Redefining Healthy Food: An Ecological Health Approach to Food Production, Distribution, and Procurement

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Introduction

Over the last century, we have radically altered the way we produce and distribute food. This transformation of our food and agricultural system has fundamentally affected the health of our planet and its inhabitants. We are already experiencing significant impacts in the form of increased antibiotic-resistant bacteria, poisoned air and water, food-borne pathogens, and collapsing rural communities. We are at the brink of inability to provide future generations with fresh air, water, and food.

The current obesity crisis is receiving attention, yet lacks the context of food production and ecologic impacts. Poor nutrition is a risk factor for four of the six leading causes of death in the United States: heart disease, stroke, diabetes, and cancer. Our current food system favors the production of animal products and highly refined, calorie-dense foods, rather than the fresh fruits and vegetables, whole grains, and other high-fiber foods important in prevention of these diseases. Hidden behind these nutritional imbalances is a food system reliant on and supported by methods of production and distribution that hurt our environment and us. Perversely, it is the obesity crisis that is providing the opportunity to re-examine our twenty-first century food and agriculture practices through a new health-conscious lens.

Furthermore, it has provided an awakening to the intricate relationship healthcare has with food production and ecological and human health. It is forcing a shift in awareness of the importance of healthcare's role in prevention and wellness and in developing national leadership with respect to the need to address the food system itself as a means to healthy food. Moreover, the obesity crisis is forcing a realization of our intrinsic connection to global health and ecological processes. Understanding these complex relationships gives us an opportunity to restore control over a situation that has pervasively influenced the health of humans and our environment.

Obesity in context

While the medical community has long recognized the importance of good nutrition, new food-related diseases have created a public health crisis and exacerbated the financial health concerns of medical institutions. Obesity is now the leading health concern (Anderson and Smith 2003). Diet-related medical costs for six health conditions—coronary heart disease, cancer, stroke, diabetes, hypertension, and obesity—exceeded $70 billion in 1995 (Nestle 2003). And, by virtue of the increased resources focused on obesity, the crisis has become an issue for everyone, overweight or not (Nestle 2003).

Almost one fifth of children and adolescents are considered overweight, and one-third obese (Ogden et al 2006). Obesity rates for children aged six to eleven have tripled since the 1970 (Institute of Medicine 2004), and 9 million children over the age of six are considered obese (Institute of Medicine 2004). Clinical interventions such as gastric bypass are escalating. The estimated number of hospital discharges with gastric bypass increased from 14,000 in 1998 to 108,000 in 2003 (Shinogle, Owings, and Kozak 2005). Clinical interventions are costly and not in keeping with successful public health strategies.

Furthermore, they are not sustainable. We are reminded by the Institutes of Medicine (Smedley and Syme 2000) that, "It is unreasonable to expect that people will change their behavior easily when so many forces in the social, cultural, and physical environment conspire against such change." A host of factors has been raised as potential contributors to obesity, including seemingly unrelated issues such as chemical pollution (Keith et al 2006). In short, for a variety of reasons, clinical approaches are not sustainable, and, as with any public health intervention, we need to approach the obesity crisis with an understanding of the broader context in which it is occurring.

An ecological approach

Food production, distribution, and procurement intersect a wide variety of issues. Economics, immigration policy, spirituality, agriculture and trade, culture, environment, and nutrition are but several of the myriad concerns associated with the food we grow and eat. And because food is also a fundamental human need, there is a strong cross section of organizations and interests involved in food and agricultural policy and practice. There is perhaps no issue that has such a wide depth of actively involved interests.

The complexity of interests requires a systems, or ecological approach. Such an approach is challenging because it is not linear and requires observation of the whole context, while seeking to understand the connections between their parts. Clearly, society is not eating more high-fat sugary foods because people woke up and decided that is what they wanted. A variety of forces has created an industrialized food system that markets and makes available inexpensive high-fat sugary food. By taking an ecological approach, we can attempt to see the complexity of interrelationships and, hopefully, provide a more useful analysis of the system. This complexity is blatantly apparent when we learn that, in the last several years, two of the largest food companies have purchased two of the nation's top weight-loss companies (Sorkin 2006). Yet, for the purposes of this discussion, we also discover that our industrial food system is not only implicated in the obesity crisis, but profoundly affecting human and ecological health by contributions to antibiotic-resistant bacteria, quality of our air and water, the decline of rural socioeconomic health, and others.

Background: The growth of modern agriculture

Before we explore these pressing human and ecological health concerns, it is important to understand some of the forces involved in the development of our current food system. As we will discover, the system has evolved to the degree that food and agricultural enterprises have become interchangeable. This synopsis attempts to explain some of the major forces involved in the transformation to a form of agriculture that would be unrecognizable to our parents or grandparents. It is especially important to appreciate this concept, since surveys demonstrate that most consumers, regardless of class or ethnicity, have little comprehension of how their food is produced today (Bostrom et al. 2005).

The development of our current food system has principally followed the same path as other sectors in our society—industrial capitalism and globalization. At the turn of the twentieth century, society was predominantly rural, and farmers maintained a livelihood. Farms were small, with a diversified output. Seed was collected and used for new season crops, and animal manure was used for fertilization. Crops were rotated to maintain fertility. Food was distributed to the local grocer or butcher. This farm model remained relatively constant until the middle of the twentieth century, when a variety of factors rapidly changed the nature of farming. Advances in transport efficiencies through the interstate highway system, improvements, and the development of refrigerated trucks allowed for distant delivery of "fresh" produce and meat. The discovery of ethylene and its role in the ripening of produce allowed for distant transport of food that could be artificially ripened during transportation (Halweil 2004). All of these "advances" allowed for distant distribution. Thus, the food industry began to grow and consolidate.

New scientific and technological knowledge developed during World War II further decreased the dependence of consumers on local and fresh food. Freeze-dried, dehydrated, and processed foods began to enter the marketplace. Pesticides and petroleum-based fertilizers began to be used as inputs, replacing crop rotation, manure, and diversification to maintain fertility and manage pests. Improved tractors and other farm equipment allowed farmers to engage in monoculture and increase farm size in their effort to achieve greater efficiency. Export-oriented agriculture was promoted through government programs.

Consolidation and globalization of the food system

Farmers began to outsource fertilizer, production, cleaning, and packaging their harvest, as well as other work they had routinely done (Halweil 2004). Ultimately, the processing and packaging industries became dominant, adding more economic value to the purchased product, and farmers became the suppliers of raw materials (Halweil 2004). In short order, farmer profits became costly to a rapidly consolidating industry. As an example, Iowa farmer profit margins have decreased from 35 percent to 9 percent since the 1950s (Halweil 2004). Agricultural polices and other socioeconomic factors further accelerated the rise of a highly consolidated agricultural food industry. Farm size grew, and the number of farms decreased. Since 1960, the number of farms has declined from about 3.2 million to 1.9 million, but their average size has increased 40 percent (Nestle 2003). Five companies now control 75 percent of the global vegetable seed market. Two firms control 75 percent of the world market for cereals, and, in the United States, four companies now control 80 percent of the beef packing (Halweil 2004).

Farmers whose operations fall between small-scale direct markets and large, consolidated firms manage more than 80 percent of farmland in the United States. These farmers are increasingly left out of our food system. If present trends continue, these farms, together with the social and environmental benefits they provide, will likely disappear in the next decade or two (Kirschenmann et al. undated). Rapid consolidation, initially in the seed and manufacturing sectors, but now in the huge food retail sector, means that, in the near future, roughly six multinational retail firms will determine not only the size of America's farms, but the type of management decisions made on those farms (Hendrickson et al. 2001). Similar to other global business models, the commercial interests that drive these large consolidated firms are based on three primary business objectives: the development of supply chains, biological manufacturing, and the reduction of transaction costs (Kirschenman 2002).

The industrial food system: Implications for health

Until the industrial food system was developed, farmers and farming played a pivotal role in stewardship of the land because the health of the land and their livelihood were mutually interdependent. Those who managed their land and animals well succeeded. Good management relied on the unique understanding of the natural environment, including rainfall patterns, native pests, temperature trends, soil fertility, etc. Their personal success (and by extension, the success of their communities), was inextricably linked to the farmers' understanding of the complex interaction of ecological processes. Healthy communities require healthy ecosystems, characterized by functions and systems that allow the maintenance of biodiversity, biotic integrity, and ecological processes over time (Government of British Columbia, undated). The industrialized food system divorces stewardship from food production. Experts (Kirschenmann et al. undated) have recognized that, "The development of supply chains means that on-farm decisions will no longer be made to benefit the long-term sustainability of the farm, or the good of the community, or the health of the natural resources that sustain the farm. The introduction of the concept of biological manufacturing means that farmers can no longer produce commodities based on what is best for the normal functions of the animals on the farm, or for the diversity of the landscape, or for the general health of the farm. Rather, farm management necessarily will be focused on technologies designed to produce uni-

> "For approximately the last sixty years, we have experimented with an attempt to impose an industrialized approach to agricultural production and the larger food system in which it is contained—and the system has responded with antibiotic-resistant bacteria, morbidity and mortality from nutrition-related diseases, water and air pollution, and food marketing. "

form products that meet the desired processing and retail objectives of the firm, which are, in turn, driven by economic return. And the need to reduce transaction costs means that consolidated firms will do business only with the largest farmers. It simply is less costly to contract with one farmer who raises 10,000 hogs than it is to issue contracts to ten farmers who each raise 1,000 hogs. All but the very largest farms will become residual suppliers."

In short, a tremendous shift has occurred in the nature of farming, and the important role of farming and agriculture in the protection of ecosystem health and, ultimately, human health. Fundamental ecological processes have been interrupted. The shift has transpired over the last sixty years and resulted in a predominance of large single farms producing single commodities requiring significant inputs. Large multinational food corporations battling for consumers' food dollars characterize the system. Our society has rapidly changed its food culture from one in which most food was cooked at home to one in which almost half of all meals are now eaten out. And we have shifted from a being a society in which most ate whole local foods to a one that eats highly packaged and processed foods transported great distances (Nestle 2003).

Obesity and beyond: The industrialized food system and health

As previously mentioned, a variety of forces have converged to change the nature of agriculture. We are now experiencing the strains throughout our healthcare system. While obesity is one health crisis, a wide variety of hidden health crises resulting from current agricultural practices are equally at play. These impacts to human health from industrialized food production and distribution methods are both direct and indirect. Importantly, the majority of these impacts is interrelated and is caused directly or indirectly by our intervention in and disruption of feedback loops regulating natural ecological processes and systems. Following are some examples of how our food system is having an impact on health.

Confined (or concentrated) animal feedlot operations

Confined (or concentrated) animal feedlot operations (CAFOs) may be considered industrialized protein-production facilities. They epitomize the extreme of our industrialized food system. These operations confine large quantities of livestock to a closed area where all food and water inputs are carefully controlled. They are defined as more than 1,000 beef cattle, 2,500 hogs, or 100,000 broiler hens; they generate an estimated 575 billion pounds of manure annually (IATP 2004). In some facilities, the quantities of animals produced number in the millions. From a management perspective, as capitalized ownership has consolidated, there has been a growing separation of the ownership, management, and labor of the operations, meaning that different people own, manage, and work at the factory farm. Contract growing is becoming commonplace, where family farmers sign away ownership of their animals through a contract with a major corporation (GRACE, undated). These animal operations are concentrated geographically.

Though not exclusive to CAFOs, a wide variety of feed additives are provided, including growth hormones, antibiotics in feed and water, and arsenic. Arsenic, though banned in European livestock production, is used domestically as a growth promoter to compensate for poor growing conditions and for pigmentation. According to the US Environmental Protection Agency (EPA), approximately 70 percent of the 8.7 billion broiler chickens produced annually are fed arsenic (Wallinga 2006a). In a recent study, 55 percent of raw, supermarket chicken contained detectable arsenic, and nearly 75 percent of breasts, thighs, and livers from conventional producers carried detectable arsenic (Wallinga 2006a). Arsenic causes cancer and

contributes to other diseases, including heart disease, diabetes, and decreased intellectual function. Even low exposures to this type of serious toxin are generally presumed to be risky (Wallinga, 2006b). In many areas of the country, groundwater used for drinking water may be naturally high in arsenic. The application of arsenic-laden manure further contributes to this drinking-water concern (Christen 2006).

The largest 2 percent of US livestock farms now produce 40 percent of all animals in the United States (Agriculture Research Service 2005). In 2002, half of all hogs in the United States were raised on large-scale farms that managed more than 5,000 hogs (GRACE undated). Ten companies produce 92 percent of the nation's poultry (Kratz 1998). In Utah, one farm will raise more than 1.5 million hogs in a year, creating the same amount of excrement as the population of the city of Los Angeles (Barboza 2000). The animal density creates tremendous logistical concerns for CAFO operations. So much animal waste is created that local soils have little capacity to absorb it all, creating water-quality and drinking-water effects. As the manure is often sprayed, it creates illness-producing odors in nearby communities. In 2002, both the Michigan Medical Society and the Canadian Medical Association called for moratoria on new CAFO construction (Michigan State Medical Society 2002). In 2003, the American Public Health Association (APHA) passed a resolution urging federal, state, and local governments and public health agencies to institute a "precautionary moratorium" on the construction of CAFOs because of health concerns (APHA 2003). These included runoff, community impacts, air-quality concerns, worker health and safety, and issues of antibiotic resistance.

Antibiotic resistance

One of the most important advances in treating infectious disease has been the development of antibiotics. Alarmingly, these compounds are now threatened by a global crisis of antibiotic resistance. Currently, 60,000 Americans die annually from resistant infections (Centers for Disease Control 2004). The Congressional Office of Technology Assessment calculated that, as of 1995, resistance by just six types of bacteria increased hospital treatment costs by $1.3 billion annually (Shea, Florini, and Barlam 2001). It is estimated that $30 billion is spent on the cumulative effects of antimicrobial resistance each year (including multiple-drug regimens, extra hospital days, additional medical care, and lost productivity) (American College of Physicians 1999). For four important drug/bacteria combinations, resistance increased by between 40 percent and 49 percent in just five years (1994–1999) (US Department of Health and Human Services 2000).

Even more disturbing is the growing prevalence of super bugs, bacteria that are multidrug resistant. As of 1998, strains of at least three bacterial species capable of causing life-threatening illnesses were resistant to *all* available antibiotics (Levy 1998). A wide variety of public health and medical organizations recognize the impending crisis. The World Health Organization (WHO) has stated that, "There is clear evidence of the human health consequences due to resistant organisms resulting from non-human usage of antimicrobials" (WHO 2003) and the Infectious Diseases Society of America states that a "perfect storm is blowing in the field of infectious diseases" (Infectious Diseases Society of America 2004).

Yet, it is estimated that more than 70 percent of all antibiotics consumed in the United States are used as feed additives for poultry, swine, and beef cattle for nontherapeutic purposes (Mellon, Benbrook, and Benbrook 2001). That is, they are used to promote growth and to compensate for diseases caused by poor animal husbandry, the very conditions provided by CAFOs. There is a strong consensus that agricultural usage contributes to antibiotic resistance in humans. The US Institute of Medicine/National Academies of Science states, "Clearly, a decrease in antimicrobial use in human medicine alone will have little effect on the current situation. Substantial efforts must be made to decrease inappropriate overuse in animals and agriculture as well" (Institute of Medicine 2003). More than 300 organizations, including the American Medical Association and APHA have advocated ending the nontherapeutic use of medically

important antibiotics as feed additives. While some producers have begun to reduce their use, it is difficult to independently verify, as there are no regulations that track usage. Moreover, because as much as 75 percent of an antibiotic may pass undigested through an animal, its waste can contain antibiotics as well as antibiotic-resistant bacteria and their genes (Campagnolo and Rubin 1998). Furthermore, antibiotic-resistant bacteria can move off the production facilities into communities via food, water, direct animal contact, and other pathways.

Water pollution: Animal wastes and nutrients

Over centuries, farmers developed methods to increase the fertility of their soils. They used animal pastures and rotations of clover and other nitrogen-fixing crops. The recent transition to an industrialized agriculture model and an associated trend toward monocultures has created a variety of negative impacts resulting from the interruption of ecological cycles that farmers understood and worked with synergistically. Since 1972, there has been a tripling of counties that have more that 55 percent of their plantings in corn and soybeans (Porter, Russelle, and Finley 2000). Corn and soybeans are two of the most overproduced crops. Twenty-five percent of all US farmland—80 million acres—now grows corn (Christensen 2002).

The concentration and relocation of animal production to the Southeast and West have created extreme manure problems in those areas, and the loss of pastures, crop rotations, and manure has depleted soil fertility in the Midwest. As a result, petroleum-derived nitrogen and other fertilizers must be added to soils. Poor nitrogen retention by corn and soy rotation results in contaminated surface waters that migrate to the Gulf of Mexico, where nitrogen creates massive annual algae blooms. These blooms metabolize all available oxygen, leaving a 20,000 square kilometer dead zone in the Gulf (Rabalais, Turner, and Scavia 2002). Thirteen percent of domestic drinking-water wells in nine Midwestern states had nitrates exceeding the safe drinking-water level of 10 mg/l (Henderson 1998). According to the EPA, hog, chicken, and cattle waste has polluted 35,000 miles of rivers in twenty-two states and contaminated groundwater in seventeen states (Environmental Protection Agency and US Department of Agriculture 1998).

Pesticides

Over half a century ago, farmers succeeded without synthetic pesticides. Today, the entire web of life is contaminated. From a human perspective, this contamination begins in the womb, where metabolites to common pesticides have been found in meconium (Whyatt and Barr 2001) and in fetal cord blood (Houlihan et al. 2005). Human infants are literally bathed in pesticides prior to birth as they go through intricate developmental processes and continue into life through exposure to pesticide contaminated air, water, and food. Pesticides and their metabolites are now routinely part of the human body burden, the load of chemical contamination carried by human populations (Environmental Defence 2005).

Environmental exposures are widespread. For example, concentrations of atrazine, alachlor, and broadleaf pesticide 2,4-D in rainwater have been reported to exceed the safe drinking-water standards (Gilliom, Alley, and Gurtz 1995). A 1994 study estimated that 14.1 million Americans drank water contaminated with the pesticides atrazine, cyanazine, simazine, alachlor, and metolachlor (Wiles et al. 1994). Extensive herbicide use in agricultural areas (accounting for about 70 percent of total national use of pesticides) has resulted in widespread contamination of herbicides in agricultural streams and shallow ground water. The chance of finding agricultural weed killers in house dust increases by 6 percent for every 10 acres of cropland found within a roughly 800-yard perimeter of a house (Raloff 2006). Farm-worker and community exposures are another concern. Use of agricultural chemicals known to cause cancer in California increased 127 percent from 1991 to 1998. Farm workers have a 59 percent to 70 percent greater risk of cancer (Reeves, Katten, and Guzman 2002).

In 1991, the US Geological Survey (USGS) of selected herbicides in eight rivers in the Mississippi River Basin found atrazine in all samples taken, with concentrations exceeding the federal drinking-water standard, or maximum contaminant level, in 27 percent of the samples (Goolsby, Coupe, and Markovchick 1991).

In a related water-quality assessment report (USGS 1999), USGS highlights several important points with respect to its water quality findings.

- Health effects of pesticides are not adequately understood.
- Most contamination occurred as pesticide mixtures and that no or limited experiments are done on mixtures.
- Breakdown products, for which there are no established standards or guidelines, may have effects similar to their parent pesticides.
- Water-quality standards and guidelines have been established for only about one-half of the pesticides measured in the water-quality assessment samples.

The report also suggested "effects on aquatic organisms may be greater than on humans in many agricultural areas." Although there are no US EPA aquatic-life criteria for the major herbicides, Canadian guidelines were exceeded at 17 of the 40 agricultural streams studied, most commonly for atrazine or cyanazine (USGS 1999).

Long-term low-level exposure to pesticides has been linked to an array of chronic health problems, including cancer, birth defects, neurological, reproductive and behavioral effects, and impaired immune function (Sanborn et al. 2004). Growing children consume far more food and water per body weight than adults, and their biological detoxification mechanisms are not fully developed. The Ontario College of Family Physicians has completed a literature review of pesticides and determined that, "The results of the systematic review do not help indicate which pesticides are particularly harmful. Exposure to all the commonly used pesticides … has shown positive associations with adverse health effects. The literature does not support the concept that some pesticides are safer than others; it simply points to different health effects with different latency periods for the different classes (Sanborn et al. 2004).

It urges a focus on reducing exposure to all pesticides, rather than targeting specific pesticides or classes. It also clearly points out the severity of pesticide-related illness necessitates prevention, which is much more proactive and powerful than attempting to treat exposure. They encourage family doctors to learn about high-risk groups (women during childbearing years, occupationally exposed patients, children) and to then teach methods to reduce exposures. Finally, they suggest that physicians come together to convey health concerns to politicians who make regulatory decisions relative to pesticide use and public health (Sanborn et al. 2004).

It is worth recognizing the irony embedded within the pesticide problem. The more pesticide used, the greater natural-selection pressures work to develop resistance pests, requiring greater quantities or new pesticides. We now see a worldwide trend of increasing appearance of herbicide resistance, as predicted by Rachel Carson, author of *Silent Spring*, decades ago (Gunsolus 1999). We are concurrently affecting the health of the ecosystem by destroying ecosystem diversity while exposing human populations to a variety of agents with a host of health effects.

Energy use and air pollution

Actors in the transformation of our food system have included technological improvements, infrastructure investment, and cheap fuel cost. These have, in turn, permitted an ever-expanding reach for the least

expensive units of production and the best market for food companies. Food has become a commodity, and we now see a trend of agricultural imports and exports both rising rapidly. From 1993 to 2001, we experienced increases in food export and import of 25 percent and 57 percent respectively (Mamen et al. 2004). California imports and exports similar quantities of Brussels sprouts, cherries, and other products in a global food shuffle (Mamen et al. 2004). The California-grown tomatoes in a bottle of organic Heinz Ketchup, purchased in Oakland, make a roundtrip of 5,000 miles to Toronto, Ontario, for processing (Mamen et al. 2004). The distance from farm to market has increased about 20 percent in the last two decades, with food traveling between 2,500 and 4,000 miles before it reaches the plate (Pirog et al. 2001). Food in the United Kingdom travels 50 percent farther on average than it did two decades ago (Jones 2001), and trucks moving food account for 40 percent of all road freight. These are not for niche products, but include food staples such as apples, cheese, and garlic. Domestically, food and agricultural products (not including imported or exported foods) constitute more than 20 percent of total US commodity transport (Norberg-Hodge, Merrifield, and Gorelick 2002). In the United States, the average prepared meal includes ingredients produced in at least five other countries (Pirog 2003). We are literally burning through fuel in a global shifting of food and food products. As one would imagine, on-farm fossil-fuel use includes machinery such as tractors and refrigeration. But, the largest fossil-fuel source is the manufacture and transport of nitrogen containing fertilizers (Soil Conservation Council of Canada 2001).

A recent report by the United Kingdom agency, Defra, (Smith et al. 2005) highlighted the growing concern with food miles: "The rise in food miles (the distance food travels from where it is grown to where it is consumed) has led to increases in the environmental, social, and economic burdens associated with transport." The report continued, "These include carbon dioxide emissions, air pollution, congestion, accidents, and noise. There is a clear cause-and-effect relationship for food miles for these burdens—and, in general, higher levels of vehicle activity lead to larger impacts. Growing concern over these impacts has led to a debate on whether to try to measure and reduce food miles" (Smith et al. 2005).

It has been calculated that the use of imported ingredients for a basic diet can increase energy use and greenhouse gas emissions by 400 percent (Carlsson-Kanyama 1998). The localized human-health impacts from traffic congestion and related air pollution include low birth weight, increased cancer risk, and increased hospitalizations from asthma from a variety of air pollutants (primarily ultrafine particles, benzene, nitrogen oxides, carbon monoxide). Collectively, diesel-powered vehicles account for nearly half of all nitrogen oxides and more than two-thirds of all particulates from US transportation. The International Agency for Research on Cancer classifies diesel exhaust as a probable human carcinogen, and the US EPA has proposed the same classification. The California EPA estimates that 450 out of every million Californians are at risk of developing cancer due to diesel-exhaust exposure. The EPA estimates that fine particulates ($PM_{2.5}$) kill 20,000 people and hospitalize many more each year (Hoek et al. 2002, Wilhelm and Ritz, 2002. Zhu et al. 2002, Lin 2002). While food will still need to be transported to urban areas, clearly a decrease in quantity and quality of food-miles emissions is imperative. Importantly, 75 percent of consumers prefer that their food be domestically grown (Wimberley et al. 2003).

Rural communities and socioeconomic health

As industrialized food squeezes cost out of the system, small family farmers increasingly earn less return on every dollar spent, with marketers and input suppliers taking the rest. In 1990, farmers received nine cents on every food dollar spent, and, by 2000, that number had dropped seven percent, while farming costs had risen by 19 percent (Mamen et al. 2004). The average income on family farms is now negative, with off-farm jobs making up for the difference (Mamen et al. 2004). Depressed family incomes, high levels of poverty, low education, and social and economic inequities between ethnic groups are associated with land and capital concentration in agriculture (US Congress 1986). In communities with large indus-

trialized farms, we find a two-tiered income distribution with elites and a majority of poor laborers and no middle class (MacCannell 1983). In the United States, farm families are more than twice as likely to live in poverty, and, in Europe, a similar pattern is found (Pretty 1998).

Industrialized meatpacking is recognized as one of the most dangerous occupations; over one-quarter of all workers need medical attention beyond first aid. In the southeast region of Minnesota, a study found that the current economic structure extracts about $1 billion from the region's farm and food economy annually, equal to the amount of all farm products raised there (Meter and Rosales 2001). Collectively, the global food system has effectively externalized respect for human welfare and dignity. The Minnesota Bishops Statement on the Farm Crisis included recognition that, "These changes have moral and ethical implications which cannot be ignored..." (Flynn et al. 2000).

One might consider the AMA Declaration of Professional Responsibility, which "commits to respect human life and dignity of every individual, and to advocate for social, economic, educational, and political changes that ameliorate suffering and contribute to human well-being" (American Medical Association 2001) to be a similar rallying call for the rural farm crisis.

Food system interconnections: Food guidelines and food subsidies

While we have examined some of the larger system aspects influencing health, it is worth exploring some of the interconnections. While there are disparities, the US food supply provides a daily average of 3,800 calories. Even considering potential food wastage, there is a significant excess of calories in the food supply (Nestle 2003). It is argued that the excess supply forces intensive competition between food industry players for food dollars and that, to attract sales, food companies must market significantly and introduce new products. Since 1990, 116,000 packaged foods have been introduced and joined a marketplace that contains 320,000 items competing for supermarket space designed for far fewer items (Nestle 2003). In 1998, approximately 75 percent of the 11,000 food items introduced were candies, condiments, baked goods, and other convenience foods (Block 2004). In 2003, the US Department of Agriculture's nutritional education budget was $333 million, vs. the $1.2 billion budget for Pepsi alone, and $6 billion for food industry advertising. It is a reminder why a program that focuses on educating the public about the food pyramid and dietary guidelines won't work; there is just not enough money to compete in the marketing battle.

These food industry offerings are supported by US federal government subsidy programs, which favor five crops—corn, wheat, cotton, soybeans, and rice—and account for two-thirds of all subsidies. On an annual basis, corn is consumed 1.2 percent as a vegetable, 8 percent as a sweetener, 50.1 percent as an animal feed, 2.6 percent as starch, 5 percent as alcohol (ethanol), 22.6 percent as exports, 10.3 percent as reserve stocks, and 0.2 percent as seed.

Vegetable growers and ranchers receive very little government money. As a result, if we were to compare food-pyramid recommendations with government subsidies, they would be almost perfectly at odds. Fruit and vegetables, those foods recommended by the pyramid, receive little support, while meat and grains receive by far the most support. The low commodity prices have allowed the food industry to replace sugar with high-fructose corn syrup (six times sweeter than corn) and have provided a low-cost fat (soybean oil), thus keeping sugary, high-fat food inexpensive. These subsidized, cheap, and nutritionally bankrupt products remind us of the complexities of our food system and the "fuel" that feeds it.

Interconnections and feedback loop: Chemical contamination of the food web

Interrelated with the issue of pesticides is the ubiquitous contamination of our food web with persistent bioaccumulative toxic compounds and those that act as "signal disruptors." Until recently, it was believed that the impact of a toxic compound was related to its dose and that this response was linear. There is

now evidence that a host of compounds act at minute concentrations and interfere with chemical signaling. A subset of these is able to interfere with the normal function of the endocrine system. This issue is relevant to the food system for a variety of reasons. For example, a variety of pesticides and a breakdown product from the common plastic polycarbonate, bisphenol A (BPA), has now been found to interfere with the ability of nitrogen-fixing bacteria to form a symbiotic relationship with their leguminaceous hosts (plant-like beans, peas, and alfalfa) (Fox et al. 2001). This relationship is a key ecological process that affects how nitrogen is made available for use by plants.

BPA is used to make polycarbonate plastic and readily breaks down, thus contaminating food and water. BPA reaches the human fetus in the womb at levels that are well within the experimental ranges shown to alter development. Studies link BPA to prostate cancer (Ho et al. 2006), insulin resistance and type two diabetes (Alonso-Magdalena et al. 2006), and there is growing evidence of its role in obesity, in which it has been shown to interfere with weight homeostasis by increasing fat-cell numbers and uptake (Masuno et al. 2002). BPA use is ubiquitous in the food system. It is used as a chemical liner in canned goods and in a host of other food-related applications, including the majority of plastic cutlery, dishware, hard plastic disposable glasses, and beverage bottles such as baby bottles and water bottles.

Another direct example of the intersection of chemicals and the food system is the issue of fluorotelomers. A class of these persistent bioaccumulative and toxic compounds is used in, or result from, the creation of a wide variety of food-related products, including nonstick cookware (such as Teflon) and grease-resistant food packaging such as microwave popcorn bags, fast-food and candy wrappers, and pizza-box liners. These compounds are contaminating food, water, and humans and are being discovered throughout the food web, including the bodies of polar bears (Kannan et al. 2001). Animal studies are now showing that these fluorinated compounds cause cancer, liver damage, growth defects, and immune system damage (DeNoon 2005).

These examples demonstrate once again the intricate feedback mechanisms within our food system. They further delineate the need for a systems approach with respect to the influence chemical contamination is having on our food system. Especially relevant is how the majority of the aforementioned food uses—packaged food, disposable dishware, etc.—help sustain a fast-food-packaged lifestyle.

Reconfiguring the food system with a health lens

No matter how we try to distance our food production from natural processes, in the end, the foods we produce are dependent upon delicate players in a complex system that has evolved over eons of time. Pollinators, nitrogen-fixing bacteria, microbes, temperature and light variations, etc., all play a role in intricate biological processes. For approximately the last sixty years, we have experimented with an attempt to impose an industrialized approach to agricultural production and the larger food system in which it is contained—and the system has responded with antibiotic-resistant bacteria, morbidity and mortality from nutrition-related diseases, water and air pollution, and food marketing. From a public health perspective, our current system has failed. We need a new approach for food production and distribution with a health focus. Such a system will be preventive in nature and provide the capacity for self-renewal. By recognizing the linkages between human and global ecology, we can envision a food system that works to support health.

Healthy food and a healthy food system

One good lesson from our experiment with our industrialized food system is that it has allowed us to understand what not to do if we want food that is healthy for consumers, the workers that grow it, and the environment that sustains us. And perhaps the most important principle is that agriculture should conform as close as possible to natural systems. While a variety of other indicators may exist, we can see that a food system that follows this principle might be represented by the following (Hird 2003):

- proximate, originating from the closest practicable source or the minimization of energy use
- healthy as part of a balanced diet and not containing harmful biological or chemical contaminants
- fairly or cooperatively traded between producers, processors, retailers, and consumers
- nonexploiting of employees in the food sector in terms of rights, pay, and conditions
- environmentally beneficial or benign in its production (reduced inputs such as pesticides, fertilizers, energy use, etc.)
- accessible both in terms of geographic access and affordability
- high animal-welfare standards in both production and transport
- socially inclusive of all people in society
- encouraging knowledge and understanding of food and food culture

Importantly, a wide variety of studies demonstrate the viability of these types of agricultural practices, and we are beginning to see a revolution toward a healthy food system.

A healthy food system

The industrialized model promotes supply chains, biological manufacturing, and the reduction of transaction costs. Considerable evidence shows that this model of large monoculture is actually less productive. In fact, small farms are more productive than large industrial farms, with as much as 1,000 percent more output per unit area (Rosset 1999). The advantage lies in the small farms' ability to produce diversified crops, thus providing various products throughout the growing season. The misconception that large industrialized farms are more productive frequently depends upon how productivity is defined. By defining production of a particular type of crop per acre, large farms with monocultures will necessarily be more "productive." If we are looking at food production per acre in tons, calories, or dollars, the polycrop is far more productive for all farm sizes (US Department of Agriculture 2002).

Furthermore, studies have demonstrated that farms that rely on fewer inputs (petroleum-derived fertilizer, pesticides, etc.) are more efficient in use of land, nutrients, and energy and cost less to maintain than chemical-intensive monocultures (Halweil 2004). Moreover, a variety of studies from around the world reveal that organic farming (farming without synthetic inputs) can produce as much as and sometimes much more than conventional farms (Halweil 2006). A three-year Minnesota study demonstrated a direct correlation between year-round plant cover on the land and reintegration of livestock onto farms, with improved water quality and fish health in the streams. Profitability of farmers in the watersheds rose as the diversity of their farming systems increased (Boody et al. 2005).

Reduced pesticide use eliminates pesticide exposure to the consumers, with organic food providing the least amount of exposure to pesticide residues (Baker et al. 2002). A recent study revealed detectable metabolites of organophosphate pesticide (OP) residues in children eating a conventional diet. Once these children were placed on an organic diet, there were no detectable metabolites. Placed back on a conventional diet, the metabolites were again detected. This and an earlier study (Lu et al. 2006; Curl, Fenske, and Eglethun 2003) demonstrated that, on a daily basis, the majority of the exposures to OP insecticides among children are occurring through the diet and are the result of OP insecticide use on crops, rather than uses in the home, schools, and residential environments.

Benefits of integrated and small-scale livestock production that minimize and eliminate the need for inputs are obvious. Pasture-raised animals and small-scale production will allow for beneficial use of manure and can reduce and eliminate the need for synthetic fertilizers. By supporting healthy growing

conditions, we can eliminate the need for arsenic and nontherapeutic antibiotics. In a World Health Organization review of Denmark's elimination of nontherapeutic antibiotic use, a dramatic decrease in resistant bacteria was observed in animals, meat, and humans. In addition, eliminating the routine use of antibiotics in livestock reduced human health risks without significantly harming animal health or farmers' incomes (Wegener 2003).

A variety of studies are now providing evidence that the industrialized food system is having a detrimental impact on the nutritional quality of food. Recent studies of vegetables, fruits, and wheat find median declines since the mid-twentieth century of 5 percent to 35 percent in concentrations of some vitamins, minerals, and protein (Meyer 1997; Davis, Epp, and Riordan 2004; White and Broadley 2005). This has been attributed to the "dilution effect," through which yield-enhancing methods such as genetics, fertilization, and irrigation tend to decrease nutrient concentrations (Jarrell and Beverly 1981). A variety of studies have demonstrated higher nutrient levels in organic produce (Worthington 2001). The current beef-production system is supported by cheap grain inputs. As beef do not naturally have a high grain diet, antibiotics must be fed to help prevent resultant stomach infections. By feeding cattle on pasture, antibiotic use can be reduced, while at the same time providing healthier beef and milk. Grass-fed cattle almost always produce steak and ground beef lower in total fat than conventional beef and tend to result in steak with higher levels of omega-3 fatty acids and other beneficial nutrients. Pasture-raised dairy similarly tends to produce milk with higher levels of essential fatty acids.

The large-scale impact of the globalized food system has spurred the development of Fair Trade, an international third-party certification system that guarantees that farmers and workers in the global south receive a fair price for their product. While this label is most recognized for its coffee certification, as a result of the social and economic crisis in the domestic farm community, a working group was established to develop similar criteria for domestic agricultural production.

In the United Kingdom, the British Medical Association (BMA) has endorsed the work of the Fair Trade movement and has called on the BMA and all medical schools and hospitals in the United Kingdom to set an example by purchasing Fair Trade produce wherever such an alternative is offered. The interest in protecting environmental and social health is gaining momentum not only in the farm sector, but also in the rural economic development community. In Iowa, Woodbury County recently became the first county in the United States to promote organic farming by providing a property-tax rebate for farmers who convert from conventional to organic farming practices. This action was supported by data demonstrating the impact of industrialized agriculture on local economies. The county soon followed with its Local Food Purchase Policy. The policy requires the county to purchase locally grown organic food through its food-service contractor. The resolution has the potential to shift annual food purchases to a local farmer-operated cooperative, thus increasing local demand that will lead to increased production and processing. A study by the Leopold Center has demonstrated that, by eating five half-cup servings of local vegetables daily, Iowans would not only fulfill the requirements of the food pyramid, but would provide a net economic stimulus of more than 4,000 jobs to the State of Iowa (Swenson 2006).

Clearly, there is a recognition that our industrial food system is out of control. While still a small percentage of the national market, organic and other certified foods are the fastest growing segments of the food sector. Sixty-six percent of US consumers report they use organic products at least occasionally, and more than a quarter of Americans are eating more organic products than they did one year ago (Whole Foods Market 2004). Reasons cited for buying organic foods were that they are better for the environment (58 percent), better for their health (54 percent), and better for supporting small and local farmers (57 percent). In addition, 32 percent of respondents believe that organic products taste better; while 42 percent believe organic foods are of higher quality (Whole Foods Market 2004). The survey found that consumers felt that smaller scale family farms were more likely to care about food safety than large-scale industrial farms, and that it was important to know whether food is grown or produced locally or region-

ally (Roper Public Affairs and Media 2004). As numerous market analyses have shown, approximately 25 percent of today's food customers want the unique products that this second market can offer them. Among the attributes making these markets attractive to consumers is the knowledge that a family farmer locally grew their food (Pirog 2004).

> "One good lesson from our experiment with our industrialized food system is that it has allowed us to understand what not to do if we want food that is healthy for consumers, the workers that grow it, and the environment that sustains us."

Healthy food and the healthcare market

It is not only the consumer and retail marketplace that are beginning to influence the dynamic of our current food system. We are witnessing a transition in the marketplace in which hospitals and health systems are adopting a systems approach. Healthcare has realized that it is an important player in the food system, not only because of the tremendous resource it allocates to treating food and nutrition-related disease, but because it plays an important role through its considerable food budget.

Hospital food is big business. In 2004 alone, the top healthcare group purchasing organizations (GPOs) purchased approximately $2.75 billion worth of food (Food Service Director 2005). The total healthcare market for food and beverages is about $12 billion (Healthcare Food Service Management 2006). While patient food receives considerable attention in the media, it is cafeteria and catered food that make up the largest percentage of food in the budget, accounting for approximately 55 percent to 70 percent of hospital volume (Food Service Director 2005).

Hospitals and health systems are not only changing procurement practices to support a healthy food system; they are explicitly identifying the link between a healthy food system and healthy patients, communities, and the planet in their policies and programs. These systems are the pioneers in an ecological approach to preventive medicine.

Kaiser Permanente

Since 2005, Kaiser Permanente (KP) has distinguished itself as a leader in recognizing the need for advancing and implementing a sustainable food system approach. KP's vision includes the aspiration to "provide healthier food in a manner that promotes agricultural practices that are ecologically sound, economically viable, culturally appropriate, and socially responsible" (Kaiser Permanente 2005). KP has developed Healthy Picks criteria for its cafeteria and has piloted healthy vending, incorporating nutritionally and ecologically healthy choices. In November 2005, KP sponsored FoodMed, the first conference on healthy and sustainable food designed for a healthcare audience. It also has hosted training for its foodservice contractors, putting them on notice about KP's intent to adopt a sustainable food approach. KP's food work is best known for adopting farmers' markets at twenty-five of its medical facilities, providing locally grown fresh produce and flowers for KP workers and the community. As KP shared at a presentation at the CleanMed 2006 conference in Seattle, its work has also included:

- setting criteria for healthy food and creating guidelines for implementing sustainable food sourcing, including a two-page sustainable food addendum to the request for information process for its food supplies;
- elimination of rBGH (an artificial growth hormone banned in most Western countries);
- development of a local food-distribution model, collaborating with the California Alliance with Family Farms to source locally grown produce from predominantly low-income, minority farmers; and
- specification of local sourcing and hormone-free meats and dairy and serving fresh fruit instead of sweets as dessert.

Catholic Healthcare West

Catholic Healthcare West (CHW) is the largest Catholic health system in the United States and, like KP, has been a leader in the development of a sustainable food-system approach. Some facilities are already far along. For example, Dominican Hospital in Santa Cruz, California, buys produce from a local, minority-run organic farm and has an on-site garden that provides produce and flowers for the facility. CHW was a co-sponsor of FoodMed and began its work by adopting a model food and nutrition services policy statement. This reads in part: CHW recognizes, "food production and distribution systems have wide ranging impacts on the health of people, their communities and the ecosystems in which they live… healthy food is defined not only by nutritional quality, but equally by a food system which is economically viable, environmentally sustainable and which supports human dignity and justice…CHW aspires to develop a healthy food system" (HCWH 2006).

As part of its first-year implementation plan, CHW is implementing an education program about the ecological impacts of the food system and surveying its dairy providers with a first-year goal to eliminate diary raised with the use of rBGH. CHW has also completed a systemwide review of its coffee procurement and coffee-preparation equipment to access its ability to introduce Fair Trade coffee. CHW was the first health system to sign the Healthy Food Pledge, sending a strong market signal to the food system.

Local examples

At the individual facility level, there are numerous other examples. These organizations have started small, and, in the words of one representative, have taken "baby steps." They demonstrate the possibilities even within small, financially challenged institutions.

Good Shepherd Medical Center, located in Hermiston, Oregon, has eliminated fat fryers, serves organic produce and rBGH-free milk, and has implemented a comprehensive approach to eradicate food additives. It has eliminated beef products and serves bison, which is naturally lean and can be served in the cardiac ward.

St. Luke's Hospital in Duluth, Minnesota, serves only Fair Trade coffee, offers organic fruit, serves rBGH-free milk, is introducing a locally grown organic salad bar, and provides wild salmon caught by a community member. St. Luke's also composts its food waste and has a comprehensive food-recovery program where unused food is provided to the local food bank. Last December, the annual holiday dinner, in which lunch is provided free to staff, served all local and/or organic food and was featured in the local newspaper and statewide on Minnesota Public Radio.

For the last ten to fifteen years, Fletcher Allen Health Care has been buying food and disposing of food waste using practices that benefit patients, staff, the local economy, and the environment. The hospital purchases locally grown—often organic—food, hormone-free milk and Free Trade coffee. It also composts its food waste and has provided local vegetables to its employees through an on-site vegetable stand.

Physicians Plus, a Madison-based health insurance company encourages its 95,000 members to join the community-supported agriculture (CSA) movement by subsidizing CSA memberships. CSA is a method for small-scale commercial farmers to have a successful, closed market by selling produce directly to consumer members through a system of regular local delivery or pick-up of fruits and vegetables.

Benefits

Perhaps one of the most overlooked aspects of the healthy food-system approach is the benefit that accrues to the hospital. Kaiser Permanente's farmers markets have been cited in numerous media and media markets with very positive exposure. St. Luke's very small stepwise program has been covered on statewide and regional radio and in national print media. National media has highlighted those facilities

that were signatories to the Healthy Food Pledge. This positive publicity was not the driving rationale, yet it has provided tremendous marketing and good will for these organizations.

Moreover, these programs have resonated extremely well within the local community. For example, media coverage of St. Luke's cited the numerous local vendors and producers supplying the hospital. Local food procurement creates an immediate connection with patients, staff, and visitors to the community and embeds the facility in the local community in a unique and positive fashion.

Healthcare as leader

Unquestionably, creation of a healthy food system is not a simple task and is not the role of one actor. Healthcare cannot do it alone. Yet, healthcare and the public health community can play a leadership role and historically have risen to the task. For example, success was achieved in advancing policy and legislation to remove lead from paint and fuel. Healthcare has provided leadership in raising an awareness of the dangers of tobacco smoking. Hospitals and healthcare systems that advanced the first smoke-free environments, and the American Medical Association called for divestment of cigarette companies. Over the last ten years, healthcare has laid the groundwork for national comprehensive mercury elimination by raising the awareness of mercury as an ecological health concern and by reducing and almost completely eliminating mercury use in healthcare. This has been achieved through support for mercury legislation, comprehensive education and advocacy, and implementation of alternatives by health systems and nursing and medical organizations.

We are beginning to see the same leadership through implementation of a similar precautionary and preventative approach to our food system. As Preston Maring (2004), a physician at Kaiser Permanente and leader in bringing farmers' markets to many of the Kaiser Permanente medical centers stated, "What can be more closely related to health than what we eat?"

In the same way that hospitals became some of the first organizations to model a prevention approach, we are now seeing the same sector stepping up to the plate to model healthy food practices.

Designing a healthy food system

The complexity of a systems approach will necessitate a variety of interventions. Moreover, some will not always be obvious. For example, should a facility purchase local or organically grown produce? One important step forward is to articulate a new vision regardless of the potential challenges along the way, allowing for a stepwise approach to that goal. The following paragraphs explain steps that healthcare leaders are beginning to explore and adopt.

Healthy Food Pledge

One action that health system and facilities have taken is to support Health Care Without Harm's Healthy Food Pledge. Without encumbering facilities with mandates, hospitals pledge to initiate a healthy food system approach. To date, signatories include top-100 hospitals such as Hackensack University Medical Center, Oregon Health Sciences University, Catholic Healthcare West, and a host of other facilities. The pledge sends an important signal to the marketplace and policymakers about their interest in local, nutritious, sustainable food.

Signatories agree to:

- Work with local farmers, community-based organizations, and food suppliers to increase the availability of locally sourced food.
- Encourage vendors and/or food-management companies to supply food that is, among other

attributes, produced without synthetic pesticides and hormones or antibiotics given to animals in the absence of diagnosed disease and which supports farmer health and welfare and ecologically protective and restorative agriculture.

- Implement a stepwise program to identify and adopt sustainable food procurement. Begin where fewer barriers exist and immediate steps can be taken. For example, the adoption of rBGH-free milk, Fair Trade coffee, or introduction of organic fresh fruit in the cafeteria.
- Communicate to GPOs interest in foods that are identified as local and certified.
- Educate and communicate within the system and to patients and community about nutritious, socially just and ecological sustainable food, healthy food practices and procedures.
- Minimize or beneficially reuse food waste and support the use of food packaging and products that are ecologically protective;
- Develop a program to promote and source from producers and processors that uphold the dignity of family, farmers, workers, and their communities and support sustainable and humane agriculture systems.

Healthy meetings and conferences

Healthcare professionals frequently attend conferences for professional development, and hospitals and health systems host a wide variety of workshops, conferences, and symposia, both on site and at local facilities. These events are extremely important because they help link the professional medical community to the marketplace. It would be logical to provide meat raised without nontherapeutic antibiotics at a meeting of those professionals who recognized their significant role in the development of antibiotic-resistant bacteria. Serving healthy food at conferences and meetings (and, importantly, letting consumers know through signage), tangibly connects health leaders to the issues they are working on and provides market stimulus.

At the FoodMed conference co-sponsored by KP, HCWH, and CHW, all food was local and/or organic and included names of the local farms. HCWH's CleanMed conference food was similarly sourced. By serving nutritious and healthy food, health systems can begin an educational process and support those conference centers and hotels willing to purchase resources from the local community. St. Luke's Hospital's local and organic staff party was another example of how organizations are successfully bringing the issue into the facilities. A potent aspect of local purchasing is that it centers the hospital facilities as community institutions. At the St. Luke's event, names of all the local producers were listed on the food dishes. In its cafeteria is a display board with photos and information on the local community members supplying the cafeteria.

Purchasing power

Hospitals and hospital systems are now becoming aware of their ability to use their purchasing dollar to affect change in the marketplace. Smaller facilities, such as St. Luke's, are asking their GPO to provide a level of service and product that heretofore has not been available. In February 2006, St. Luke's was quoted in *Food Service Director Magazine*, **"**We're part of VHA Novation—we have the buying power of the entire VHA. But as a small, locally run, independent hospital, we must put the pressure on US Foodservice and Novation to get things we want. They haven't negotiated any contracts that cover rBGH-free milk. These GPOs need to start listening to their member hospitals, and when little St. Luke's says we want organic, locally grown, antibiotic-free, they need to listen."

Hospitals are also recognizing a variety of hurdles at the distribution level. For example, food-service departments typically order from their distributor's electronic catalogue, but these sophisticated databases provide almost no information on those products supportive of a healthy food system. They do not provide information on whether the product is domestically or locally produced, produced without nontherapeutic antibiotics, organic (or other certifications), rBGH-free, or other attributes that support a healthy food system. The system does not screen foods based on a particular hospital's criteria, such as foods high in sugar, salt, CAFO produced, trans fats, or other. Yet, the technology is available, and hospital systems and GPOs have the ability to preferentially award contracts to distributors and food-service contractors that support a healthy food approach. The supply chain will respond to its market. By using contracting power and requiring disclosure, hospital and health systems can send important signals and change the supply chain.

Developing marketing-free zones, not free-marketing zones

There is good understanding of how the soft-drink industry has been able to use vending-machine revenue to gain access to schools. Most vending-machine contracts provide a financial return to host schools or other businesses. This revenue frequently funds after-school activities, and, if school budgets are tightened, these activities become dependent on the revenue from the vending machines. Attempts to rid schools of high-sugar vending then run into conflict with those programs dependent on vending revenue.

This model parallels that in healthcare. Most food-service departments count on the revenue from their vending machines to augment their budget. If the food-service department budget gets reduced, then that department becomes reliant on the vending-machine revenue and, in short order, the facilities have become complicit in selling sugar to patients, visitors, and staff.

Another symbol of unhealthy food and food habits are fast-food establishments. According a recent study, 38 percent of the nation's top health institutions have a fast-food facility on site. (University of Michigan Health System 2002). With cost containment as a constant healthcare concern, one can understand the appeal of a fast-food chain to a healthcare food-services director searching for a way to cut cafeteria costs, increase customer satisfaction, and potentially increase revenue. In light of considerable evidence for the food industry's aggressive marketing campaigns, including research on food marketing to children, the appeal to the fast-food industry of having a franchise within a healthcare facility is obvious; a healthcare franchise would be an important marketing target because fast food would have instant health legitimacy through its healthcare alliance. On first glance it is a win-win, yet for an industry interested in supporting good eating habits and providing leadership, fast food-healthcare relationships are creating heated dialogue in nations around the globe.

To add an additional layer of complexity, there is an important subtext that should not be lost. If fast food—greasy hamburgers, French fries—is unhealthy, healthcare facilities should take them off their cafeteria menu as well. Or at a minimum, they should begin a transition and serve local and/or grass-fed beef or bison and potatoes, eliminate food additives and trans fats, adopt appropriate portion sizes, and eliminate bundling (buy a burger and get a free soda).

The food industry has spent time and money to understand how to motivate and interest consumers in its products. Healthcare organizations can take a hard look at how they can provide a necessary service—snacks or meals to patients or staff—without reinforcing food-industry messages whose primary interest is profit, not health. Hospitals and health systems can be models for food marketing-free zones through the elimination of large advertisements on vending machines, food-industry advertisements on cups and food tray liners, and sponsorship of healthcare-related events.

Healthcare leaders can say that it is unethical to market to children. While this industry has the legal right to do so and may provide significant short-term revenue, the long-term costs are now becoming apparent. If the AMA called for divesture from the cigarette industry, it might be worth exploring cutting similar ties to the food industry.

Farm and agricultural policy

At the state and local levels, there are wide variety of legislative initiatives that can benefit for healthcare's involvement, including funding support for sustainable agriculture, organic and/or local procurement preferences similar to the Woodbury County legislation, rebuilding of local meat and food-processing capacity, food-labeling initiatives, and many more. In 2007, the US Farm Bill will be reauthorized, with hundreds of programs that will have huge impact on our food production and distribution. While many parties will be at the table advocating for their interests, it is extremely important that healthcare add its voice. Healthcare leaders have an opportunity now to provide input on what a Farm Bill with a health lens would look like—one that values healthy diets, is ecologically protective, and fosters a vibrant sustainable agricultural economy.

There is a strong and growing constituency that supports a healthy food system and could benefit from healthcare's involvement. Yet, regardless of healthcare involvement from a legislative-policy perspective, healthcare's interests will only be strengthened by building the examples and models of hospitals advancing an ecological healthy food system through policies and practices from the ground up.

Challenges

We have arrived at a critical point in time, as we experience a multitude of negative health impacts from a food system that is out of control and exacerbating healthcare's financial crisis. The public has little understanding of where and how food is produced. By recognizing the complexity of interactions between food production and health, we can begin to address health problems through preventive interventions and build a new, healthy food system. It makes sense that the healthcare industry would be the messenger.

One challenge with respect to implementing a healthier model will be the concern that short-terms costs may be higher. As Nancy Gummer, RD, nutrition service director at Good Shepherd Medical Center reminds us, "What we're discovering is, it's a perception that doing the right thing is more expensive...It's not a reality... I haven't been a month over budget, on food or anything else." Even if it were, a hospital comes out ahead, Gummer said. "When you're looking at food costs and health costs, you can't look at, 'How much per pound am I paying?' You have to look at the whole picture. Healthier people use less healthcare resources" (Cole, 2006).

Though Americans have some of the cheapest food, the true costs (social justice, environmental burden, health impacts, etc.) have been externalized. Yet, since most people do not understand how food is produced and distributed, these issues go unnoticed. Throughout the supply chain, food is seen as a commodity, but it is clearly not an undifferentiated product. How and where it is produced can significantly change not only its quality, but also a cascade of cultural and ecological health impacts. Accordingly, dieticians, food-service directors, nursing and medical staff, and others have not thought about the health attributes of food beyond nutritional quality. As a result, there will be debate over how we define healthy food. Is it defined strictly by nutritional quality or are there other elements to consider? And, while there is growing awareness, environmental health is still seen as distinct from human health, as is social justice. Gummer further reminds us of fundamentally important questions, "What's the healthiest food I can feed these patients? How can the food we buy contribute to the health of the environment we're living in?" (Cole 2006).

As we approach a systematic problem, it can be helpful to acknowledge that change will make some people uncomfortable, and as the marketplace shifts, not everyone will benefit. Unquestionably, we need more production of fruits and vegetables. Our food system does not support local production. As new models of local distribution evolve, they may challenge existing models. It makes sense to build a new food system that provides a transition that attempts to benefit all members of the community.

Healthcare is habituated to technological fixes and tends not to reward prevention. The breadth and burden of the obesity crisis may be big enough to awaken healthcare to the need for a systems approach. By contrast, sustainable agriculture is a systemic approach involving low technology. Reconciling these functional differences may be complicated, but discussions are necessary with respect to allocating healthcare dollars for both treatment and prevention.

At times, approaching change will raise more questions than answers. For example, although we can estimate treatment costs associated with increases in antibiotic-resistant bacteria, we do not know with certainty whether this occurs from agricultural use or clinical use, in spite of knowing that the majority of nontherapeutic antibiotic uses are in agriculture. Furthermore, we know that pesticides have contaminated the entire food web, and that pesticides are associated with negative health effects. However, we cannot accurately assess the mortality or morbidity associated with pesticides. Still, attempting to reduce unnecessary usage of nontherapeutic antibiotics and pesticides in light of their potential to produce harm represents a precautionary approach embraced by healthcare—a sense of acting protectively in spite of gaps and uncertainties in the established science. A precautionary approach can seem at odds with the evidence-based approach promulgated in healthcare, even though they both employ available science. They are simply used for different applications. We will need to recognize how and when to use these tools.

Conclusion

Until recently, humans have been able to dissociate their activities from ecological processes. The air, water, and land have carried the burden of these activities. As our population and activities have increased, we now have little room for error or disregard. We are reminded from the recent United Nations Millennium Ecosystem Assessment, "At the heart of this assessment is a stark warning. Human activity is putting such strain on the natural functions of Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted" (United Nations 2005). Increasingly, we are recognizing that we cannot be healthy on an unhealthy planet.

"Increasingly, we are recognizing that we cannot be healthy on an unhealthy planet."

Over the last sixty years, we have developed a food system, which, on its face, is very efficient. This food system is dependent on a practice of agriculture completely at odds with the functioning of natural systems. We have developed synthetic inputs, decreased diversity, and contaminated the food web. We have evolved a food system that supports and has accelerated a high-technology industrialized agriculture, which is now out of control, critically affecting cultural, social, and ecological systems. We are at a crossroad. We can choose to continue to intervene and tweak an incredibly complex network of relationships and feedback mechanisms and hope that we understand these dynamic intricacies that have evolved over eons of time, or we can advance an agricultural model that works in concert with these ecological processes. Healthcare leaders are playing a decisive role in advancing a food system that is healthy for patients, communities, and the planet. What leaders must recognize is that, ultimately, such a system is imperative for human, community, and global health.

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References

Agriculture Research Service, US Department of Agriculture. 2005. *National Program 206: Manure and Byproduct Utilization Action Plan;* http://www.ars.usda.gov/research/programs/programs.htm?np_code=206&docid=658.

Alonso-Magdalena, P., S. Morimoto, C. Ripoll, E. Fuentes, and A Nadal. 2006. "The Estrogenic Effect of Bisphenol-A Disrupts the Pancreatic ß-Cell Function in vivo and Induces Insulin Resistance." *Environmental Health Perspectives 114*:106-112.

American College of Physicians. 1999. *Emerging Antibiotic Resistance, Facts and Figures;* http://www.acponline.org/ear/factsfigs.htm.

American Medical Association. 2001. Declaration of Professional Responsibility, *CEJA Report* 5-I-01; http://www.ama-assn.org/ama/pub/category/7491.html.

American Public Health Association (APHA). 2003. Policy Statement 2003 -7 Precautionary Moratorium on New Concentrated Animal Feed Operations; http://apha.org/legislative/policy/policysearch/index.cfm?fuseaction=view&id=1243.

Anderson, R. N., and B. L. Smith. 2003. "Deaths: Leading Causes for 2001." *National Vital Statistics Reports 52*(9): 1-85.

Baker, P., C. Benbrook, E. Groth, and K. L. Benbrook. 2002. "Pesticide Residues in Conventional, IPM-Grown and Organic Foods: Insights from Three U.S. Data Sets." *Food Additives and Contaminants 19*(5): 427-446; http://www.consumersunion.org/food/organicsumm.htm.

Barboza, D. 2000. "Goliath of the Hog World." *New York Times*, April 7.

Block, G. 2004. "Foods Contributing to Energy Intake in the US: Data from NHANES III and NHANES 1999-2000." *Journal of Food Composition and Analysis 17*: 3-4.

Boody, G., B. Vondracek, D. A. Andow, M. Krinke, J. Westra, J. Zimmerman, and P. Welle. 2005. "Multifunctional Agriculture in the United States." *BioScience 55*(1): 27–38.

Bostrom, M., A. Aubrun, A. Brown, and J. Grady. 2005. *Perceptions of the U.S. Food System: What and How Americans Think About Their Food*. Battle Creek, MI: W. K. Kellogg Foundation.

Campagnolo, E.R., and C. S. Rubin. 1998. *Report to the State of Iowa Department of Public Health on the Investigation of the Chemical and Microbial Constituents of Ground and Surface Water Proximal to Large-Scale Swine Operations*. Washington, DC: Center for Disease Control and Prevention—National Center for Environmental Health.

Carlsson-Kanyama, A. 1998. "Climate Change and Dietary Choices: How Can Emissions of Greenhouse Gases from Food Consumption be Reduced?" *Food Policy* Fall/Winter: 288-289.

Centers for Disease Control (CDC). 2004. "Campaign to Prevent Antimicrobial Resistance in Healthcare Settings;" http://www.cdc.gov/drugresistance/healthcare/problem.htm.

Christen, K. 2006. "Chicken Poop and Arsenic." *Science News Online*, March 29; http://pubs.acs.org/subscribe/journals/esthag-w/2006/mar/science/kc_chickenpoop.html.

Christensen, L. A. 2002. "Soil, Nutrient, and Water Management Systems Used in U.S. Corn Production." In *Agriculture Information Bulletin No. 774*. Washington, DC: US Department of Agriculture, Economic Research Service; http://www.ers.usda.gov/Publications/aib774/.

Cole, L. 2006. "This is Hospital Food?" *The Oregonion*, March.

Curl, C., R. Fenske, and K. Eglethun. 2003. "Organophosphorous Pesticide Exposure of Urban and Suburban Preschool Children with Organic and Conventional Diets." *Environmental Health Perspectives 111*: 377-382.

Davis, D. R., M. D. Epp, and H. D. Riordan. 2004. "Changes in USDA Food Composition Data for 43 GardenCrops, 1950 to 1999." *Journal of the American College of Nutrition 23*(6).

DeNoon, D. 2005. "Teflon Safety Gets Closer Look EPA Expert Panel Preliminary Finding: PFOA a 'Likely Carcinogen.'" *WebMD Magazine,* July 12; http://www.webmd.com/content/article/108/108991.htm.

Environmental Defence. 2005. *Toxic Nation, A Report on Pollution in Canadians*. Toronto, Ontario: Environmental Defence; http://www.environmentaldefence.ca/toxicnation/report/Rev_English%20Web.pdf.

Environmental Protection Agency and US Department of Agriculture. 1998. *Draft Unified National Strategy for Animal Feeding Operation*. Washington, DC: Environmental Protection Agency and US Department of Agriculture; http://water.usgs.gov/owq/cleanwater/afo/.

Flynn, H., J. Roach, V. Balke, B. Harrington, J. Kinney, R. Lucker, R. Schwietz, and L. Welsh. 2000. Minnesota Bishops' Statement on the Farm Crisis 2000; http://www.ncrlc.com/bishop-statements-webpages/RCS-minn.html.

Food Service Director. 2005. *Industry Census*, June 15; http://www.fsdmag.com.

Fox, J. E., M. Starcevic, K. Y. Kow, M. E. Burow, and J. A. McLachlan. 2001. "Nitrogen Fixation: Endocrine Disrupters and Flavonoid Signaling." *Nature 413*: 128-129.

Gilliom, R. J., W. M. Alley, and M. E. Gurtz. 1995. *Design of the National Water-Quality Assessment Program—Occurrence and Distribution of Water-Quality Conditions: US Geological Survey Circular* 1112, Denver, CO: US Geological Survey, 33.

Goolsby, D. A., R. C. Coupe, and D. J. Markovchick. 1991. *Distribution of Selected Herbicides and Nitrates in the Mississippi River and Its Major Tributaries: April Through June 1991*, Denver, CO: US Geological Survey, 23-33.

Government of British Columbia, Ministry of Forests. Undated. *Glossary of Forest Terms;* http://www.for.gov.bc.ca/hfd/library/documents/glossary/H.htm.

GrassRoots Action Center for the Environment (GRACE). Undated. "The Issues—Factory Farming." Sustainable Table website, http://www.sustainabletable.org/issues/factoryfarming/.

Gunsolus, J. L. 1999. *Herbicide Resistant Weeds*. North Central Regional Extension Publication 468. St. Paul, MN: University of Minnesota Extension Service; http://www.extension.umn.edu/distribution/cropsystems/DC6077.html#.

Halweil, B. 2004. *Eat Here: Reclaiming Homegrown Pleasures in a Global Supermarket*. New York: W. W. Norton & Co., 63.

Halweil, B. 2006. "Vision for a Sustainable World, Can Organic Farming Feed Us All?" *World Watch Magazine 19*(3).

Healthcare Food Service Management. 2006; http://www.hfm.org/about.html.

Health Care Without Harm. (HCWH). 2006. "Catholic Healthcare West Food and Nutrition Vision Statement;" http://www.noharm.org/details.cfm?ID=1298&type=document.

Henderson A. 1998. *A Survey of the Quality of Water Drawn from Domestic Wells in Nine Midwest States*. Atlanta, GA: Centers for Disease Control and Prevention.

Hendrickson, M., W. Heffernan, P. Howard, and J. Heffernan. 2001. *Consolidation in Food Retailing and Dairy: Implications for Farmers and Consumers in a Global Food System*. Washington, DC: National Farmers Union.

Hird, V. 2003. *Sustainable Food Chains, Briefing 6 Public Procurement of Sustainable Food; Review of activity 2003*. London: Sustain.

Ho, S-M, W-Y Tang, J. Belmonte de Frausto, and G. S. Prins. 2006. "Developmental Exposure to Estradiol and Bisphenol A Increases Susceptibility to Prostate Carcinogenesis and Epigenetically Regulates Phosphodiesterase Type 4 Variant 4." *Cancer Research 66*: 5624-5632.

Hoek, G. B., Brunekreef, S. Goldbohn, P. Fischer, and P. A. van den Brandt. 2002. "Association Between Mortality and Indicators of Traffic-Related Air Pollution in the Netherlands: A Cohort Study." *Lancet 360*(9341): 1203-9.

Houlihan, J., T. Kropp, R. Wiles, S. Gray, and C. Campbell. 2005. *Body Burden—The Pollution in Newborns a Benchmark Investigation of Industrial Chemicals, Pollutants, and Pesticides in Umbilical Cord Blood*. Washington, DC: Environmental Working Group; http://www.ewg.org/reports/bodyburden2/execsumm.php.

Infectious Diseases Society of America. 2004. "Backgrounder: 'Bad Bugs, No Drugs;'" http://www.fda.gov/ohrms/dockets/DOCKETS/04s0233/04s-0233-c000005-03-IDSA-vol1.pdf.

Institute for Agriculture and Trade Policy (IATP). 2004. "IATP Press Release Applauds American Public Health Association Call For Precautionary Moratorium on New CAFOs," January; http://www.commondreams.org/news2004/0108-04.htm.

Institute of Medicine, Board on Global Health. 2003. *Microbial Threats to Health: Emergence, Detection, and Response*. Washington, DC: National Academy of Sciences Press; http://books.nap.edu/books/030908864X/html/.

Institute of Medicine. 2004. "Focus on Childhood Obesity;" http://www.iom.edu/?id=22593&redirect=0.

Jarrell, W. M., and R. B. Beverly. 1981. "The Dilution Effect in Plant Nutrition Studies." *Advances in Agronomy 34*:197–224.

Jones, A. 2001. *Eating Oil: Food Supply in a Changing Climate*. London: Sustain and Elm Farm Research Centre, 1,10,14, 30, 31.

Kaiser Permanente. 2005. Presentation accessed from Hospitals for a Healthy Environment website; http://h2e-online.org/teleconferences/molydesc.cfm?Date=2005-04-08&teleconfid=51.

Kannan, K., J. Koistinen, K. Beckmen, T. Evans, J. F. Gorzelany, K. J. Hansen, P. D. Jones, E. Helle, M. Nyman, and J. P. Giesy. 2001. "Accumulation of Perfluorooctane Sulfonate in Marine Mammals." *Environmental Science and Technology 35*: 1593-1598.

Keith, S. W., D. T. Redden, P. T. Katzmarzyk, M. M. Boggiano, E. C. Hanlon, R. M. Benca, D. Ruden, A. Pietrobelli, J. L. Barger, K. R. Fontaine, C. Wang, L. J. Aronne, S. M. Wright, M. Baskin, N. V. Dhurandhar, M. C. Lijoi, C. M. Grilo, M. Deluca, A. O. Westfall, and D. B. Allison. 2006. "Putative Contributors to the Secular Increase in Obesity: Exploring the Roads Less Traveled." *International Journal of Obesity*, June 27.

Kirschenmann, F. 2002. "The Future of Agrarianism: Where Are We Now?" Written for the conference considering Wendell Berry's *The Unsettling of America* 25 years later, Georgetown University, April 25-27, 2002; http://www.leopold.iastate.edu/pubs/speech/files/042502-future_of_agrarianism.pdf.

Kirschenmann, F., S. Stevenson, F. Buttel, T. Lyson, and M. Duff. Undated. "Why Worry About the Agriculture of the Middle? A White Paper for the Agriculture of the Middle Project;" http://agofthemiddle.org/.

Kratz, G. 1998. "Will Corporate Farms Hog Market?" *Deseret News Service*, September 16.

Levy, S. B. 1998. "The Challenge of Antibiotic Resistance." *Scientific American 278*(1998): 46–56; www.sciam.com/1998/0398issue/0398levy.html.

Lin, S., J. P. Munsie, S. A. Hwang, E. Fitzgerald, and M. R. Cayo. 2002. "Childhood Asthma Hospitalization and Residential Exposure to State Route Traffic." *Environmental Research, Section A*, *88*(2): 73-81.

Lu, C., K. Toepel, R. Irish, R. Fenske, D. Barr, and R. Bravo. 2006. "Organic Diets Significantly Lower Children's Dietary Exposure to Organophosphorous Pesticides." *Environmental Health Perspectives 114*(2); http://www.ehponline.org/docs/2005/8418/abstract.html.

MacCannell, D. 1983. "Agribusiness and the Small Community." Background Paper to Technology, Public Policy and the Changing Structure of American Agriculture. Washington, DC: Office of Technology Assessment, U.S. Congress.

Mamen, K., S. Gorelick, G. Norberg-Hodge, and D. Deumling. 2004. *Ripe for Change–Rethinking California's Food Economy*, International Society for Ecology and Culture, 66; http://www.isec.org.uk/articles/RipeForChangeFactsheet.pdf.

Maring, P. 2004. "Produce to the People." *The Permanente Journal 8*(2); http://xnet.kp.org/permanentejournal/spring04/produce.pdf.

Masuno, H., T. Kidani, K. Sekiya, K. Sakayama, T. Shiosaka, H. Yamamoto, and K. Honda. 2002. Bisphenol A in Combination with Insulin Can Accelerate the Conversion of 3T3-L1 Fibroblasts to Adipocytes. *Journal of Lipid Research 3*: 676-684.

Mellon, M., C. Benbrook, and K. L. Benbrook. 2001. *Hogging It: Estimates of Antimicrobial Abuse in Livestock*. Cambridge, MA: Union of Concerned Scientists.

Meter, K., and J. Rosales. 2001. *Finding Food in Farm Country: The Economics of Food & Farming in Southeast Minnesota*. Lanesboro, MN: Community Design Center, 3-5; http://www.crcworks.org/ff.pdf.

Meyer, A. M. 1997. "Historical Changes in the Mineral Content of Fruits and Vegetables." *British Food Journal 99*: 207-211.

Michigan State Medical Society. 2002. Resolution 105- 02A, May.

Nestle, M. 2003. *Food Politics*. Los Angeles, CA: University of California Press, 7.

Norberg-Hodge, H., T. Merrifield, and S. Gorelick. 2002. *Bringing the Food Economy Home: Local Alternatives to Global Agribusiness*. Bloomfield, CT: Kumarian Press, 18.

Ogden, C. L., M. D. Carroll, L. R. Curtin, M. A. McDowell, C. J. Tabak, and K. M. Flegal. 2006. "Prevalence of Overweight and Obesity in the United States, 1999-2004." *Journal of the American Medical Association 295(*13): 1549-55.

Pirog, R. 2003. *Checking the Food Odometer: Comparing Food Miles for Local Versus Conventional Produce Sales in Iowa Institutions*. Ames: IA: Leopold Center for Sustainable Agriculture; http://www.leopold.iastate.edu/pubinfo/papersspeeches/food_travel072103.pdf.

Pirog, R. 2004. *Ecolabel Value Assessment Phase II: Consumer Perceptions of Local Foods*. Ames, IA: Leopold Center for Sustainable Agriculture; http://www.leopold.iastate.edu/pubs/staff/ecolabels2/summary.pdf.

Pirog, R., T. Van Pelt, K. Enshayan, and E. Cook. 2001. *Food, Fuel, and Freeways: An Iowa Perspective on How Far Food Travels, Fuel Usage and Greenhouse Gas Emissions*. Ames, IA: Leopold Center for Sustainable Agriculture, Iowa State University, 1, 2; http://www.leopold.iastate.edu/pubs/staff/ecolabels2/summary.pdf.

Porter, P., M. Russelle, and R. Finley. 2000. "Cropping Systems, Precipitation, and Runoff Trends in SouthWestern Minnesota: The Case for Cover Crops," presentation at Minnesota Water 2000, University of Minnesota Water Resources Center, Minneapolis, April 26, 24.

Pretty, J. 1998. *The Living Land: Agriculture, Food and Community Regeneration in Rural Europe*. London: Earthscan Publications.

Rabalais, N. R., E. Turner, and D. Scavia. 2002. "Beyond Science into Policy: Gulf of Mexico Hypoxia and the Mississippi River." *BioScience* 52(2): 129-42.

Raloff, J. 2006. "Farm Fresh Produce." *Science News Online* 170(2); http://www.sciencenews.org/articles/20060708/food.asp.

Reeves, M., A. Katten, and M. Guzman. 2002. *Fields of Poison 2002: California Farm Workers and Pesticides*. San Francisco: Pesticide Action Network and Californians for Pesticide Reform; http://www.panna.org/resources/gpc/gpc_200304.13.1.07.dv.html.

Roper Public Affairs and Media. 2004. *Food and Farming 2004*. Prepared for Organic Valley Family of Farms; http://organicvalley.coop/pdf/roper_survey.pdf.

Rosset, P. 1999. *The Multiple Functions and Benefits of Small Farm Agriculture, Policy Brief No. 4*. Oakland, CA: Foodfirst/Institute for Food and Development Policy, 12-13.

Sanborn, M., D. Cole, K. Kerr, C. Vakil, L. Sanin, and K. Bassil. 2004. *Pesticides Literature Review*. Toronto, Ontario: The Ontario College of Family Physicians; http://www.ocfp.on.ca/loca/filescommunications/current%20issues/pesticides/final/%20paper%2023APR2004.pdf.

Shea, K., K. Florini, and T. Barlam. 2001. *How Antibiotic Resistance Threatens Children, Seniors and the Medically Vulnerable*. Washington, DC: Environmental Defense, 5; http://www.environmentaldefense.org/documents/162_abrreport.pdf.

Shinogle, J., M. Owings, and L. Kozak. 2005. "Gastric Bypass as Treatment for Obesity: Trends, Characteristics, and Complications." *Obesity Research 13*: 2202-2209.

Smedley, B., and S. L. Syme, ed. 2000. *Promoting Health Intervention Strategies from Social and Behavioral Research*. Washington, DC: National Academies Press.

Smith, A., P. Watkiss, G. Tweddle, A. McKinnon, M. Browne, A. Hunt, C. Treleven, C. Nash, and S. Cross. 2005. *The Validity of Food Miles as an Indicator of Sustainable Development*, prepared by AEA Technology for the UK Department for Environment Food and Rural Affairs (Defra); http://statistics.defra.gov.uk/esg/reports/foodmiles/default.asp.

Soil Conservation Council of Canada. 2001. "Global Warming and Agriculture: Fossil Fuel" Factsheet 1(3).

Sorkin, A. R. 2006. "Nestlé to Buy Jenny Craig, Betting Diets Are on Rise." *New York Times,* June 19.

Swenson, D. 2006. *The Economic Impacts of Increased Fruit and Vegetable Production and Consumption in Iowa: Phase II*. Report to the Regional Food Systems Working Group Leopold Center for Sustainable Agriculture, May 2006.

United Nations Millennium Ecosystem Assessment. 2005. "Living Beyond Our Means: Natural Assets and Human Well-Being," statement from the board.

University of Michigan Health System. 2002. "Nation's Leading Hospitals Serving up Fast Food;" press release; http://www.med.umich.edu/opm/newspage/2002/fastfood.htm#table.

US Congress, Office of Technology Assessment. 1986. *Technology, Public Policy, and the Changing Structure of American Agriculture*. Washington, DC: U.S. Government Printing Office; http://govinfo.library.unt.edu/ota/Ota_3/DATA/1986/8633.PDF.

US Department of Agriculture (USDA), National Agricultural Statistics Service. 2002. *Census of Agriculture,* 1: 58-65; http://www.nass.usda.gov/Census_of_Agriculture/index.asp.

US Department of Health and Human Services, National Nosocomial Infections Surveillance System (NNIS). 2000. "Semiannual Report," June; http://www.cdc.gov/ncidod/hip/NNIS/june2000sar.pdf.

US Geological Survey (USGS). 1999. "The Quality of Our Nation's Waters—Nutrients and Pesticides." U.S. Geological Survey Circular 1225; http://pubs.usgs.gov/circ/circ1225/pdf/index.html.

Wallinga, D. 2006a. *Playing Chicken—Avoiding Arsenic in Your Meat*. Institute for Agriculture and Trade Policy.

Wallinga, D. 2006b. "Frequently Asked Questions on *Playing Chicken: Avoiding Arsenic in Your Meat*." Institute for Agriculture and Trade Policy, April 4; http://www.environmentalobservatory.org/library.cfm?refid=80533.

Wegener, H. C. 2003. Current Opinion in Microbiology 2003; World Health Organization. Impacts of antimicrobial growth promoter termination in Denmark: The WHO international review panel's evaluation of the termination of the use of antimicrobial growth promoters in Denmark. 2003; http://www.who.int/salmsurv/en/Expertsreportgrowthpromoterdenmark.pdf.

White, P. J., and M. R. Broadley. 2005. "Historical Variation in the Mineral Composition of Edible Horticultural Products." *Journal of Horticultural Science and Biotechnology 80*, 660-667.

Whole Foods Market. 2004. "Organic Foods Continue to Grow in Popularity According to Whole Foods Market." News release, October 21; http://www.wholefoodsmarket.com/company/pr_10-21-04.html.

Whyatt, R. M., and D. B. Barr. 2001. "Measurement of Organophosphate Metabolites in Postpartum Meconium as a Potential Biomarker of Prenatal Exposure: A Validation Study." *Environmental Health Perspectives 109*(4):417-20.

Wiles, R., B. Cohen, C. Campbell, and S. Elderkin. 1994. *Tap Water Blues: Herbicides in Drinking Water*. Washington, DC: EWG/PSR Press.

Wilhelm, R., and B. Ritz. 2002. "Residential Proximity to Traffic and Adverse Birth Outcomes in Los Angeles County, California, 1994-1996." *Environmental Health Perspectives 111*: 20-216.

Wimberley, R. C., B. Vander Mey, B. Wells, G. Ejimakor, C. Bailey, L. Burmeister, C. Harris, M. Lee, E. McLean, J. Molnar, G. Ohlendorf, T. Tomazic, and G. Wheelock. 2003. Food from our Shopping World: The Globalization of Food and How Americans Feel about It; http://sasw.chass.ncsu.edu/global-food/foodglobal.html.

World Health Organization (WHO). 2003. 1st Joint FAO [Food and Agriculture Organization of the United Nations]/OIE [World Organization for Animal Health/WHO Expert Workshop on Non-Human Antimicrobial Usage and Antimicrobial Resistance: Scientific Assessment, Geneva, December 1-5, 2003; executive summary available at http://www.who.int/foodsafety/micro/meetings/nov2003/en/.

Worthington, V. 2001. "Nutritional Quality of Organic Versus Conventional Fruits, Vegetables and Grains." *The Journal of Alternative and Complementary Medicine 7(2*): 161-173.

Zhu, Y., W. C. Hinds, S. Kim, and C. Sioutas. 2002. "Concentration and Size Distribution of Ultrafine Particles near a Major Highway." *Journal of the Air and Waste Management Association 52*(9): 1032-42.