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Historical Perspectives on Resource Use in Food Systems

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Environment, Resources and Food Safety

No one would deny that industrial agriculture and fishing have been highly productive—but at what cost? Articles in this section explore the historical development and contemporary impact of food production on the environment, availability of water and other resources, energy, food safety, and even our waistlines. John Jemison and Amanda Beal note that today's food system has become dependent on inputs that may no longer be sustainable, or may become too costly to produce. They discuss some of the expensive "externalities" produced such as impaired watershed quality, soil degradation, pollution, reduction in biodiversity, and impacts on human health. Alfred Bushway, Beth Calder and Jason Bolton describe the importance of food safety regulations and practices in this era of global food systems and illustrate some of the challenges facing Maine's small food producers and processors; Henrietta Beaufait discusses Maine meat and poultry processing and the need for increased safety inspection capacity to allow this important food sector to continue to grow. Maine needs to invest considerable thought and time into building capacity in our local food systems to assure that resources will be protected over time as we strive to feed ourselves safely and healthily going into the future.

Historical Perspectives on Resource Use in Food Systems

by John M. Jemison Jr.

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To understand our food system's structure and function today, a historical perspective is helpful. This article addresses several key themes influencing the growth and development of the food system. Since the food system represents almost 20 percent of the U.S. gross national product, food is subject to the same basic economic principles that affect other marketed goods. Food production, however, is also a biological process. Although economy of scale, increasing farm size, and lowest-cost production methods appear to be economically profitable and highly productive based on today's food supply, these same principles threaten the long-term productive capacity of agriculture and fisheries, the environment, and consumer health. We argue that sustainable agriculture is, in reality, a new concept and is essential to agriculture's future. Finally, quality food should be a right for all people, not just the privileged.

No one questions the importance of food to human existence. For almost all of early human history, food was obtained by hunting and gathering. This early food system was generally egalitarian, such that when food was abundant, all benefitted; when limited, all went hungry and the group moved on. Overall, however, the skeletal record indicates that early human beings had a reasonably healthy balanced diet. With the development of agriculture, starting about 10,000 years ago, human relationships with natural resources and with each other changed dramatically. The word agriculture comes from the Latin *ager* (field) and *cultura*, which means cultivation. Agriculture is a systematic manipulation of the environment (Manning 2004). Sustainable use of the soil resource was rarely, if ever, practiced in the past. Abundant land resources allowed people to destroy the soil and move on. Early development of civilizations in the Tigris-Euphrates, Nile, and Indus valleys was no accident, and agriculture was the key to the success of civilizations. Its failure, whether caused by climate change or resource exploitation, was also the downfall of many of those civilizations.

The development of agriculture led to class-based societies, which continued through the Middle Ages. In Europe, landed gentry owned and controlled the land, and peasants farmed for a share of food. Almost all food produced was consumed locally. A rudimentary three-field rotation system was used, where one field was planted for summer crops, a second for winter crops, and a third was left fallow for soil improvement. Farm implements were simple, yields low, and there was little incentive to improve the land. Later, the medieval agricultural model was replaced by a small-farm-enclosure system in which peasants were given land on which to produce crops for themselves and the manor. This gave peasants some impetus to improve the land, practice crop improvement, and use improved crop rotations. This small-farm model would serve as the basis for the Jeffersonian ideal of the self-sufficient farm owned by individual Americans.

As the population grew, pressure to produce more food further stressed resources during the Colonial era.

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Because of the cause-and-effect relationship between population growth and agricultural production, famine has been a regular occurrence throughout ancient and modern history. But during the Colonial period, population increases stressed real food production capacity on a widespread level. While more land was cleared and wet areas filled for crop production, much of the population remained in what has been referred to as "nutritional purgatory," most with enough calories on a daily basis to survive but malnourished to the point where they could barely work (Roberts 2008). Three things served to boost caloric supply in the late Colonial period in Europe: (1) emigration of people to Argentina, Australia, and America to farm (including slave labor from Africa); (2) the importation of corn, sugar, and potatoes into Europe by the Spanish; and (3) the industrial revolution which allowed the development of an international food-production and transportation system to increase food for Europeans (Kloppenburg 1988).

> The Great Depression changed how the government approached agricultural farm policies. New practices and policies… changed the face of agriculture.

EARLY U.S. AGRICULTURAL HISTORY

In the early decades after American independence, agricultural policy focused on clearing land and growing crops. Most colonists settled and farmed along the productive alluvial bottomlands in the east and south (Effland 2000). Most farmers relied on shifting cultivation, where trees were felled and burned to provide alkalinity and release phosphorus and potassium for crop production (Kellogg 1963). Legumes, soil organic matter, and animal manure provided nutrients to the crops. Most farmers owned and worked relatively small amounts of land, and through a self-sufficiency model, produced enough food to feed their families and support their livestock; some staple crops of corn, cotton, or tobacco were grown for sale. By the 1850s, some farmers began to adopt market-based strategies of raising staple crops for sale, while saving a percentage for food and feed; others chose to purchase all their food (Helms 2000). Farming was extremely labor intensive; for example, in 1850 it took an estimated 250 hours to harvest 100 bushels of wheat (author, unpublished data). The self-sufficient model of agriculture endorsed social and familial relationships over profit as a motive for production, and it fostered a nascent environmentalism among farmers (Reznick 2007).

The Homestead Act of 1860 was landmark agricultural legislation that facilitated agricultural growth across the U.S. In contrast to European agricultural models, this transfer of public land to individuals was based on the Jeffersonian ideals of one family-one farm, land improvement, and an egalitarian value of land ownership (Lockeritz 1984). Farmers were granted 160-acre parcels if they would agree to settle and farm them. The Act implemented a one-sized model across the U.S., and farmers were encouraged to use the same farming methods across the semi-arid Great Plains and the humid prairies. Lockeritz (1984) attributed some of the exacerbated soil loss during the Dust Bowl era to this. By 1890, most of the better farmland in the U.S. was settled.

Maine's agricultural history followed a similar subsistence-based production model. Most of Maine's dairy farms were established in the central and southern parts of the state while the high-quality loam soils in Aroostook County were well-suited for potato production (Day 1963). Maine's blueberry industry began in the 1840s. Most Maine farms were rather productive for the 1850s: corn yields ranged from 60 to 80 bushels per acre for the approximately 100,000 acres produced, and potato yields averaged around 250 and 300 bushels per acre (Maine Board of Agriculture 1860).

GROWTH OF INDUSTRIAL FARMING AND A MARKET-BASED FARM ECONOMY

The break from subsistence-oriented farming to a market-based, industrial model started with the arrival of the railroad. In Maine, rail allowed farmers to market crops such as sweet corn and potatoes throughout the East Coast and marked a period of great farm growth in Aroostook County (Reznick 2007). At the peak in early 1900s, the Maine sweet corn industry supported more than 110 canneries.

Fertilizer use on farms began to increase with improvements in transportation across the U.S. The discovery, mining, and production of rock phosphate from apatite deposits in South Carolina greatly boosted productive capacity for farmers growing crops in phosphorus-limited soils.

Peak agricultural growth in the U.S. occurred at the end of World War I. Urban population growth, spurred by a growing manufacturing industry, increased demand for food and stimulated food prices such that farm incomes were on par with those in other sectors of the economy. The U.S. farming population peaked with 32 million people working on 6.5 million farms in 1920. By 1920, farming efficiency continued to improve: fertilizer sales were at 3.7 million tons/year, and it took 25 hours to harvest 100 bushels of wheat (author, unpublished data).

Maine farm numbers peaked with 64,309 farms in 1880 (Smith 2004). The arrival of the railroad brought new industries to Maine; starch manufacturing, for example, helped stimulate a seven-fold increase in potato production between 1870 and 1890. While in 1870 there were 1,600 potato farms smaller than 50 acres, by 1900, there were more than 2,500 farms under 100 acres *and* another 2,500 farms between 100 and 175 acres in size (Reznick 2007). By 1900, potato acreage had grown to 42,000 acres (Watson 1942), and by 1910 potatoes represented 50 percent of farm revenues in the state (Smith 2004). By 1930, there were more than 6,000 farmers involved in potato production on almost 250,000 acres and more than 1,200 dairy farms (Day 1963).

While the steam engine facilitated fertilizer and commodity shipments around the U.S., the gasoline-powered tractor revolutionized the transition to industrial agriculture. Tractors improved timeliness of planting and harvest and often made the difference between crop success and failure. Stock required feed, and tractors allowed hay land to be converted to cropland. Some 4.5 million horses and mules used on U.S. farms in 1920 were replaced by 1.2 million tractors by the end of World War II (White 2008). Many farm workers replaced by tractors moved to the cities and became part of the industrial economy.

The Great Depression changed how the government approached agricultural farm policies. New practices and policies such as price supports, purchasing grain to reduce inventories, and payments to farmers to not grow crops when supply exceeded demand changed the face of agriculture. This was important to maintain farm numbers and farm economic health, and this model of economic support continued through the 1970s. (See Hayes, this issue, for further details on the history of federal farm policy.)

HISTORY OF THE NORTHEAST U.S. FISHING INDUSTRY

The early history of fishing in Maine was built on a great wealth of resources. The abundance of fish in the Gulf sustained Native Americans and attracted the first European settlers. For centuries following the European settlement of Maine, when fish were plentiful in the Gulf of Maine, it seemed unlikely to most that there would ever be a day when these fisheries would be at risk for depletion or collapse. Due in part to many human-related factors, including inaccurate or insufficient data collection and monitoring, disruption of fish-spawning grounds, damming of rivers, industrial and residential pollution, and greater mechanization of fishing techniques which allowed for larger catches, however, the abundance of fish—groundfish in particular—in the Gulf of Maine has declined greatly.

In recent years, Maine's fishery has lost its diversity, becoming heavily dependent on lobster. This has been driven by an unprecedented increase in lobster population, depletion in several other important Maine fisheries, and federal regulations that have shifted access to the fishery out of state and consolidated control of those resources away from small-scale, owner-operated entities. The increase in lobster population is reflected in the landings. In 2011, landings are projected at 100 million pounds, after a steady increase that started in the late 1980s.

On land, much of the processing infrastructure has been lost. As a result, 70 percent of lobster is now shipped to Canada for processing. Along with the lost processing jobs and fewer fishermen involved in fisheries other than lobster, we also run the risk of losing the knowledge and skill that these workers have obtained through generations of labor, which can affect future opportunities for economic development in Maine's fisheries. (Alden, this issue, discusses prospects for Maine's fisheries.)

CHANGING NATURE OF U.S. FARMS

Following World War II (WWII), a highly industrial farm model focused on maximizing farm efficiency replaced any vestige of Jeffersonian farm idealism. Agricultural production themes of concentration, specialization and standardization have shaped the entire food system (Fitzgerald 2005). Growers readily adopted new technologies to replace older ones, including synthetic nitrogen fertilizers for biologically fixed nitrogen from clover rotations; herbicides for cultivation for weed control; and synthetic insecticides for crop rotations to control pests. The ramifications of these soil- and crop-management decisions are discussed further in Beal and Jemison (this issue), but include increasing eutrophic dead zones in coastal waters (Diaz and Rosenberg 2008), pesticides in surface and ground water (Sullivan et al. 2009), numerous failed agricultural chemicals due to herbicide and insecticide resistance (Chaudhry 2008), and a growing list of dangerous microbes that haunt the food supply apparently as a direct result of specific farming practices (Altekruse 1999; Rocourt 2003). With each of these decisions came greater efficiency, ease, and improved yields. In the late 1990s and early 2000s, growers adopted genetically modified (transgenic) crops with the fastest rate of adoption in agricultural history.

One might question why these changes were so readily adopted by farmers and tolerated by consumers. It is possible that the post-WWII optimism created by the successful use of technology that led the U.S. and its allies to victory may have been seen as the answer to feeding a growing population? Another possible answer may lie in what Burkhardt (1992) called *productionism*, which describes a deep, primarily Western, desire to generate products, service, work, or outputs. Immigrants who settled into farm life in America came from families that had struggled economically in the "old country," and they found farm life in the U.S. to be a similar existence. Farmers offered an opportunity to produce more with less physical work may have readily adopted new technology as it appealed to their natural drive to be productive. Further, with industrial agriculture came a promise of more time to enjoy life. Unfortunately, for the most part, the promise of an easier life was not realized. Increasing farm specialization exacerbated the problem. Corn farmers for example all sold the same product: #2 grain corn. The way to get ahead in the increasingly specialized agricultural market was to produce more corn than one's neighbor, and grow it as cheaply as possible. Farmers bought bigger tractors, larger improved combines, and hybrid seed, and they produced more corn. But, the more corn they sold, the lower the price fell. As Roberts (2008) describes, although it was a boon to consumers, for farmers it was a slow motion disaster. Growers had to spread costs over more acres, forcing them to buy more land and buy out smaller farms, causing farm numbers to fall and farm size to grow. Since the adoption of the industrial model, conventional commodity farmers have had little choice but to expand their farms or sell out. Livestock farmers involved in vertically integrated livestock production are in a similar position.

Interestingly, despite the obvious failures of the system, support for industrial agriculture today continues virtually unabated. It is particularly difficult to understand when the safety of the food system and health of the consumer have degraded, the number of producers leaving farming continues to increase, companies supplying fertilizers and chemicals to farmers continue to merge or be bought out, and governmental support for research and extension continues to decline. What appears to propel agriculture forward is an apparent steady supply of inexpensive food and a strong industry lobby that works to ensure the food system, as we know it today, remains on course.

GROWTH AND DEVELOPMENT OF INTENSIVE LIVESTOCK PRODUCTION AND PROCESSING

Few topics in agriculture generate as much (often highly polarizing) discussion as the livestock industry. To some, livestock production and meat consumption are an anathema. To others, livestock production is essential to the food system due to their capacity to convert cellulose to protein. No solution will be acceptable to all, but understanding the positive and negative ramifications of various means of livestock management may be informative.

Industrialization of the meat industry directly reflects changes found on other production farms across the U.S. Poultry, pork, and beef operations have grown larger and fewer in numbers. Changes in breeding and widespread use of prophylactic antibiotics to promote growth have improved production efficiency and decreased the length of time to get animals to harvest (Roberts 2008). However, this has caused an overabundance of meat leading to (1) low meat prices and difficult economic times for livestock producers; (2) food marketers being forced to create new uses for poultry and pork, increasing average caloric intake; (3) concerns about aquifer depletion from irrigating grain; and (4) increased concerns about greenhouse gas emissions and their effect on the environment. Further, intensive production and high-volume meat-processing conditions featured recently in popular films such as *Food, Inc.* have caused many consumers to seek meat produced using organic or natural production methods or to eliminate meat from their diet.

Researchers have evaluated the efficiencies of various types of cattle-production methods. Some such as Capper, Cady and Bauman (2009), using a strictly economic life-cycle analysis approach, have stated that confined-animal-feeding operations (CAFOs) are less environmentally damaging than grazing livestock. However, they do not take into account reduced externalities, the esthetic benefit of seeing livestock grazing, or cow health. Cattle grown on grass take longer to reach slaughter weight and may have higher overall methane emissions compared to feed lot beef (Johnson and Johnson 1995), but grass-fed beef has also been shown to have an improved fatty-acid profile and have a higher antioxidant content than grain-fed beef (Daley et al. 2010). Grass feeding also may reduce the risk of shedding *E. coli* 0157 contamination (Smith 2006), and provides an efficient means of manure distribution and reduced risk of water contamination compared to feedlot beef production. We believe grazing livestock is an effective means of converting cellulose to protein and provides a vital source of plant nutrients to organic farms. In contrast, feeding cattle seven to eight pounds of grain per pound of cattle weight gain is a poor use of limited resources. Finally, reducing consumption of meat produced from high-input grain systems should improve human health and reduce environmental externalities

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ALTERNATIVE/SUSTAINABLE AGRICULTURE

Critique of the industrial model of agricultural production and support for alternative farming models began to grow in the 1960s and 1970s. Perhaps no one has more eloquently described the art of farming, along with the beauty and value of the small farm to the rural community, than Wendell Berry (1977, 2009). His writings, combined with those of Rachel Carson, Wes Jackson and others, built the foundation for the sustainable agriculture movement that would gain significant traction a decade later and ultimately gain widespread acceptance (Jackson 1984). In Maine, dissent with industrial agriculture started with the foundation of the Maine Organic Farmers and Gardeners Association (MOFGA). Formed in 1971 as an educational organization to support organic farmers, today MOFGA is the oldest organic agriculture organization in the U.S.

Despite sustainable agriculture's mainstream acceptance, a single definition of sustainable agriculture remains elusive. To some, sustainable agriculture involves how the food is produced (organic or biodynamic, for example); to others, it concerns where it is produced (local being more important than process); or it may be a blend of these with concerns over carbon emissions. To the dismay of some, Monsanto recently adopted the term for its corporate promotion: "Sustainable agriculture is at the core of Monsanto. We are committed to developing the technologies that enable farmers to produce more crops while conserving more of the natural resources that are essential to their success" (www.monsanto.com). A cynic might argue that Monsanto co-opted the organic moniker to garner market advantage; others have argued that sustainable agriculture, as a term, is so broad and vague that almost anything can fit (Farshad and Zinck 1993).

Key components that we find critical to a successful, sustainable future for agriculture are (1) conservative soil-management and soil-fertility practices that build the soil resource; (2) use of cultural and alternative pest-management methods; (3) local food systems that build rural communities; (4) a closer interaction of grower and consumer through farmers' markets and community-supported agriculture (CSA); and (5) a just pricing structure that will ensure farm success. Few of these characteristics are found in today's industrial agricultural model.

GROWING WAISTLINES AND INDUSTRIAL FOOD

The trends in industrial agriculture, particularly efficiency, concentration, and standardization reflect the changes seen within the U.S. food system over the past 40 years. Food processors are expanding by buying out other processors and vertically integrating supply and distribution networks, which allows increasing control over food output and costs (Wallinga 2009). A definite power shift has occurred in the food system; where farmers once had great influence over policies and production strategies, crop and livestock production decisions are controlled more by food processors and marketers dictating what is on grocery shelves. Further, food processors have influenced USDA to develop third-party audit systems so that processors can verify that farmers are following specific agricultural practices (www.ams.usda.gov).

While dietary guidelines have been developed to help Americans eat a balanced diet, few Americans meet the guidance for fruit and vegetable consumption. Today, the majority of grocery store shelf space is filled with processed foods. Due to improved production efficiencies and concentration within the food industries, it is often less expensive to buy processed food products than to buy meats, fruits, and vegetables and produce home-cooked meals. Unfortunately, processed foods are higher in fats and sugar and generally more calorie dense than fruits and vegetables. Between 1970 and 2003, Americans' caloric consumption increased on average more than 500 calories per day (Farrah and Buzby 2005). Exacerbating the problem is the increased demand for, and consumption of, food away from home (FAFH); consumption of calories derived from FAFH grew from 18 percent in the late 1970s to approximately 32 percent in the mid-1990s (Guthrie, Lin and Frazao 2002). Binkley (2006) has recently reported similar percentage increases in FAFH since the mid-1990s. By giving away much of the responsibility of food preparation, consumers lose control over food content (fats, sugar, sodium) and portion size with FAFH; but they have gained extra time.

People are increasingly choosing to trade food preparation for the opportunity to work more and increase their disposable income. This has apparently been an easy sell, as Americans spend more than $100 billion per year for FAFH (Jahren and Kraft 2008). The downside has been increased average weight, poorer health, increased diabetes, and a loss of food culture and capacity in the kitchen. It is hard to imagine, but we live in a world where a billion people are malnourished and another billion are overweight.

QUI BONO?

The winners in the new U.S. food system are grain commodity dealers (ADM and Cargill, for example), producers of processed foods, and most livestock producers (primarily chicken and pork producers). Their profits are well served by prices remaining at or below the cost of production. They benefit from improved crop pricing and are mostly unaffected by production externalities such as nitrate leaching, estuary eutrophication, and pesticide contamination of water supplies. Losers in the new system include most grain farmers, the environment, and consumers. While gross farm income has risen steadily over the last 80 years, long-term real net worth on farms has slowly declined (Wise 2006). Farmers who have survived have increased farm size and bought equipment that will allow them to cover the land and produce food more efficiently (Paul and Nehring 2003). As Berry (2009) stated there is a limit to how much land a farmer can work and manage well from a basis of knowledge. This leads to further soil and nutrient loss, poorer ecosystem health, and increased dependence on oil. With fewer farmers, political influence is diminished and reliance on food imports increases, stressing petroleum reserves. By growing grain at low prices and shipping it to other countries, we effectively get all the externalities at taxpayer expense. Finally, the health ramifications of cheap food are becoming increasingly apparent. What is not always apparent is the socioeconomic tie between income and poor food-consumption patterns. Lower-income Americans tend to purchase higher-calorie foods and are less likely to meet the dietary guidelines than wealthier Americans (Golan et al. 2008). Many low income Americans work more than one job, and most do not have the money or the time to prepare quality food. As we look to develop a sustainable future food system, ensuring quality food for people of all income levels is essential.

CONCLUSIONS

Our relationship with food has changed dramatically over the course of history. This brief look at some of these changes is useful to help us plan and develop a more sustainable food system in the future. The importance of developing sustainable food systems now will be essential to avoid food shortages, famine, and economic/governmental collapse. With population rising, arable soils declining, and water resources affected, the challenges are clear. The following paper delves into the challenges our food system faces as we look to the future. Knowledge of where we have been is essential to direct where our food system must go. Given our land area, water resources, and proximity to markets, Maine will play a key role in what seems surely to be a very different food system from that which we have today.

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