agricultural contaminants in every tributary, including the Snake River. The pesticides introduced substances into the environment that are linked to toxicity in fish and mammals.
- *Irrigation:* The potato required 7.5 gallons of water. The water came from the Snake River. The Snake River valley and its downstream neighbor, the Columbia Basin, produce 80% of U.S. frozen French fries. Dams along the river provide irrigation for the fields. Below Milner Dam, west of Pocatello, the riverbed is dry much of the year. As a result, 80% of the Snake's original streamside ("riparian") habitat is gone.

Transportation: A truck, powered by diesel, took the potato to the processing plant. The fuel was made from petroleum, the fossilized remains of plants and animals that were alive about 400 million years go. After processing, a freezer truck hauled the French fries to a grocery store or restaurant supplier.

Processing/Storage:

- The potatoes were sliced and frozen. This required electricity, which came from a coal-fired power plant. The freezer also used hydrofluorocarbon coolants. Some of these coolants escaped from the plant. They rose ten miles up, into the stratosphere. The coolants did not deplete the ozone layer, but they did trap heat, contributing to the greenhouse effect. (One type of coolant, chlorofluorocarbon (CFC), depletes the ozone layer, but it is now banned.)
- Cutting and processing the potato created two-thirds of a gallon of waste-water. This water contained dissolved organic matter and one-third gram of nitrogen. The waste-water was sprayed on a field outside the plant. The field was unplanted at the time, and the water sank underground.
- Remaining potato scraps were sold as cattle feed.

Preparation/Consumption: Before they are eaten, the frozen potatoes are fried in oil to make French fries. The oil is made from soybeans, corn, or cottonseed. In the US, the majority of soybeans for cooking oil are grown in the Midwest.

Disposal: After frying, wasted fat remained. If the liquid fat is poured down the drains, it may harden and can create a blockage (just as it can in your arteries). The disposal of fat has become a problem in many cities; in London, for example, many sewer blockages are caused by fat. The plastic bag the frozen fries came in will go into a landfill. There, it will take at least 250 years to break into little pieces. It will not decompose. The paper box the fries were served in will go into a landfill (Ryan and Thien. 1997).

Potato Story 2: Traditional Peruvian-grown potato

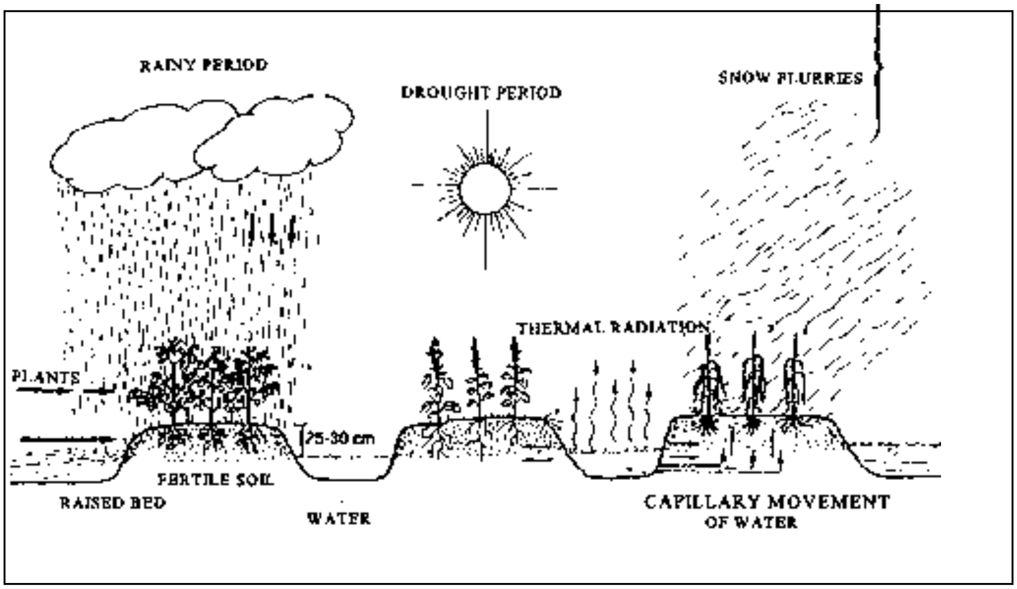
Scientists believe that potatoes grew wild in the mountainous regions of Peru as long as 13,000 years ago. The Inca civilization dominated the region from 1350-1533 and cultivated potatoes (which they called *papas*). The Incas developed more than 200 varieties of potatoes and developed new ways to increase production while maintaining soil fertility. Here are some of their techniques:

Growth:

Cultivating and harvesting: To prepare the soil the Peruvian farmers developed a foot plow called *taclla* that used a person's weight as leverage to turn over the heavy sod. The Incas depended on human power and hand tools to harvest crops.

Pest management: Pests were controlled using natural predators, and there was no use of human-made chemicals. Soil fertility was maintained with compost and manure.

Irrigation: Since potatoes are native to Peru, they are adapted to the climate and need little irrigation. To protect crops from flooding or drought, the Incas built a system of raised beds and canals, pictured right. The water in the canals also protected against extreme changes of temperature.



Processing and storage: To prepare their potatoes for storage, the Incas left potatoes out overnight to freeze, and in the morning they walked on the potatoes to remove the moisture. This process was repeated for 4-5 days. The resulting product was called *chuño* and could be stored for up to four years. This storage method insured that the tribe had food even in times of extreme weather and poor crop yields.

Transportation: *Chuño* was a staple food for the Incas. People traveled on foot between the highlands and lowlands to trade among villages. A network of paths helped promote trade and contact, and llamas were used as pack animals.

Consumption: Most of the potato, besides the moisture extracted while making *chuño,* was consumed. Besides being used as food, the potato was also used by the Incas as part of their medicinal and spiritual rituals.

Disposal: Little, if any, waste was created from making *chuño.* Water extracted from the potatoes returned to the ground and the *chuño* naturally decomposed if it was unused. Other "wastes" from food or animals turned to compost within days or weeks and served as nourishment for the soil.

Many scientists and farmers today recognize the value of the Inca's agricultural knowledge and expertise. Today Incan farming methods are being revived to provide nutritious food using methods that maintain the health of the local ecosystem.

Text based on information from the Office of International Affairs, Organization of American States. (1989) ***Lost Crops of the Incas: Little-Known Plants of the Andes with Promise for Worldwide Cultivation***

Potato Story 3: Organic, Locally Grown Potato

This potato was grown at a farm located near your home.

Growth:

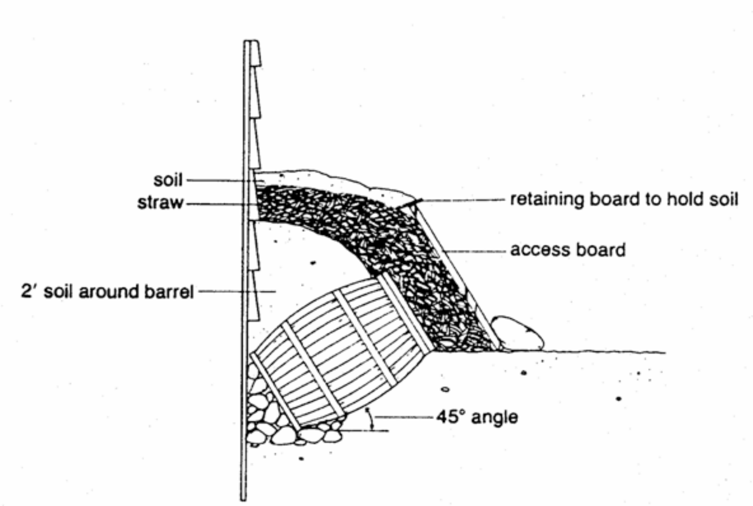
- *Cultivating and harvesting:* Due to the variety of crops grown at the community farm, all planting and harvesting is done by hand and there is no use of harvesting equipment. The potato is then sold at the farm or at the local farmer's market.

- *Pest management and fertilizer:* The potato was grown on land that was fertilized using compost and manure; the farm does not use any synthetic fertilizers or pesticides. The farm uses manure from their animals, and compost from plant matter and food scraps. Instead of using pesticides, the farm uses integrated pest management. Therefore, there is no contamination of waterways or surrounding animal habitat. Also, the potato was one of over a dozen different types of crops. Having a diversity of plants, and rotating them year to year, helps control pests, disease, and increases overall soil fertility.

- *Irrigation:* The farm has its own well, which taps into a groundwater aquifer. The farm uses sustainable watering practices, including drip irrigation (watering right around each plant). This consumes considerably less water than spray pipes because there is less water lost by evaporation and run-off.

Transportation: It takes less than a gallon of fossil fuels to get the potato from the farm to the local farmer's market. Because the farmer's market is located near the center of the city, many residents can walk, ride bikes, or take the bus to buy the potatoes. Some customers drive.

Processing and Storage:
The little time between harvesting the potato and the short trip to the local market eliminates the need for the potatoes to be frozen or even refrigerated. Once purchased, the potato can be best stored in a burlap sack in a dry, dark place where the temperature stays at 30-40 degrees Fahrenheit. Options include a refrigerator, or a storage barrel buried underground. The barrel will keep potatoes for 6-10 months without the use of added energy.



Consumption: The entire potato is edible, and can be fully consumed.

Disposal: A potato that has not been prepared with excessive amounts of fats or oils can be composted, becoming nutrients for other plants. The decomposition process will take several weeks.

(Text based on information from the Community Farm of Ann Arbor: http://www.communityfarmofaa.org/). 3

Input-out put diagram for recording responses

Inputs (materials, energy, labor):

1. Growth and harvest	2. Transport	3. Processing	4. Consumption	5. Disposal

Outputs (wastes, emissions):

Table to record responses

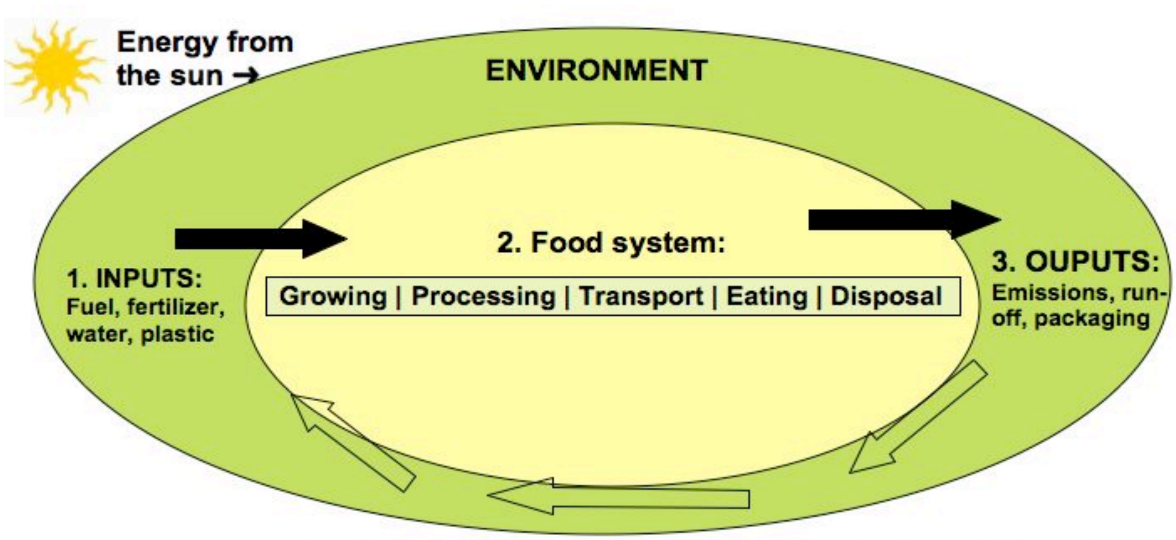
Summarize the inputs and outputs needed for the three different types of potatoes at each stage.

	French fry	Potato grown with Peruvian methods	Locally grown, organic potato
Growth: Cultivation/ harvesting methods			
Growth: Fertilizers/ Pest management used			
Growth: How water is obtained			
Transportation			
Processing/ Storage			
Consumption/ Disposal			

Summary: Food systems and the environment

As you have learned the production of food requires materials and energy (inputs), and produces wastes (outputs). But where do all the inputs come from? Where do all the outputs go? The answer is *the environment*. This is because all aspects of a food system exist within the environment, which is a “containing” system. Here are four key ideas to remember:

1. The environment serves as the ultimate source of all inputs: Everything needed to produce food comes from the living or non-living substances of the environment, including soil, water, trees, solar energy, and pastures for animals. (The people who provide labor for food production also depend on the environment.) The more materials drawn from the environment for a particular food, the larger its footprint.



The environment is the source of all materials and energy, and the “sink” into which all outputs go. Wastes are transformed, but do not go “away.” Some wastes (such as compost or paper) may become new inputs.

Diagram: Creative Change Educational Solutions. Adapted from works of Herman Daly.

2. The stages of the food system involve transforming natural materials: For example, oil is refined into fuels; coal is burned to make electricity; trees are made into paper for packaging. These activities require energy (typically, fossil fuels). Thus, the more energy and materials used for processing, the larger the footprint.

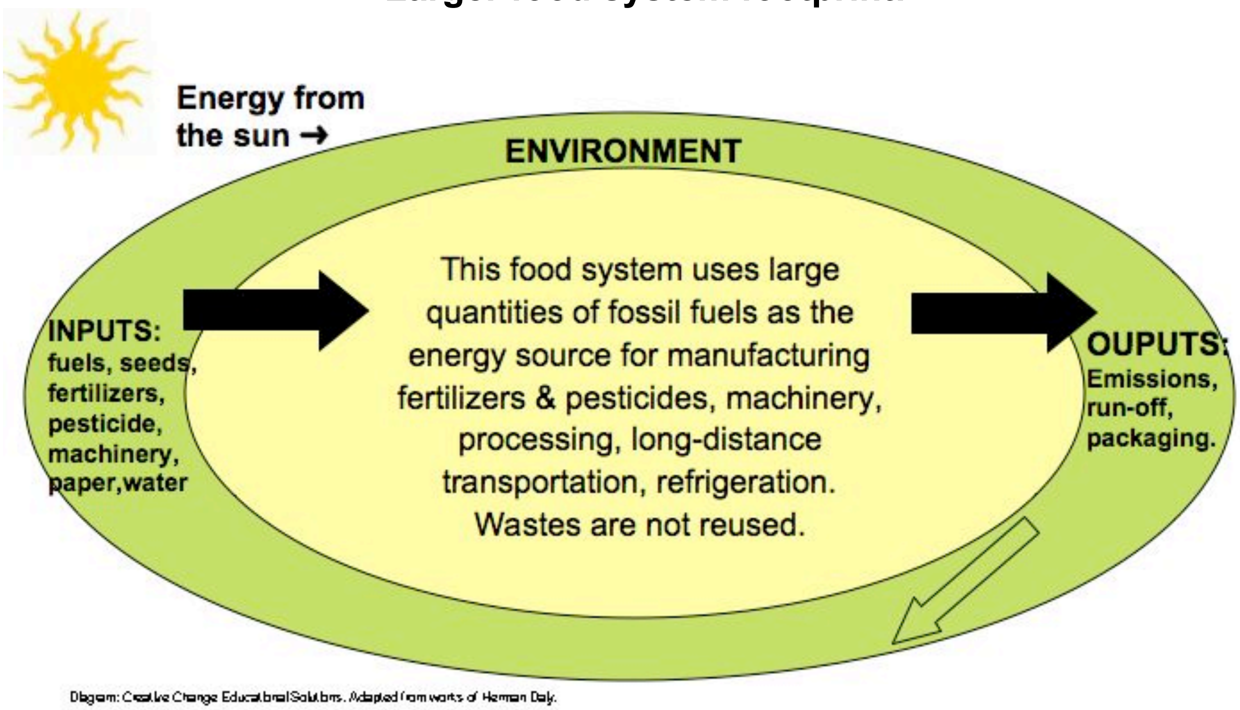
3. The environment serves as the final "sink" into which all outputs go. The outputs created in the food (run-off, emissions, packaging, etc) stay in the environment. Discarded packages go into landfills, run-off goes into rivers, and fuel emissions go into the atmosphere. Wastes may transform (through burning or decomposition), but the laws of physics tell us that they do not go away. In reality, then, it is impossible to throw something "away" since all wastes end up going into some other part of the environment. Because of this, the more polluting wastes produced, the bigger the environmental impact and the larger the footprint.

One aspect of a sustainable food system is to reduce the footprint to within environmental limits: “Sustainability” is a complex concept with many aspects. One element focuses on environmental impacts, and to utilize materials and produce wastes at a rate that the environment can renew. Examples: Catching fish at a rate that ensures replacement. Adding fertilizers at a rate that does not overload the ability of wetland and waterways to filter them. Using energy in a way that reduces emissions.

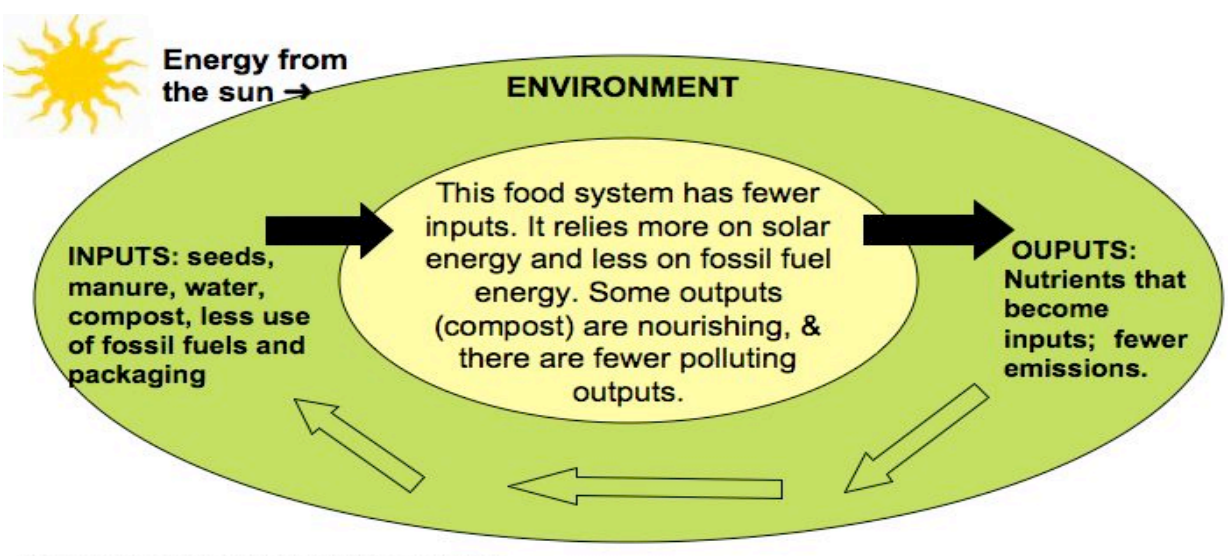
Note: The diagram shows human activities in the center; this reflects the fact that humans exist within the larger biosphere. This is not meant to suggest that humans are the most important species, or that the natural world exists for their needs only.

Here are some additional diagrams to help explain the difference between large and small footprints in food systems:

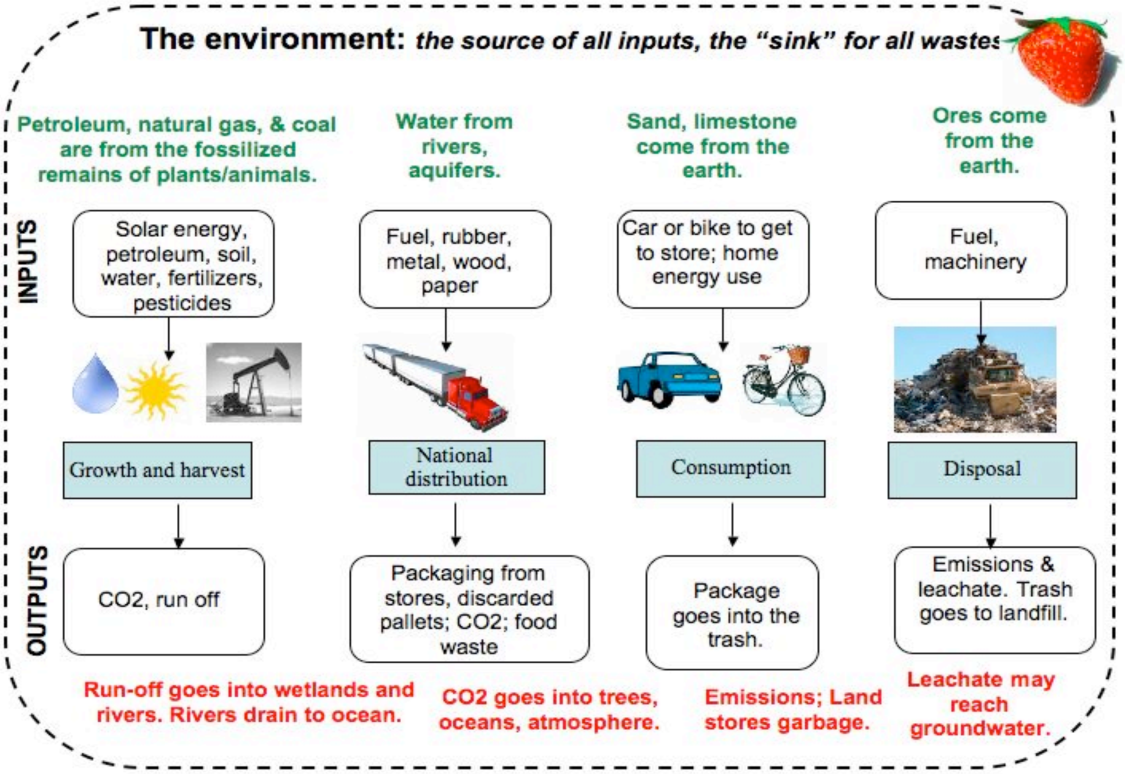
Larger food system footprint:

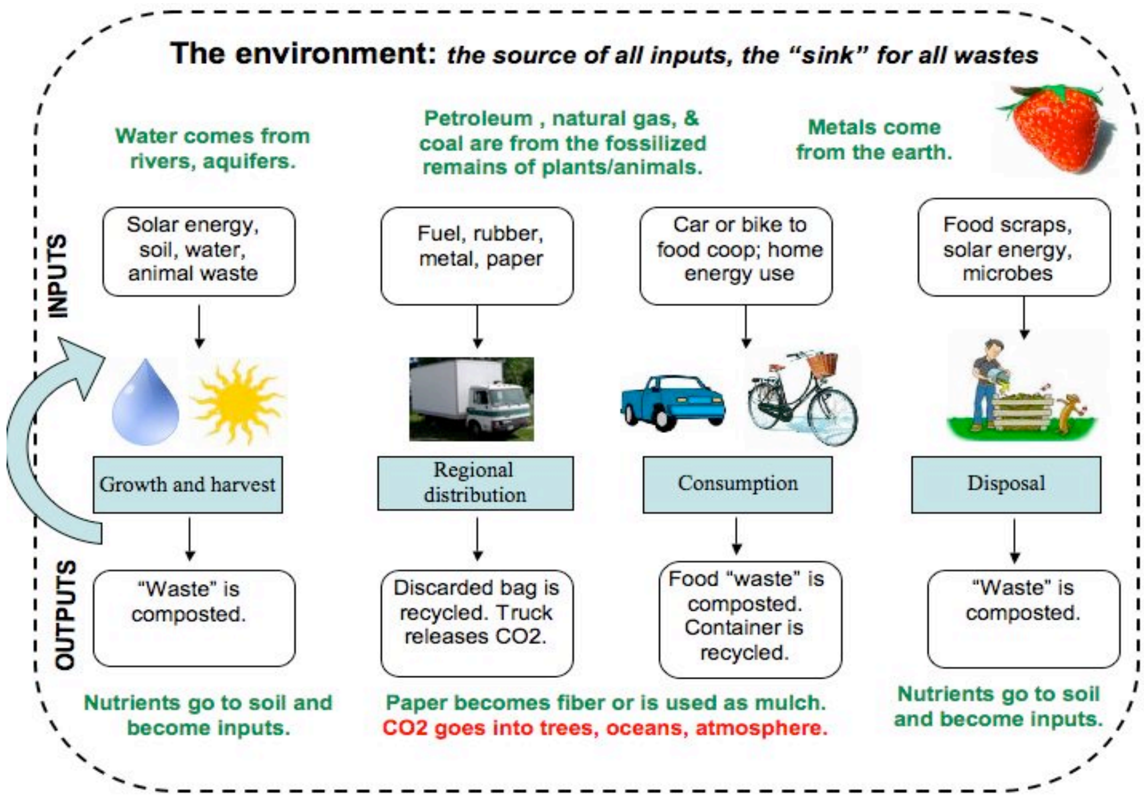


Smaller food system footprint:



These diagrams show the "life cycles" of two different strawberries. The top berry was grown in a distant state, and with the use of petroleum-based inputs. The bottom strawberry was grown regionally, and with fewer of these inputs. The diagrams show how all inputs come from the environment, and all wastes go back into it.





Activity 4) Reducing our “food footprint”

Introduction

Reducing our “food footprint” means reducing the negative environmental impact of the foods we eat. The use of fossil fuels in food production, transportation and other stages is one of the biggest contributing factors to a food’s footprint. As you may know, burning fossil fuels releases carbon dioxide, one of the main gases contributing to global climate change. Thus, one of the main ways to reduce your food footprint is to choose foods that are produced using fewer fossil fuels.

Directions

The table below provides an overview of fossil fuel use in U.S. good production. The percentages represent the fossil fuels used in each stage of the food system. For example, 6.6% of the total fossil fuels used in the food system are used in packaging materials. In the blank column, brainstorm food choices you can make that would reduce the amount of fossil fuels used.

Food system stage	% of fossil fuels used in the this stage	Examples of energy used and impacts	What choices and actions can reduce the use of energy at this stage?
Agricultural production	24%	Researchers estimate that 40% of energy used at this stage is for producing synthetic fertilizers and pesticides; 25% is for diesel fuel; 35% is for other uses such as irrigation Excessive fertilizer can runs off into waterways; too much creates algae blooms and can kill other aquatic life forms.	
Transportation	13.5%	Gas and diesel fuel are used to transport foods from manufacturers to store, and from stores to your home.	
Processing Industry	16.4%	Electricity (often powered by coal) is used for processing steps such as baking, drying, slicing, and freezing.	
Packaging Material	6.6%	Making packaging requires energy as well as raw materials to make glass, plastics, aluminum, and paper products. Disposing of these wastes requires fuel for trucks and	
Food Retail	3.7%	Stores use electricity for refrigeration and freezing, among other uses.	
Commercial Food Service	6.6%	Cooking and preparing food for restaurants, schools and other institutions consumes natural gas and electricity.	
Household Storage & Preparation	31.7%	Operating refrigerators, freezers, stoves, ovens, and dishwashers uses electricity and natural gas.	

(Heller and Keoleian, 2000)

Ways to lower your food footprint at different stages of the food system

Production:

- Eat seasonally and locally. Choose foods available by season that have not been transported long distances. For example, when food from Europe is imported to the USA by plane, it takes 127 calories of energy (aviation fuel) to transport 1 calorie of food energy across the Atlantic (Cormack, 2000). "Locavore" is a new term for someone who tries to eat locally; a "100 mile diet" is a particular type of local eating that focuses on foods grown within that range.
- Plant a garden or take part in a community garden. Home-grown food travels only yards to your plate.
- If you eat meat and dairy, choose pasture-fed products. Non pasture-fed meat is from animals that are typically fed corn and soy. Producing these grains is very energy-intensive, both in terms of the fertilizer usage and the transportation and processing. By some estimates, it takes about seven pounds of corn to produce one pound of beef (Leibtag, 2008). To contrast, pasture-fed animals rely more on grass; this reduces energy use while providing benefits for grasslands, assuming there is no over-grazing.
- Choose foods grown with methods that reduce the use of fossil fuels. Options:
    - Choose certified organic foods, which eliminate the use of fossil fuel-based fertilizers and pesticides made with fossil fuels. (Remember though, that organic foods can still rack up a high carbon footprint if they travel a long distance or are grown using a lot of machinery. For this reason consider a food's overall life cycle, not just production methods.)
    - "No-till" farming reduces the use of machinery and keeps organic matter in the soil, adding fertility. Soil that is not tilled also stores carbon, acting as a "sink" for carbon dioxide (Elstein, 2004). As of this writing, foods are not identified in stores with a "no-till" label the way organic foods are.
    - Eat lower on the food chain. Choosing to eat just one meal per week without meat can make a difference.

Processing and transportation:

- Choose whole/unprocessed foods: Grinding, milling, cooking, freezing and other steps of food production are energy-intensive. For example, the grinding, milling, wetting, drying, and baking of a breakfast cereal requires about four calories of energy for every calorie of food energy it produces. Producing a two-pound bag of breakfast cereal burns the energy of a half-gallon of gasoline; this does not include fuel for transportation (Manning, 2004).
- Choose foods with less packaging to reduce waste.

Purchasing, consumption and disposal:

- Shop at your local farmer's market, natural foods store, coop or other venue that is committed to supporting local and organic agriculture.
- Conserve energy in food preparation and storage. Put lids on pots when boiling water. Keep your refrigerator and freezer tuned and running at an appropriate temperature. When possible, choose energy efficient appliances.
- Consider traditional methods of food storage and preparation often rely on naturally-occurring heating and cooling, such as solar ovens and driers or root cellars.
- Compost food scraps in an outdoor bin or worm bin.

Questions:

- Which actions do you already do?

- What are the barriers to choosing more of the above actions?

5) Before the next session

- Think of the best meal or eating experience you ever had. What made it memorable?
- Now think of the most expensive meal you've ever had. Is it the same as your response above? If your responses are different, what made the 2nd meal expensive?
- Take notes to use for the next session's discussion.

Extension Opportunity: Learn more about your footprint

The "footprint" concept is derived from a scientific measurement tool called the "Ecological Footprint" (EF). The EF estimates "the amount of land and ocean required to sustain your consumption patterns and absorb your wastes on an annual basis." In other words, it measures the amount of land, trees, ocean, etc. required to produce all your materials (inputs) and absorb your wastes (outputs) for not only food habits, but overall lifestyle including the your housing, transportation, and consumption of goods. An on-line quiz (http://www.myfootprint.org) enables you to find out what your footprint is, and how to reduce it. The site is presented by Redefining Progress (http://www.rprogress.org)

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