The Industrial Agriculture System

"The Biography of a Tomato"

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Overview

This lesson is designed to be used as part of the larger curricular module, "Investigating Systems in Nature and Industry" (I3) but it can be very effective as a stand alone lesson as well. The lesson is conducted in two parts over two class sessions. In Part 1 students create a concept map of the supply chain of a typical north American tomato. In part 2 the supply chain is analyzed and studied to find environmental/social problems and design features that cause them. The concept map is created through the reading and discussion of "the Biography of a Tomato", a story adapted from *Ecoloigial Design* by Sim Van Der Ryn. The story was researched and created by Peter Bahouth from the Turner foundation. Its also known as "Attack of the Killer Tomato."

Big Ideas

All consumables created in our industrial civilized society have a long supply chain that is complex and often unseen by consumers. Considering the entire supply chain of products and is essential for designing sustainable systems.

DoRight Curriculum Segment

#5: What forces are shaping our world?

Grade Levels: 4-12 (adaptable)

Instructional time:

45 minutes for each part, 90 minutes total

Standards Based Subject Area Connections

Social studies: geography, industrial revolution, interdependence between agriculture, social issues and the economy,
Science: chemistry, biosphere, soil science, systems

Sustainability Topics

Supply chains, human impact on the environment, interdependence between environmental/economic/social issues, ecological footprint

Materials

- Blank paper for making concept map, 8.5x11 or larger
- Industrial Agriculture Analysis Sheet

Objectives

Curricular Objectives

- Create a graphic resource for reference in the study of supply chains
- To compare with ecosystem principles with principles for sustainable systems.
- To generate an assortment of environmental problems for further study within subject area classrooms.

Student Learning Objectives

Students will acquire:

- Understanding of the big ideas (above).
- Foundational knowledge of environmental and social problems associated with industrial agriculture
- Awareness that each product or activity in modern life has far reaching ripple effects that have to be considered, both environmentally and socially
- Knowledge of the geography of North America
- Introductory knowledge of pesticides, packaging, fossil fuels, toxic wastes, and their associated environmental problems.
- Understanding of the difference between closed loop and open loop energy/material flows, and that closed loop systems are more sustainable.

The Lesson Plan

Teaching strategy

Your goal is to present a completely objective view of the system, and let the students ferret out the ethical dilemmas and options in a subsequent analysis, (e.g. the dilemma between the positive of solving world hunger and the negative of using farming strategies that are damaging to human health and well being). On the first reading of the story and the creation of the concept map, explain what the elements are, but resist going in any depth on analysis or evaluation of the elements. Let students generate that later in analysis. Its important they are not preached to about problems and the "evils" of unsustainable systems. They should simply make clear observations and come to conclusions on their own. This is in keeping with a central strategy in SE not to present the environmental and social problems of industrialization as the result of gross negligence and greed, but as natural, byproducts of a sincere effort to improve society—byproducts that need to be fixed, and are being fixed, by all of us.

Part 1: Construct concept map

Tell this story to students, creating the map/picture of it as you go following the suggested script below. The "discussion points (DP) indicated expand on the various elements of the story. Use your judgment as to how many and into what depth you engage these as you create the map. Each discussion point can

actually be used to launch an entire area of study. Explaining each piece as you create the map can get tedious and lose momentum with kids, but throwing in information on certain parts as a "preview" of what's to come in the analysis is good to keep interest as well. Find your own balance.
Note:

- The story line is presented in open text.
- Answers from students and discussion spawned from their answers are indicated in < >
- Special instructions for the teacher delivery are indicated in [ ]
- Optional discussion points are indicated—DP:

Introduction
Explain to students:

We are going to investigate our world today—we're going to take a journey into the story behind where our food comes from, and what it takes to bring it to our table. This is a story that is indicative of where the vast majority of our produce comes from that we purchase from conventional grocery stores (name your local store…). Approximately 80% of the produce you buy is grown and produced this way. This story is what is known as a *supply chain*, or *lifecycle analysis* of this product. A very similar story is true for everything we have in this room--that computer, that chair, this marker, and so on. Everything manufactured by humans has a long supply chain or biography. When we examine the supply chain of all of the goods we consume we will discover some problems created that need to be addressed, and how to solve them. To get started however, today we are going to investigate the biography of a conventional tomato you might buy at the local supermarket.

The Story—The Biography of a Tomato

"So, how does a tomato's life begin?"
<as a seed>
"That's right, and in this case the seeds are hybrid seeds created at the University of California at Davis. That's a great agricultural university. What does hybrid mean? In this case, what is a 'hybrid seed?' "
<students will say, car, a car that gets good mileage. Hybrid means a cross between two things. In this case, a cross between two tomato plants with different characteristics (color, disease resistance, flavor, etc.) created through cross pollination and selective breeding.>>

DP: Industrial agriculture uses hybrids created to improve traits that maximize yield, survivability, minimize disease and need for water. This process has resulted in a monoculture of crops within the industrial system. In recent decades heirloom cultivars have become very popular in home gardens and independent farms. Heirlooms are cultivars that were grown long before hybridization and maintain a wider diversity of variety. Many believe that hybrids lack some of the nutritional qualities and flavor of heirloom varieties.

“As it turns out, the tomato is grown in Mexico. How do you think they get the seeds down to Mexico?”

<students guess, suggest planes, etc. ans: trucks. The company is in business to make money, so they are going to use the cheapest transportation available.>>

“So let’s show that, go ahead and draw a truck on your map to show that on the roadway down to Mexico.” [in YOUR depiction of the truck make the exhaust from the pipe very prominent. You should not comment on that at all. They will observe and copy what you draw. Its important to leave as much as possible for them to discover on their own later in analysis.]

“Now, we have the seeds located in Mexico and in order to grow a tomato what’s our first step?”

<put the seed in the soil>

“So before we put the seed in the soil we have to gas the soil with Methyl Bromide. Methyl Bromide is used to fumigate the soil, to kill fungus and microbes that might harm the baby tomato plants. The fields are covered with plastic tarps and the gas is pumped into the soil and allowed to sit for days. We use Methyl Bromide so we will have as many healthy plants as possible. Remember, the industrial agriculture company is in business to make money, so they must do everything they can to maximize profits. Methyl bromide also helps to grow more food, which will feed more people.”

DP: Methyl Bromide is illegal or being phased out in most nations of the world. It is still legal in California to grow strawberries, cut flowers, walnuts, and many other crops, as well as Mexico. It is a class I neural toxin and is the most ozone depleting chemical known. It is applied by spreading tarps across the soil and pumping the gas into the soil and letting it sit for days. The farmworkers in Mexico are rarely given proper protection and Methyl Bromide creates serious respiratory problems for those who apply work with it without protection.

“Great, now we can put our seeds in the soil and grow a young tomato plant. [draw tomato plant]. But guess what, bugs are eating the baby plants! We can’t have that! Remember, we need to maximize yield. So in order to get rid of the bugs we have to manufacture pesticides. What is a pesticide?”

<various answers—pesticides are chemicals that are poisionous to the bugs we want to kill. They help more plants survive which means more food for people and more profits for the agriculture company.>

DP: Pesticides, as well as the use of high nitrogen synthetic fertilizers are leading causes of water pollution, as they wash off the crops and drain through watersheds. There are hundreds of “dead zones” around the world in coastal areas where agricultural toxins and high nitrogen drainage has choked out life from overwhelming algae growth that depletes oxygen supply.

“The pesticides are manufactured in a pesticide factory in Emelle Alabama. [draw factory]. When pesticides are manufactured, toxic waste is created which is

dumped near a poor African American community. This is causing some tension and problems up there in Emelle as you can imagine, but we'll get back to that later."

> *DP: In many localities around America and the world, economically disadvantaged groups suffer the most from environmental degradation. This is an issue that calls into question the fairness of a democratic system, private property rights and the responsibility of the society to protect the commons.*

"Now, how are we going to get the pesticides down to Mexico?"
<truck>

"Yes, excellent." [draw truck]

"Now we're doing pretty well, and at last, WE'VE GROWN A TOMATO!!! [draw tomato]. So when you go to the market, you often see tomatoes wrapped in plastic in plastic trays. Plastic doesn't grow on trees, does it? (ha ha, though it seems like it does when all the litter gets stuck there….), so where do we get plastic? It has to made in a plastic factory. The plastic factory is located in Point Comfort, Texas. [draw factory with smokestacks]. There are many different ingredients that are used to make plastic. Oil is one, but we also need chlorine. Who has heard of chlorine? What is chlorine used for?"
<likely answer: swimming pools>
"And why is it used in swimming pools?"
<likely student answer: to make them clean>
"What is going on, what does it mean to be 'clean?' "
<accurate answer: Chlorine kills bacteria and algae, making the water clean. It kills life, it's a type of poison.>>

"And just like plastic, chlorine doesn't exists in nature as chlorine, it needs to be made by a chemical factory. And it turns out that when chlorine is manufactured, you create dioxins. Dioxins are a whole family of chemicals (hundreds) that cause cancer."

> *DP: Chlorine does not exist in nature, but must be synthesized from other compounds. It is widely used in swimming pools and many cleaning chemicals. It is also used to bleach paper to make it really white. In very small quantities chlorine is considered to be harmless, but this belief is being challenged by new research, and the exact amount of Chlorine that is harmless is debated. Chlorine also interacts with other compounds in the environment to create very toxic substances. The Dioxins that are created from chlorine manufacture and processes are proven carcingens and considered among the most poisonous substances in existence. Dioxin contamination of our environment is a serious growing concern, with close links to exceptionally high cancer rates in the United States.*

> *DP: Oil is also a central ingredient in the manufacture of plastics. Oil is a nonrenewable resource, and needs to be preserved. Currently the United States*

needs to import nearly 75% of all its oil from other countries. This forces the U.S. to be allied with countries that don't support the same standards of human rights and democracy. Many countries that have links to supporting terrorism supply the U.S. with oil. See "State of the World" for more information on oil.

"So how do we get the big rolls of plastic down to Mexico?"
<truck>
"That's right, so let's represent that by drawing another truck and road to Mexico."

"Now this is wonderful, we have our tomatoes grown and wrapped and ready to go to New York (or your state…). But what else do we need before we put them on the truck?"
<boxes>
"And what are boxes make of?"
<cardboard>
"And where do we get cardboard?"
<the carboard factory>
"And what does the cardboard factory use to create the cardboard?"
<trees>
"Yes, so we must chop down some trees. In this case, we get our trees from British Columbia." [draw tree and label]

DP: Deforestation is a leading cause of species extinction worldwide. Currently 1/4 of all mammals are threatened with extinction. According to a report in 2005 by the UN Food and Agriculture Organization (FAO), .13 million hectares (32 million acres) of forest are lost to deforestation annually, equivalent to 0.18 percent of the world's forests. In the pacific northwest, deforestation is largely responsible for the decline and near extinction of wild salmon. Clear cutting forests creates erosion which makes streams shallow. The shallow streams make the water too warm for fish to swim up and spawn. See "State of the World" for more information on forests.

"And the cardboard factory is located in the Great Lakes region, so we have to put the trees on trucks and drive them to the box factory in the great lakes." [draw truck]

"And how do we get the boxes down to Mexico? Again, by truck!" [draw truck and road to Mexico].

"Now, we're looking pretty good, but guess what? We're running out of gas!! We need some gas for all these trucks. Where does gas come from?"
<variable answers, e.g. gas stations, etc. Lead to: from oil in the earth>

DP: Oil is the result of millions of years of processing organic matter—plants and animals—under high heat and pressure inside the earth. That's why it is caused a fossil fuel. There is only one amount of oil in the ground, the earth is not making more oil. When its gone, its gone forever. Oil is essentially stored

solar energy, solar energy accumulated over millions of years. The United states gets approximately 70% of its oil from other countries, and some of those countries are not very friendly to the US. That puts our country at risk—its not good for our national security. Oil burning is a leading cause of too much carbon dioxide in the atmosphere, which is a major cause of global warming. See "State of the World" for more information on oil.

"We will drill for oil in the Gulf of Campeche in Mexico. This is an area by the Yucatan Peninsula in the Gulf of Mexico. The oil is transported by boat and train to the Pemex oil refinery in Mexico to be made into gas. [draw oil derrick, boat, and Pemex refinery]. The gas is then distributed to all the trucks." [draw lines to trucks. Note that there are other steps, e.g. distribution points, gas stations, etc., but this version of the story is simplified for the big picture.]

"At last, we have our tomatoes grown, they are wrapped, boxed, and the trucks have gas. But in order to make the long trip to New York, we have to pick the tomatoes when they are green. If we picked them red they would not make it, even though the trucks have refrigeration. But of course we can't put them in the market when they are green, so ether is applied to make the tomatoes red."

DP: Ether is a natural chemical that plants emit which affects their ripening process. The application of ether speeds the ripening of the tomato. This actually happens in nature. In fact, it is ether, or ethylene from tomatoes that makes them ripen faster if you put them in a brown bag.

"Now that we have the ripe tomato in the market, it arrives, finally, watery and weary, on your plate for dinner."

[As this story nears conclusion, you may hear comments from students such as "I'm never eating tomatoes again!", or "I hate tomatoes." Remind them (and yourself) not to overreact, and that in the analysis we will learn to understand this system more intelligently and make sensible decisions.

Part 2: Analysis

Overview

The analysis utilizes a line of inquiry to reveal the environmental problems created by various aspects of the industrial system. Waste, natural resources and energy used in the system map are identified along with their corresponding environmental problems and solutions. Comparision of the industrial system with the ecosystem (Strongest tree) reinforces essential principles for sustainable systems design which leads to an introduction of the design principles of biomimicry and ecological design. Citizen-based solutions are also identified—changes in consumption choices and behaviors that can leverage change in the system.

This analysis is designed to be an overview and generator of topics for more in depth study. As presented below, students will gain this overview, and you can expand on various topics in the lesson to the extent your time or inclination allows. Don't be overwhelmed—it can be fine to pick certain areas to emphasize or go for the overview. This system map generates a wealth of topics and information which would take an entire course or more to fully study and understand. A simple description of each environmental problem in the matrix is indicated below. For more in depth information on these topics refer to "The State of the World."

Process

Follow the suggested line of inquiry below to fill out the Industrial Agriculture Analysis Sheet with the students. It is strongly suggested to place the students in cooperative groups of 4 and use the Power Café format for this inquiry. The Power Café keeps students engaged and continually shifts the focus between teacher and student, creating a game show style atmosphere for working through the systems observations. (see Power Café).

The Inquiry

1. Finding waste and associated problems

"Let's stand back and take a look at what's going on here. For perspective, let's compare the industrial system to the ecosystem we just studied. What was special about the ecosystem? What was the big idea that made it so amazing, that enabled it to be sustainable for billions of years?"

<primary answer: waste = food>

<other answers: all elements were interdependent, they obeyed the rules of Silent Squares, the energy and materials followed a closed loop system, there was no waste, everything is recycled in its local position, all of the energy came from the sun.>

"Yes, absolutely. Now let's take a look at the industrial agriculture system we just mapped out. We want to find out if the waste in this system is food, and/or how it relates to the system.

"First, let's just identify the wastes. For 60 seconds, observe the system with your group, discuss and make a mental list of all the wastes you can find. Don't write them down yet, just be prepared to share out. You have 60 seconds. On your mark, get set, GO!!!"

[Refer to the Industrial Agriculture Analysis sheet and have various groups share. This can lead to a substantive discussion. Continue until all of the wastes are listed in the appropriate box. Some students may say plastic and cardboard are waste. This is both true and not true depending on how the products are disposed of. If they are recycled they are food, and if not, they are waste.]

DP: Waste plastic is a serious problem for the world's oceans. The U.N. Enviroenmentl Programme concluded in 2006 that every square kilometer of sea held nearly 18,000 pieces of floating plastic. In the Pacific, there exists a

patch of plastic pieces (some pulverized to nearly microscopic size), spread out twice the size of the U.S. Recent studies of 560 dead fulmars in the North Sea near Holland found 19 out of 20 had plastic in their stomachs. For more on oceans see "State of the World." (Economist, Jan. 3, 2009, p. 8)

Now a big question is, what are the environmental problems created by these wastes?

[Query the class to find out what their existing knowledge is, using the power café timed group discussion to pull the existing knowledge from the class. Have some discussion, and arrive at the conclusions indicated in the analysis sheet. If students have done the activity, "State of the World", you can refer back to that understanding. If not, refer to that lesson for more information on these topics. Provide students with an explanation appropriate for your context. (time, goals, student prior knowledge, etc.).

Follow a similar process with the students to fill in the cells for natural resources, energy, and associated problems.

A reference list of the problems are provided below. Refer to "State of the World" for more in depth explanations.

- Pesticides/water pollution: Pesticide toxins and high nitrogen fertilizers find their way into water tables, waterways, wetlands and oceans, contaminating water sources and creating dead zones in early 300 locations of the ocean.

- Chlorine/Dioxins: Doxins are proven cancer causing agents. The cancer rates in the U.S. are among the highest in the world.

- Deforestation/Species extinction: Deforestation creates species extinction and removes an essential sink for carbon dioxide, exacerbating climate change.

- Oil: Causes climate change and reduces national security though dependence on foreign sources. Planetary supply is limited and it must be coserved to avoid a highly disruptive economic transition to alternatives.

- Electricity/ coal: Causes climate change, mercury in fish, acid rain, and other forms of air pollution.

- Climate change: Considered the most potentially catastrophic global environmental problem of our time.

- Soil loss: Since the beginning of industrial agriculture practices, 1/3 of topsoil has been lost .

The idea of an ecological footprint can be introduced here in an inquiry fashion.

2. The Ecological Footprint (EF)

This point in the inquiry is an opportune time to introduce the idea of an ecological footprint. You can skip this step, or simply have a 5 minute version of the discussion below. Its very valuable to spiral important topics such as EF throughout the unit. Study of the ecological footprint is an ongoing theme through the DoRight curriculum, and culimates with the Doright Enterprises audit.

Explain to students; <<maybe make this a reading—or use the Jeremy and rena story>>
In reflection on our Industrial Agriculture Analysis we can see that for us to consume tomatoes it requires a significant amount of land area, used in many ways. When you eat a tomato you are using a small percentage of all the land for each component—seed production, transportation, agricultural land, oil drilling, forests, factories—AND you are using part of the atmosphere, oceans and soils to absorb the wastes. Everything you consume has a similar supply chain, and you are responsible for your percentage of land use to create those products as well. When you add it all up, you get the total ecological footprint measure for your lifestyle. Obviously, if you change your lifestyle, you change your footprint.

Just for fun, lets guess—what do you think your ecological footprint actually is? In other words, how much land area in acres does it take for YOUR life to lived the way you are living it. [answers will vary dramatically]

<<ans: Americans average is 22 acres>>

What if everyone lived like you? Could we all fit on the earth? Let's see, there are 6.5 billion people on the earth, …… ,<get numbers>

[This problem is explored in more depth in people, people people]

3. Problem solutions

Examining the biography of a tomato has revealed a wide assortment of problems. The solutions to these problems fall in several categories—citizen actions, legislative, and technological. In this lesson we introduce this, and focus primarly on the citizen actions *specifically for purchasing produce*, as well as introducing larger principles of design being considered by scientists and corporations. DoRight Enterprises

- Citizen Actions for Industrial Agriculture Problems

- Buy locally produced products
- Buy organic products
- Grow your own produce

4. Systems Comparison with Ecosystem—Biomimicry and Ecological Design

So, are any of these wastes food for the system

<in the industrial system, waste = pollution. Some students may point out isolated cases where items are recycled, or carbon dioxide waste is food for plants, etc. This can get complcated>

Is this industrial agriculture system sustainable? Why or why not?

<the waste in the industrial system is not used as food>

Biomimicry: designing industry using natural systems, structures and processes as mentor, inspiration and model.