Food Miles

Buy Local, Pollute Less

Overview

Food is produced and distributed in many different ways. Today's modern agricultural production and global markets often stretch food supply chains across continents and seas around the globe. The further food travels from the farm to consumer, the more energy is required to transport it. Using fossil fuel energy in transportation emits carbon dioxide, which is a greenhouse gas and leading contributor to global climate change. The US, with only 1/20 of world population, produces 1/4 of world greenhouse gas emissions. Roughly 35% of US CO_2 emissions come from industry; 33% of that is from transportation.

This activity engages students in harvesting and packing a crop, then familiarizes them with food distribution issues. Students will estimate the energy use and pollution impacts of (the expected transportation of) the crop they harvested and compare that with an equivalent crop transported a long distance.

The goal of this activity is to introduce the idea that there are different environmental and social consequences between different food supply chains, depending on whether they are local, national or transnational. The activity also addresses some of the benefits of local distribution and consumption for the farmer and consumer. The following resource references are provided to improve your familiarity with the topic.

Resource References

Where does food come from? Food Routes Network
http://foodroutes.org/whycare2.jsp

Five reasons for buying locally grown products. Community Alliance with Family Farms
http://caff.org/programs/buylocal.shtml#whyblg

Trace the French Fry: An Introduction to the Food System (p. 44 - 46) In French Fries and the Food System: A Year-Round Curriculum Connecting Youth With Farming And Food, 1991.by Sara Coblyn. Lincoln and Roxbury: A publication of the Food Project

Fuel and Energy Source Codes and Emission Coefficients. Energy Information Administration, U.S. Department of Energy
http://www.eia.doe.gov/oiaf/1605/factors.html

Truck Fuel Consumption and Travel. Research and Innovative Technology Administration, U.S. Department of Transportation http://www.bts.gov/publications/national_transportation_statistics/html/table_truck_profile.html

Carbon Emissions Worksheet for Individuals and Households, 2000. Annie Faulkner, New England Coalition for Sustainable Population http://www.vtearthinstitute.org/carbonwksht.html

Farm to Table: Calculate the travel costs for foods you consume (p. 123-127). Healthy Foods From Healthy Soils. 2003. Elizabeth Patten, Kathy Lyons. Tilbury House Publishers, Gardiner, Maine

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Introduction

This activity is designed to engage students in discovering that food comes from various regions of the US and other countries, and typically requires a significant amount of handling and distribution to reach us as consumers. Students will see that there are variable benefits and costs associated with handling and transportation, depending on the distance between where food is produced and where it is consumed. They will observe a crop growing in the field and help in harvesting and packing it. Students will investigate the supply chain of a crop they help harvest and compare it with that of a commercially purchased crop of the same type. Students will then make an accounting of the energy inputs and CO_2 output inherent in each of these supply chains. Students will examine which supply chain contributed most to greenhouse gas production and global warming. Students will be introduced to the concept that sustainable agricultural production and distribution efforts to maximize social and environmental benefits while minimizing energy consumption and pollution.

To Lead This Activity You Need to Know

- Production practices of the crop(s) with which the students will work.
- Harvesting, post-harvest handling and packing practices used with the crop(s).
- How to calculate the energy requirements and pollution produced for a given produce supply chain.

Key Concepts:

- Crop production and distribution process (crop growth, harvest, packing, and transporting)
- Food Supply Chains (local, regional, national, global)
- Energy consumption
- Pollution
- Climate Change
- Global Food Diversity
- Organic Agriculture
- Community Supported Agriculture (CSA)
- Farmers Markets

Objectives

- Understand different crop production and supply chains.
- Practice the skills needed to harvest and properly pack a crop for distribution.
- Estimate crop distribution expenses in terms of fuel and pollution cost.
- Compare and evaluate different food distribution scenarios on the basis of fuel and environmental costs as well as social benefits of alternative distribution pathways (e.g., farmers market, CSA).

Materials

Harvesting and Packing

- A harvestable mature farm crop and an equivalent product purchased from a store
- Harvesting and packing tools and supplies

Food Supply Chains

- A piece of poster paper or a display board large enough for the group to see
- Markers to write on the poster or display board

Estimating Benefits and Impacts of a Supply Chains

- A piece of poster paper or a display board large enough for the group to see
- Markers to write on the poster or display board
- A world map and means to measure distances
- Calculators (1 per 3-5 students)

Activity (50 minutes)

Harvesting and Packing (25 minutes)

1. After welcoming the students to the farm and describing how your farm works, explain that on today's visit they are going to help harvest and pack a crop. They will also explore the issue of distribution of farm products and account for the energy use and pollution impacts of different approaches to getting the crop to consumers.
2. Walk the student through the field and show them the crops being grown. If possible, show the crop in its different growth stages, from seedling to full maturity. Bring students to the mature crop location and show the distinctions of what make that crop ready for harvesting, contrasting it with the immature and/or over-mature plantings or individuals.
3. Demonstrate how to select and harvest the crop and then supervise the students in doing these tasks. Ideally, this will be done in conjunction with the farm's own schedule so that the students can be acknowledged for the contribution they actually make to the task of harvesting.
4. Once back in the packing area, demonstrate the steps involved in cleaning, grading, sorting and packing the crop in preparation for distribution. Let the students participate in these steps and supervise them.
5. Discuss the next steps in the distribution process: where is it going, who is taking it there, how far it is going, how long will it take, how it will be sold and who will consume it.

Food Supply Chains (10 minutes)

1. Pass around store bought equivalents of the crop(s) harvested by the students, which could be pre-packaged or fresh; it is preferable for the produce to have a label or similar method that identifies where it was grown. Ask if there are different transportation requirements for the store bought product compared to crop they helped harvest and distribute today.
2. Display the two possible food chains shown in Figure 1 on your poster paper (without the headings). Discuss the different participants in the food chains: producer, packer, shipper, wholesale distributor, retailer and consumer (see Figure 1). Have the students choose which one would represent typical commercially sold produce. Then ask which pathway would most likely represent locally grown produce, such as farmers market and community supported agriculture (CSA) (see Figure 1).

Figure 1: Possible Food Supply Chains

Commercially Marketed Produce: Producer –> Packer –> Shipper –> Distributor –> Retailer –> Consumer	• **Producer**- grows of the crop • **Packer**- cleans and packs the crop • **Shipper -** Transports the crop • **Wholesale Distributor-** buys from producers and sells to processors and retailers • **Retailer**- sells to the consumer • **Consumer**- you, the public
Direct Marketed Produce: Producer –> Consumer	• **Producer**- the farmer or grower of the crop who also retails • **Consumer**- you, the public

Estimating Benefits and Impacts of Different Supply Chains (15 minutes)
(See student worksheet)

1. Review with the students the steps needed to get the crop they just harvested and packed to the local consumer (e.g., Farmers' Market, CSA, local retail outlet). Students could also reflect on the steps involved in growing a crop themselves and consuming it at home, if their family has a farm or garden.
2. Show the students the purchased equivalent again and ask about the difference in the number of steps between distributing today's harvested farm crop and the store bought equivalent. Ask them if there are any consequences of these differences for

consumers, society or the environment. Build on the answers they provide and ask them how they estimated those consequences.

3. Ask the student what they think about smog and global climate change. Ask them what contributes to these conditions. Introduce the next activity as a way of estimating to what extent our food distribution and consumption choices might be contributing to smog and climate change and which choices reduce these impacts. Explain that this activity is a way to estimate the amount of air pollution resulting from energy used in different crop supply chain scenarios.
4. Ask two students to be writers on the big sheet of paper and guide them through the accounting process. To account for the amount of fuel consumed in a particular supply chain one needs to estimate the miles traveled between the locations where the crop is grown and where it is purchased, and then divide that number by the fuel efficiency of the vehicle typically used in transporting that crop. Regionally grown crops are typically transported using box-trucks and other 2-axel diesel vehicles with an average fuel efficiency of 9 miles per gallon. Crops that travel long distances between where they are grown and sold (interstate, nationally or internationally) are typically transported using combination tractor-trailer diesel trucks, with an average fuel efficiency of 6 miles per gallon. It is important to keep in mind the total load capacity of the vehicle being used. Box-trucks have approximately an 8 pallets capacity, where as tractor-trailer trucks have approximately a 24 pallets capacity.
5. To estimate the total amount of CO_2 emitted from the vehicle when transporting a vehicle full of a crop, multiply the total amount of fuel consumed by the CO_2 coefficient (carbon dioxide released into the atmosphere per unit combustion of that fuel).
6. Identify a vehicle's truckload (i.e., net crop weight) capacity by finding the per box weight of a crop and multiply it by the number of boxes in a pallet. Calling a local farm and/or wholesale distributor can provide the weight of a crop per box, and the number of boxes per pallet. Then multiply the crop weight per pallet by the number of pallets per vehicle used.
7. The following is an example of estimating the total crop weight capacity of tomatoes using a tractor-trailer truck. A tractor-trailer truck at capacity can hold 24 pallets. Each pallet can hold 80 boxes of tomatoes, with each box weighing 25 pounds. First multiply the number of boxes (80) per pallet by the total number of pallets per truckload (24). The result is a total of 1,920 boxes. Now multiply the total number of boxes (1,920) per truckload by the weight of each box (25 lbs). This results in a total truckload capacity of 48,000 pounds of tomatoes.
8. Divide the truckload crop weight capacity by the total CO_2 emissions of that vehicle. This will provide an estimate of the amount of CO_2 produced per pound of crop transported.
9. Select the typical weight of a crop purchased at the market. Multiply it by the amount of CO_2 produced per pound of crop transported to get an estimate of the amount of CO_2 pollution associated with that market choice.

Example of estimation process:

Not every transportation supply chain covers the same distances or uses the same vehicles. In the following examples, we go through step-by-step process of estimating of the amount of CO_2 pollution resulting from two supply chains, the first is long distance and the second is regional. In these examples we use tomatoes to compare how different transportation supply chains can result different amounts of CO_2 pollution.

(See attached Student Worksheet)

Question 1.

How much fuel did the supply chain of tomatoes use if:

a. the tomatoes were being transported from a farm in Homestead, Florida to San Francisco, California, a distance of 3,154 miles and,
b. the vehicle (tractor-trailer truck) gets approximately 6 miles per gallon of diesel.

Answer 1.

3,154 miles ÷ 6 miles per gallon = 526 gallons (rounded to whole gallons)

The supply chain would use approximately 526 gallons of diesel per truckload of tomatoes.

Question 2.

How much pollution in pounds of CO_2 would be emitted if:

a. 526 gallons of diesel was used and,
b. each gallon of diesel produces 22 pounds of CO_2?

Answer 2.

526 gallons x 22 lbs CO_2 per gallon = 11,572 lbs CO_2

The resulting pollution would equal 11,572 pounds of CO_2.

Question 3.

What is the per pound amount of CO_2 for the tomato shipment if:

a. each tractor-trailer emitted 11,572 pounds of CO_2 pollution and,
b. each tractor-trailer truck load contained 48,000 pounds of tomatoes?

Answer 3.

11,572 lbs CO_2 ÷ 48,000 lbs tomatoes = 0.24 lbs CO_2

The transportation costs, in terms of pollution, for each pound of tomatoes equals .24 pounds of CO_2.

Question 4.

If 3 lbs of tomatoes were purchased in San Francisco, California and these tomatoes were grown in Homestead, Florida and transported using a tractor-trailer truck, how much CO_2 pollution would have resulted?

Answer 4.

0.24 lbs CO_2 x 3 lbs tomatoes = .72 lbs CO_2

The 3 pounds of tomatoes would be associated with .72 pounds of CO_2 pollution, due to its transportation.

Now repeat the calculations process for a supply chain of local or regionally sourced tomatoes.

Questions 1.

How much fuel did the supply chain of tomatoes use if:

a. the tomatoes were being transported from a farm in Capay Valley, California to San Francisco, California, a distance of 180 miles and,
b. the vehicle (box-truck) gets approximately 9 miles per gallon of diesel?

Answer 1.

180 miles ÷ 9 miles per gallon = 20 gallons (rounded to whole gallons)

The supply chain would use approximately 20 gallons of diesel. (rounded to the nearest whole gallon)

Question 2.

How much pollution in pounds of CO_2 would be emitted if:

a. 20 gallons of diesel was used and,
b. each gallon of diesel produces 22 pounds of CO_2?

Answer 2.

20 gallons x 22 lbs CO_2 per gallon = 440 lbs CO_2

The resulting pollution would equal 440 pounds of CO_2.

Question 3.

What is the per pound amount of CO_2 for the tomato shipment if:

a. each box-truck emitted 440 pounds of CO_2 pollution and,
b. each box-truck load contained 16,000 pounds of tomatoes?

Answer 3.

440 lbs $CO_2 \div 16{,}000$ lbs tomatoes = 0.027 lbs CO_2

The transportation costs, in terms of pollution, for each pound of tomatoes equals .027 lbs of CO_2.

Question 4.

If 3 lbs of tomatoes were purchased in San Francisco, California and these tomatoes were grown in Capay Valley, California and transported using a box-truck, how much CO_2 pollution would have resulted?

Answer 4.

0.027 lbs CO_2 x 3 lbs tomatoes = 0.08 lbs CO_2

The 3 lbs of tomatoes would have resulted in 0.08 lbs of CO_2 pollution.

Now compare the total CO_2 pollution produced by each supply chain per pound of tomatoes. When buying tomatoes and choosing between long distance or locally grown, choosing to buy from which supply chain would contribute least to CO_2 pollution, smog and global warming?

Answer:

The purchase of Capay Valley, California tomatoes would make the least contribution to smog and global warming, because at the point of purchase, the transportation of Capay Valley tomatoes contributed nearly10 times less CO_2 pollution per pound of tomatoes than that of the Homestead, Florida tomatoes. Note: Long-distance transporters typically have full loads in both directions, but local or regional transporters may have an empty truck following delivery. If we assume that this is true in our example, we need to double the amount of fuel used and CO_2 produced in our regional example. If we do this in this example, the tomatoes trucked across country still result in nearly 5 times the amount of CO_2 pollution as the regionally produced tomatoes.

Discussion and Reflection (10 minutes)

Ask the students when they buy other types of produce such as apples or oranges, do they think about where the food they eat is grown? Does it matter that apples and oranges in our markets may be grown in hundreds of miles away in other parts of the country or even thousands of miles away across the oceans on other continents? Did they know that apples are produced in many states within the U.S. and that less than 80 years ago most the apples eaten in the US were likely grown within the very same regions they were consumed?

Ask the students what they or their parents buy at the store. Was it grown nearby, in the state, or even on the North American continent? Have you ever seen signs in the store about where the food was grown, such as on what farm or in what state or country?

Review the concepts of Community Supported Agriculture, farmers markets, and other methods of direct marketing. Ask the students what they think the difference in pollution costs are between locally grown and distributed food and the long-distance food sold in the grocery store? What are some of the benefits of local distribution and consumption for the farmer? Why would a farmer want to distribute food locally, why would s/he choose to distribute nationally or globally? What are some of the benefits to the consumer? (see Local Food, Taste the Difference! activity in this packet) What are some of the disadvantages to the farmer and consumer and society?

Student Worksheet

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Estimate the per-pound carbon dioxide (CO_2) pollution produced by the transportation of a selected food crop. Do this estimation twice, once using an example from a regional or local food supply chain and once for a long distance supply chain. Compare results.

Answer the following questions in order to calculate an estimate:

1. What is your selected crop? ______________
2. Where was the crop grown? _____________ (farm location)
3. Where was the crop consumed? _____________ (your location)
4. Distance crop traveled from farm to consumer? ___________ miles
5. Typical vehicle used in transporting the crop? ___________
6. Fuel efficiency of the vehicle used? ______ miles per gallon
7. How many gallons of fuel were used in transporting the crop?

____________	÷	___	=	_________ gallons of diesel
Distance Between Farm and Consumer (miles)		Vehicle Fuel Efficiency (mpg)		

8. How much carbon dioxide pollution was emitted per truckload?

____________	X	22	=	__________ pounds of CO_2
Amount of Fuel Consumed		Emission Coefficient		Estimated CO_2 Emitted

9. How many pounds of crop can a truckload hold? ________ lbs
10. What is the per pound amount of CO_2 for the crop transported ______ lbs/crop

____________	÷	____________	=	__________ lb CO_2 per lb of crop
Total Amount of CO_2 Emitted Per Truckload		Truck Load Capacity Per Crop		

Choosing to buy from which supply chain would contribute least to CO_2 pollution, smog and global warming? ____