PHOTOS BY CYNTHIA VAGNETTI

5 | HOW DID WE GET HERE? THE DEVELOPMENT OF THE "MODERN" FOOD SYSTEM

Summary

What are the origins of today's agricultural system? In this lesson, you will map the geographic origins of common foods and evaluate how changes in food-related technologies impact your eating habits. Then, you will read short selections about historic points in agriculture and create a timeline of significant global "food events" such as Columbus' voyage, the introduction of synthetic fertilizers, and the "green" revolution.

Guiding Questions

- How did today's food system develop?
- What are the key historical events?
- How are these historical events related?
- What is technology? How has it developed in relation to agriculture?

Activities

1) Tomatoes Aren't Italian? (group mapping activity)

2) Can't Live Without It (discussion)

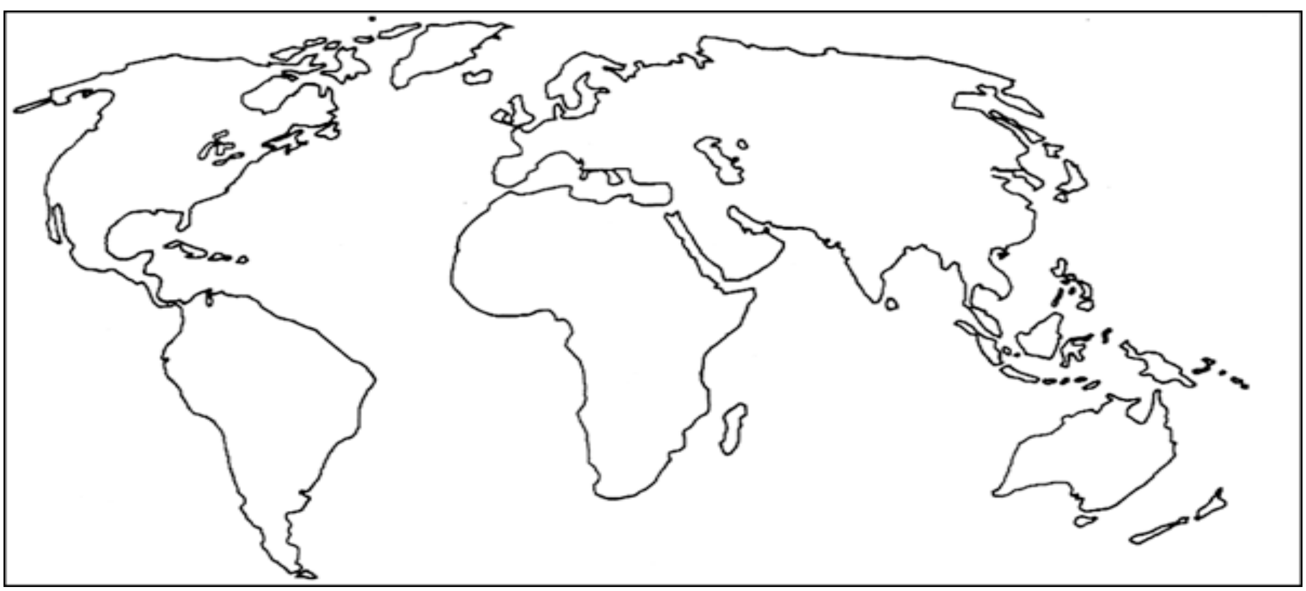
3) How Did We Get Here? (group timeline and discussion)

Activity 1) Tomatoes Aren't Italian?

1. Review the list of foods below and choose two of your favorites.
2. Write each choice on a sticky note, and place the stickies on the region of a world map where you think the food originated from. (If no world map is available, write the number of the food on the map below.)

Foods:

1) coffee
2) peppers
3) beans
4) chocolate
5) corn
6) avocadoes
7) potatoes
8) tomatoes
9) peanuts
10) wheat
11) beans
12) onion



When you are done, review the correct responses on the next page.

Origins of Food

"New" World: North America, South America, Central America

- North America: Sunflowers, Corn (Mexico), Avocadoes
- Central America: Peppers, Beans Chocolate
- South America: Potatoes, Tomatoes, Peanuts

"Old" World: Europe, Africa, Asia

- Europe: Wheat, Beats, Onions, Cabbage, Apples, Peas, Carrots
- Africa: Radishes, Watermelon, Coffee
- Asia: Rice, Sugarcane, Mangoes

Discussion questions

- What was new or surprising?
- What events do you know of that contributed to transfer of foods between the New and Old worlds?
- What questions does this raise?

(Smith, 1998)

Activity 2) Can't Live Without It

Note: For this lesson, "technology" is defined as any human-created invention, or any natural force humans can control (such as fire).

Directions

1. Choose 2-3 items from the list below. Which technology could you not live without? Which are most essential to your obtaining food? Which are not essential, but are great to have?
2. Discuss how your eating habits would be different if that item didn't exist or was never invented or discovered.

Technologies:

- modern, large-scale tractors and other farm machinery
- selective breeding of plants and animals and understanding of genetics
- refrigeration
- synthetic fertilizer
- fire
- plastic packaging
- assembly lines
- espresso machine
- microwave oven
- frozen meals and "TV dinners"
- pots and pans
- oven




Discussion questions

- In what ways has technology impacted the way you eat today?
- How is technology different now than when you were younger? What about when your parents or grandparents were younger?
- What technologies do you think have had the biggest impact on today's food system?
- What historic events led to the creation of invention of these discoveries?
- What other questions does this raise?

Activity 3) How Did We Get Here?

Activities 1 and 2 began to explore the role of history and technological changes in creating today's food system. In this activity, you will look more closely at specific events in "food history," identify the connections, and assess the impacts of these changes.

Directions:

1. On the following pages are one-page summaries of significant events in "food history." You will work in a pair or small group and read one of these. The selections are as follows:

    1) The Agricultural Revolution
    2) Columbian Exchange and Colonialism
    3) The Scientific Revolution and the Emergence of the "Modern" Worldview
    4) "Eating the Leftovers of World War II" (the development of synthetic nitrogen fertilizer)
    5) The Green Revolution
    6) 1970s: "Get big or get out."
    7) The Gene Revolution

2. On a piece of flipchart paper, your group will summarize your selection by writing down 3-5 key points that respond to these questions:

- Summarize the key events in the reading: What is significant? What happened or changed in terms of technology?
- How did this event change agriculture and the way people eat? (Consider how food was grown, transported, processed, and or sold/distributed.)
- What are the costs and benefits of the changes described?
- How are the changes still impacting us today?

3. You will then present your selection along with others, resulting in a full group timeline.

Questions after all sections are presented:

- What was new or surprising?
- How are the events in each selection connected?
- In what ways have these events moved us towards or away from a sustainable food system as defined in Session 2 ("a food system that maintains health, sustains the environment, preserves our cultural fabric, and benefits the regional economy")?

Selection1) Agricultural Revolution

Until 10,000 years ago (or BCE, "before the common era"), humans lived as hunters and gatherers. People either gathered and ate available plants, or killed animals that ate those plants. In this way, the human food supply was mostly dependent on the energy flow provided by the sun.

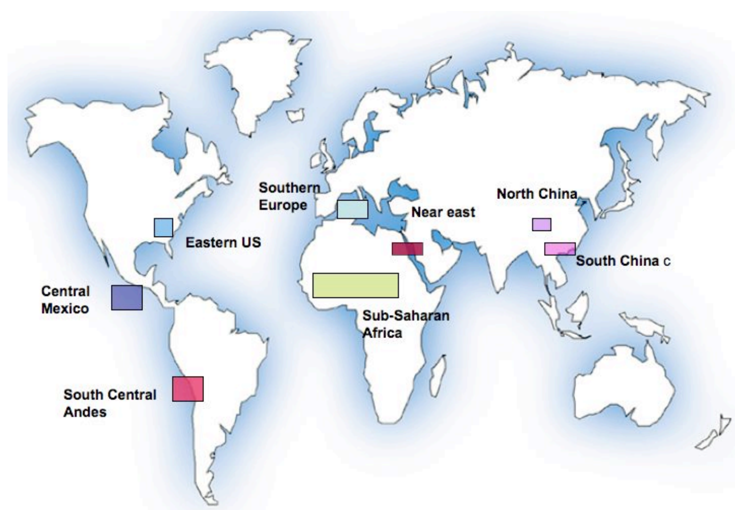
Around this time, people began controlling the growth of food. This transition, known as the Agricultural Revolution, was not isolated to one place or time, but occurred over several thousand years in multiple places as shown in the table and map below:

Region	Year BCE	Crops and Animals
Near East (Fertile Crescent)	9500	barley, emmer, wheat, pigs, sheep
Central Mexico	9000	squash, beans, maize
South China	8500-6500	pigs, sheep, rice, millet
South Central Andes	7000	squash, beans, quinoa, potatoes, llamas, guinea pigs
Europe, mostly southern coast	7900	wheat, lentils, barley, sheep and goats, cattle, pigs, tuna
Eastern U.S	4500	gourds, sunflower seeds, chenopodium seeds
Western U.S.	4500-4000	sunflower seeds, goosefoot plants, marsh elder
Sub-Saharan Africa	3500	cattle, pigs, goats pearl mullet,

(Compiled from Smith, 1998)

While agricultural practice took on many forms based on region, key changes included:

- Permanent settlement and farming that transformed wild areas to domesticated fields. Over time, small settlements became larger cities.
- Human breeding of new forms of plant or animals that were different from their wild ancestors. Domesticating gave humans control over reproduction.
- Gradual development of new tools and use of animal labor.



Technologies

Along with domestication came a series of tools to grow, process, and cook foods. The stone axe, hoe, and sickle were among the first tools used; for example, fields were cleared to plant seed using the hand hoe. Around 3500 BC, farmers began using animals, such as oxen. These animals were used to drag simple plows to loosen the soil and clear the land. The scratch plow, believed to have been developed in Mesopotamia around 4000 BCE, increased the ability to clear fields. By that time, people were also using wheels and mills powered by flowing or falling water to grind grains and process food as well as clay ovens to bake. In 1000 A.D. the invention of the heavy plow was a major advance. All of these technologies enabled a surplus of food for storage. This freed people from the need for constant food production, enabling people to begin specializing in work such as pottery or clothing production. Surpluses also created a need for a new class of bureaucrats and rulers to manage the growing trade (USDA, ARS, 2007; Smith, 1998).

Early farming greatly altered the landscape, and created soil erosion and degradation from over-farming and over-grazing. Because space had to be cleared in order to farm early farmers most likely confronted issues of deforestation.

Selection 2) Columbian Exchange and Colonialism

Imagine Italy with no tomatoes, Russia with no potatoes. This was the case before the late 1400s. At this time Christopher Columbus left Spain in a desperate search of a Spice Route to the Indies that was not under foreign control. This set off centuries of European imperialism in the "New World," sparking a series of changes in how the world eats today.

Columbus' journey to the New World set off a massive set of changes in agriculture and trade between the "New World" (the Americas) and the "Old World" (Europe and Asia). The travel between Europe and the Americas (by Columbus and his followers) led to exchanges of not only plants, but also people. These exchanges led to dramatic social, ecological and economic changes.

In terms of food exchanges, maize from the "New World" was introduced to Africa. Corn and potatoes traveled from the "New World" to Europe, replacing many grain crops such as wheat. Corn and maize produced more calories per acre and could also grow in fields where rye and grains couldn't (Smith, 1998).

Traditional Maize comes in 1,000s of varieties

Other "New World" foods such as sweet potatoes, pineapple, peanuts, vanilla, green beans, and turkey were also taken to the "Old World" and used in many diverse ways. The increased food production from corn and potatoes resulted in increased European population. In the other direction, Europeans brought beef and pork to the Americas. Before this, most of the indigenous populations were not everyday meat eaters, but over time, cattle breeding became central to many cultures of the Americas (such as in Argentina). Impacts included clearing forests for cattle, increased importance of animals in the economy, and cultural traditions tied to food (ibid).

Economic, environmental and social changes

The geographic links created through Columbus' journey opened up a new era of European conquest of the New World, and accelerated the growth of economic ties among Europe, African, the "New World" and Asia. For example, by the seventeenth century, French explorers had begun colonizing Africa and claimed not only the land, but also captured people to sell in the slave trade. Many of these Africans were taken to the Caribbean Islands to work on plantations growing sugar cane—a crop with origins in Asia. This illustrates the growing global scale of trade that emerged at this time.

Through colonialism, Europeans established their economic and political power through military force and conquest. In terms of food production, this had significant social and environmental impacts. The pattern repeated itself in the Americas, Asia, and Africa; colonizing powers took control of land—the main element in food production—from indigenous people. Forests were cleared, and the best lands were planted with "cash" crops to export (such as sugar cane, tobacco, coffee or cotton), forcing the production of local food to marginal or environmentally fragile areas. Indigenous farmers did not benefit from growing cash crops because they were paid very little. Generally, European colonizers determined the prices, paid locals poorly, and sold the products for a large profit to European and North American buyers. Overall, colonialism denied people access to resources and land needed to produce food, resulting in poverty, hunger, and environmental damage including deforestation and soil erosion (Lappe, 1986).

Columbus' journey was thus a catalyst for a new economic era. The foods resulting from the geographic exchanges are found on many tables today. In addition, the economic and social inequalities established through colonialism continue to shape current global relations.

Selection 3) The Scientific Revolution and the Emergence of the "Modern" Worldview

Travel back to the 1490s and the beginning of the 1500s (the 16^{th} century). Columbus had arrived in the New World and other explorers, such as Ferdinand Magellan, were circumnavigating the globe and fundamentally changing people's understanding of the world. In the same period (in 1514), Nicholas Copernicus asserted that the sun, not the earth, was the center of the universe, setting the stage for a series of dramatic discoveries in physics, astronomy, and biology. These changes, now known as the "Scientific Revolution," fundamentally transformed science, society and culture.

The root of this transformation was a particular lens for viewing humanity's relationship to nature. At the core of today's "modern" thinking, this lens emphasized humans' separation from the environment and their superiority over it. Leading scientists of the era viewed nature as a force to tame, and reduced the world to controllable parts--a "mechanistic" worldview driven by the era's most notable thinkers:

- Sir Francis Bacon (1561-1626) published *Novum Organum* in 1620. This book outlined a new system of logic based on the process of Inductive thinking: from individual parts to the whole. By breaking down natural forces to their individual parts, Bacon saw a way to master and control it, as revealed in his writing: "By art and the hand" nature can be "forced out of her natural state and squeezed and molded." He also wrote, "To endeavor to extend the power and dominion of the human race itself over the universe, the human race (could) recover the right over nature which belongs to it by divine bequest" (Bacon, 1620).
- Rene Descartes (1596-1650, pictured right) published his Discourse on the Method in 1637, emphasizing the separation of the physical realm from the (spiritual) realm. He suggested that we should "render ourselves the masters and possessors of nature" (Merchant, 1980).

- Anthony van Leeuwenhoek (1632-1723) constructed powerful single lens microscopes, opening up the world of microbiology.
- Isaac Newton's (1643-1727) development of the calculus opened up new applications of the methods of mathematics to science.

These scientific practices and beliefs established the "modern" worldview grounded in science as the core source of knowledge. This view also influenced the growth of colonialism and plantations, emerging economic practices of the time that were grounded in mastering the environment (and other people) in order to extract materials and labor for profit and accumulation. The mindset of controlling nature is to some extent reflected in certain agricultural approaches, such as overriding natural fertility limits through heavy applications of synthetic fertilizers, and establishing monocultures in the name of "efficiency." The reductionist approach to science (looking at parts of a whole separate of the whole) is also reflected in the biotechnology industry, a growing economic sector based on altering organisms at the microscopic level (Merchant, 1980).

In addition, the Scientific Revolution set into a play the valuing of "expert" knowledge by scientists over traditional cultural knowledge. Today, for example, the term "primitive" is casually used to describe non-industrialized cultures that do not have "book" learning. This devalues the vast and unique knowledge of the environment that is passed on through generations, and which has allowed these cultures to survive for thousands of years. The focus on "experts" can also downplay the importance of folk knowledge and skills within a more familiar context--skills such as canning and low-impact gardening (ibid).

The biophysical reality is that humans are part of the environment, and like all species, impact it in order to live. As interest in sustainability grows, there is a renewed interest in balancing "expert" knowledge with the values and ways of knowing that have long contributed to well-being: this includes principles such as biodiversity, seasonality, ecological cycles, and practices such as food preservation and seed saving. The question remains, how shall we meet our individual and global needs for food in the future, and what values will drive our individual and collective choices?

Selection 4) "Eating the Leftovers of World War II" (the development of synthetic nitrogen)

The earth's atmosphere is 80% nitrogen. Although it is the most abundant element in the atmosphere, nitrogen from the air cannot be used by plants until it is chemically transformed, or fixed, into a form that plants can use[1].

In nature, plants depend on soil bacteria on the roots of leguminous plants (such as peas), to split (or "fix") the nitrogen. The electricity in lightning also has this ability. But these methods fix only a relatively small amount of nitrogen. As a result, the availability of nitrogen has been a limiting factor in plant growth.

This changed in 1909, when a German chemist named Fritz Haber developed a method to fix nitrogen directly from the atmosphere. This dramatically increased the amount of available nitrogen, and led to the development of synthetic nitrogen fertilizers that are central to the many of the agricultural practices developed after World War II (see below). Haber received the Nobel Peace Prize in 1918 for his work in increasing agricultural production (Nobleprize.org, 2008).

But Haber used his breakthrough in other ways--specifically, to develop explosives and poisonous gases used for chemical warfare in World War I. His chemical weapons were the source of many deaths in World War I. In the 1920s, scientists further applied his methods to develop the cyanide gas Zyklon B, which was used as an insecticide and later, in the Nazi gas chambers during World War II (Smil, 2001). Haber, who was Jewish, converted to Christianity to avoid Nazi persecution, then fled Germany in 1933 before his death in 1934.

From Munitions to Agriculture

After World War II, the manufacturing plants that had supplied the nation's weapons had a large stock of leftover ammonium nitrate. The US government understood that these chemicals had other uses. Seeing a lucrative opportunity, the Department of Agriculture opted to use these "surplus" chemicals to fertilize farmlands. In the 1950s, farmers began using ammonium nitrate to fertilize farmland, quickly increasing the amount of food a farm could produce by overriding the limited supply of naturally available nitrogen (Pollan, 2006).

Corn was one of the crops most impacted. Traditionally, corn production was especially limited because it has high nutrient needs and can deplete the soil quickly. To provide fertility, farmers applied manure, compost, or rotated crops (planting legumes to fix nitrogen); with these methods, it could take up to five years to restore fertility and plant another corn crop. But with ammonium nitrate fertilizer, farmers were no longer tied to sustaining fertility through natural methods. This allowed them to plant corn more frequently, and to devote more land to a single crop such as corn. The practice of crop rotation declined, and with it, the number of commodities grown on a single farm. This resulted in an increase in monocultures—production of one kind of crop. In 1946, the average number of commodities grown on a farm was 4.6; by 1975 it was 2.7, and by 2006, it had declined to 1.3. (USDA, 2006).

In 1950, farmers applied an average of 6 pounds of nitrogen per acre planted. By 1975 this jumped to 52 pounds. At a global level, production of synthetic nitrogen fertilizer has increased from 10 million tons in 1960 to over 800 million tons in 2005 (Food and Agriculture Organization (FAO), 2008; International Fertilizer Industry Association (IFA), 2008). In the words of scientist and activist Vandana Shiva "we are still eating the leftovers of World War II" (Pollan, 2006).

Fixing nitrogen using the Haber-Bosch process requires heat and pressure, and this requires a great deal of energy. Seventy to ninety percent of the cost of producing synthetic fertilizer, retrieval, processing and shipping, is natural gas (Rich, 2006). By some estimates, producing the fertilizer for one acre of corn requires the equivalent of 50 gallons of oil (Pollan, 2006).

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1) Nitrogen molecules must be split and then joined to hydrogen atoms in order to be available to plants, resulting in ammonium or nitrate compounds.

Selection 5) The “Green Revolution”

People have been cross-breeding seeds since the beginning of agriculture, but the practice entered a new era in the 1960s with the development of High Yield Variety (HYV) seeds. As their name implies, HYV seeds were designed to boost production--but only with applications of fertilizers, pesticides, and other energy-intensive inputs--practices best suited for large farms of limited crop varieties.

Scientists introduced these hybrid varieties to farmers in Asia, Latin America and Africa with the goal of boosting production and eventually, eliminating hunger. Mexico saw new varieties of wheat. New hybrid strains of rice were introduced throughout Asia, and new varieties of maize and sorghum were introduced to Africa. These new varieties replaced traditional food crops with the goal of creating an economy based on selling exports to “developed” countries such as the U.S. The plan was that the anticipated income would raise farmers’ profits, lift them out of poverty, and end hunger.

By the 1970s, the new seeds and farming techniques emphasizing chemical fertilizers, pesticides, and irrigation had replaced the traditional farming practices of millions of “Third World” farmers. By the 1990s, almost 75% of Asian rice areas, and 70% of the world’s corn, were sown with these new varieties. Overall, it was estimated that 40% of all farmers in the Third World were using the new seeds (IFPRI, 2002). The depth and scope of the change in farming practices earned the title the “Green Revolution.”

The new seeds increased yields dramatically: by 1975, the average yield of wheat and corn had more than doubled. The amount of grain produced per person rose from 285 kilograms in 1961 to a peak of 376 kilograms in 1986 (World Bank, 1986). By the mid-1980s, India and Indonesia were seen as success stories, countries that had become "self-sufficient in food" or even "food exporters."

If success is measured in output, then the “Green Revolution” earned its name and the praise for its leader, agronomist Dr. Norman Bourlag. Widely hailed as a humanitarian, Bourlag won the Nobel Peace Prize (1970), the Presidential Medal of Freedom (1977), and the Congressional Gold Medal (2007). Bourlag linked his work to global security, noting that, “You can't build peace on empty stomachs" (Norman Bourlag Heritage Foundation, 2008).

But the success of the Green Revolution is more mixed when ecological impacts and enduring social realities are considered. Today, there are 800 million people still hungry, and 35% of world grain production goes for animal feed. Two-thirds of the world’s hungry people are in Asia, where Green Revolution seeds have contributed to the greatest production success (FAO, 2004). Increased grain production has not translated into decreased hunger in any clear sense.

Debt and economic dependency

Many farmers took out large loans to pay for these fertilizers, fuels and machines. But the increased yields flooded the market, causing prices to drop. And, with few buyers in the international marketplace, farmers had little power to demand higher prices. Farmers thus got less for their crops than the price of the inputs, leaving them in debt (Lappe, 1986). To earn money to repay the debt, farmers planted more, requiring more loans to pay for additional energy and fertilizer, most of which was imported, and growing became more expensive. For example, in the Philippines, the price of fertilizer for hybrid rice increased by over 100% in four years; during the same time, the price the farmer received for the rice went up only 26% (Oxfam, 1985). The recurring pattern of input prices rising faster than crop prices created an enduring cycle of debt that echoed the power imbalances of colonial economies, in which the colonized country provided raw materials for the economic benefit of the colonizer.

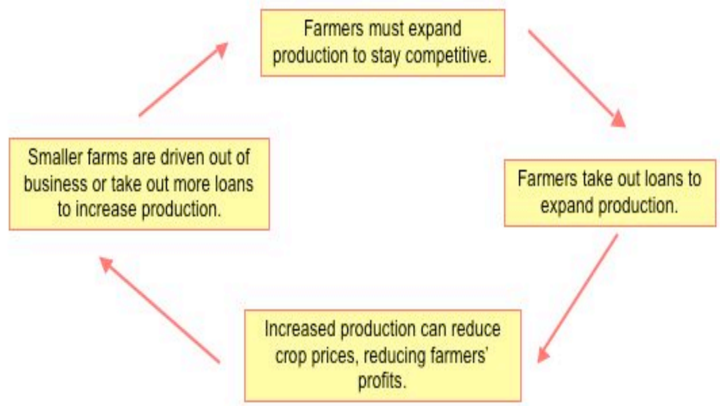
Narrowly focusing on increasing production-as the “Green Revolution” did-cannot alleviate hunger because it fails to alter the tightly concentrated distribution of economic power, especially access to land and purchasing power. Even the World Bank concluded in a major study (1986) that a rapid increase in food production does not necessarily result in decreased hunger. Current hunger can only be alleviated by "redistributing purchasing power and resources toward those who are undernourished," the study said. The enduring lesson is that if the poor lack money to buy food, or lack access to land and other resources to produce it themselves, increased production alone will not solve hunger.

Selection 6) 1970s: "Get big or get out."

The 1940s- the 1970s saw new developments in farm machinery, plant and animal breeding, specialized seeds, and increased use of chemical fertilizers and pesticides. Farmers gradually grew bigger and utilized more technology.

The growth was further encouraged through federal policies established under President Nixon's Secretary of Agriculture, Earl Butz. Whereas earlier legislation (in the Farm Bill) supported prices by limiting production, Butz shifted the focus to encourage production. New policies paid farmers based on their output of key commodities, primarily corn, soy, wheat, cotton and rice. Butz expected family farmers to change their self-perception from "farmers to agribusinessmen," and he urged them to plant "from fencerow to fencerow" and to "get big or get out" (Pollan, 2006).

While most large farms were (and still are) run by families or family-owned corporations[2], many smaller operators left the business due to a vicious cycle of debt: loans for expansion, overproduction and price drops, followed by more loans. This cycle helps explain a decades-long decline in the number of farms[3] and the number of commodities grown, as well as an increase in average farm size:



Year	# of US farms	Average farm size (acres)	Ave # of commodities grown
1946	5.9 million	195	4.6
1975	2.9	376	2.7
2006	2.1	441	1.3

(Compiled from USDA Agricultural Census, multiple years)

Concentration occurred in the meat industry as well, with non-family corporations playing a bigger role. In the hog industry, for example, the number of farms has declined by over 90 percent since 1970, even as overall pork production expanded dramatically. Similar consolidation has occurred in the meatpacking industry, where the four largest packers (organized as corporations) account for roughly 80 percent of the total industry slaughter (Hendrickson & Heffernen, 2002).

These trends corresponded with an increase in the production and consumption of processed foods made from surplus meat and commodities. For example, corn—and the sweetener made form it, high fructose corn syrup (HFCS)--has become a standard ingredient in many products. U.S. consumption of HFCS increased more than 1,000% from 1970 to 1990 (Ginsberg, 2005). The average grocery store has approximately 45,000 items, and more than 25% contain corn (Pollan, 2006). HFCS is not digestible in the stomach and makes its way, undigested, to the liver, and triggers the overproduction of tryglicerides (fat cells). HFCS also decreases the emission of the hormone leptin, which plays a key role in signaling fullness (Critser, 2003). Health experts thus believe excessive consumption of HFCS has contributed to the global rise of obesity and Type II diabetes.

This change in farm size and consumers' diet are just a few of the ways the policies of the 1970s are still impacting us today.

[2] See "What is a farm?" in Session 1 for an overview of farm ownership and structure.
[3] These trends have roots in technological changes in farming after World War II—specifically, the increase in production made possible by the development of new nitrogen fertilizers. See earlier reading in this document.

Selection 7) Gene Revolution

Since the beginning of agriculture some 10,000 years ago, civilizations have cross-bred plants and animals. For centuries, farmers and herders selected the “best” of their plants and animals to reproduce traits favored for specific climates and conditions.

The past 150 years accelerated knowledge and changes in genetics. In 1865, Gregor Mendell identified the biological principles of genetic inheritance. In 1953, James Watson and Francis Crick identified the structure of DNA, another watershed in the understanding of cells. In 1980, electrical engineer Ananda Chakrabarty received a patent on a strain of bacterium he developed; his original application was rejected in 1972, but the case went to the Supreme Court. In the landmark 1980 ruling, the court declared that “anything under the sun made by man could be patented” (Stix, 2006). This established the essential criteria for patenting life forms: that they must have a human-created alteration.

The ability to patent and license new life forms offered companies financial incentives to develop and market genetically modified organisms (GMOs). The first genetically modified commercial crops were introduced in 1996, and stocks of related companies soared. In 2000, when a “working draft” of the human genome was announced and released as public knowledge and use by all scientists, stocks in biotechnology lost substantial value (Stix, 2006). This raised the question of whether (or which) genetic information should be private and tied to financial interests.

The use of GM crops has rapidly grown. In 2006, a global total of 252 million acres were planted with GM crops. The US accounted for 54% of this, followed by Argentina (18%), Brazil (11%), Canada (6%), India (4%), China (3%), Paraguay (2%), South Africa (1%), and Iran and Eastern Africa (less then 1%) (Raney & Pingali, 2007).

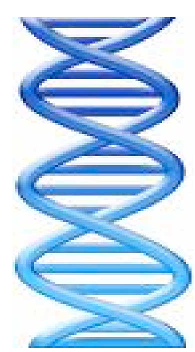
Who regulates GMOs?

The United States Department of Agriculture Animal and Plant Health Inspection Service (APHIS) and Food and Drug Administration Biotechnology Regulatory Services regulates the introduction (importation, interstate movement, and release into the environment) of genetically engineered organisms. APHIS uses a system that includes both permits and notifications. Critics point out that regulations are so loose that they are based on companies self-reporting information (Cummings, 2004). For example, a researcher may request that APHIS no longer regulate an organism by submitting a petition (USDA, APHIS 2008).

The controversy

Whereas prior forms of gene modification cross-bred one type of species, this new type of genetic modification involves implanting genes from one species into a totally different species. This is one of the key differences between “traditional” cross-breeding and new forms of genetic modification.

The new breed of GMOs has raised debate in the scientific, environmental and human rights communities. Some doubt the technology's benefits, while others raise questions about environmental and food safety issues. Questions raised:



- Who should decide how genes are manipulated?
- What are the implications of patenting life forms, especially when they are just slightly changed from varieties developed over thousands of years by other cultures?
- To what extent are GMOs addressing the root causes of hunger and food insecurity?
- How will GMOs impact biodiversity?
- Should GMOs be proven safe before coming to market, or should opponents have to prove they’re dangerous?

A summary of some key arguments appears on the next page.

Summary of Key Arguments related to Genetically-Modified Organisms

Supporters of GMOs say:	Critics say:
Methods are just an extension of agricultural modification and are thus natural and safe. "Human beings have always altered nature since the dawn of civilization by inventing agriculture, domesticating animals, preventing the spread of infectious diseases, and by providing clean water" (Monsanto, 2008). "The first general point to make is that there is, in principle, no difference between the biodiversity risks from escapes of GMOs and from fish genetically improved in some other way, e.g. by selective breeding or (in some respects) from exotic species" (FAO, 2003).	Prior forms of gene modification cross-bred one type of species. Current GMO practices include implanting genes from one species into a totally different species. For example, a company in California has experimented with injecting human genes found in breast milk into rice crops (Cummings, 2004).
GMOs are needed to meet the food needs of the hungry. GMOs can both boost production without putting more land under cultivation, which could potentially lead to deforestation (McGloughlin,1999). "Gene technologies have many solutions to offer in addressing food security issues across the world. While there are some real and perceived concerns about the safety of these techniques, their benefits far outweigh some of the risks" (Monsanto, 2008).	The world produces more than enough food (FAO). Hunger is not caused by a lack of food, let alone a lack of GMO foods. Research by an internal panel of experts raised doubts about ability of GMOs to address hunger. (IAAST, 2008). Efforts to reduce hunger must provide access to land, appropriate technology and fair credit to produce a diversity of foods for local consumption. A new study found that GM soy beans produce 10% less than non-GMO varieties (Lean, 2008).
GMOs have created new breeds of crops that have enhanced nutritional value. For example, inserting a gene from breast milk into rice would make the grain more nutritious. "Nutritional quality of staple foods can be substantially improved using transgenic methods compared to what can be accomplished using conventional breeding" (Monsanto, 2008).	The nutrients in the GMO rice already exist in a woman's body (Cummings, 2004). Instead of inserting breast milk genes into rice, focus on ensuring maternal health and encourage breast-feeding. Increasing access to education, land and other productive resources will enable better and more diversified local food production, leading to improved nutrition.
GMOs such as "Round-up Ready" soybeans can reduce the application of pesticides since the pesticide is built into the seed.	Seeds such as Round Up Ready promote dependency on the one chemical that the seeds are designed to withstand. This also overlooks the fact that heavy pesticides applications are necessary to maintain production. Recent research suggest that organic agriculture has the potential to meet world food demands (Badgley et al, 2006).
GMOs will help farmers in "developing" countries to create varieties that will thrive in specific environmental conditions, such as drought.	Over 100,000 varieties of rice have been generated by small farmers with no assistance from multinational corporations (New International, 2002). Much of the research showing success with GMOs is being conducted in temperate climate environments, not tropical or desert areas, where hunger is more severe (Pingali & Raney, 2007).
GMOs will help farmers increase profits. In India Transgenic crops have decreased the use and cost of pesticides by 41%, therefore increasing gains (Pingali & Raney, 2007).	Because GMO seeds are patented, farmers cannot save seeds, but must pay fees for access, leading in some cases to debt. In India, for example, a 450-gram packet of hybrid cotton seeds was four times the cost of traditional seeds (AP, 2003). In the long term, large-scale farmers are most likely to reap the benefits of GMOs.
GMOs are safe for the environment since they are created from naturally-occurring life forms.	All variables cannot be controlled when GMOs are released into an unpredictable environment. Cross contamination has been found. Critics say that there should be bio-safety procedures in place to use GMOs, and that many of the "developing" countries do not pass inspection (Pingali & Raney, 2007).
Scientists and business people should be rewarded for taking risks and investing in technologies that will bring progress. Regulation and other governmental intrusion will slow development.	Genes are part of the fundamental basis of life, and impact everyone. Thus, decisions about them should be made in public, democratic forums with oversight.

Before the next session

Review the following list of strategies to promote a sustainable food system. Based on your current knowledge (and without further research), consider which of the following you are aware of, and which may be in your community. Note that these strategies are covered in the following session.

Strategies:

1) Local Farmer's Markets
2) Urban Gardening
3) Community Supported Agriculture (CSAs)
4) Fair Trade
5) Farm-to-school programs
6) Organic
7) Pasture-raised animals

References for Session 5: How Did We Get Here? The Development of the "Modern" Food System

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