Practice Paper of the Academy of Nutrition and Dietetics:

Promoting Ecological Sustainability within the Food System

ABSTRACT

Registered dietitians (RDs) and dietetic technicians, registered (DTRs) can implement environmentally responsible practices in their workplace and personal lives. RDs and DTRs who conserve natural resources while minimizing environmental degradation will help maintain sustainability of the food system, which requires knowledge of the external costs of operational and personal decisions. These external costs include energy to produce, transport, and process food; water for food production, preparation, and sanitation; removal of air pollutants; and waste management. As client and public educators, RDs and DTRs are uniquely positioned to meet the growing needs of those seeking guidance on food choices as they relate to ecological sustainability. In an effort to promote ecologically sustainable diets, it is important to consider natural resources as they relate to food production, transformation, distribution, access, and consumption. It is essential that the dietetics community take a more active leadership role in support of ecological sustainability and social responsibility. RDs and DTRs can influence policy at the institutional, community, local, state, and national levels by presenting results of operational practices and science-based natural resource information. RDs and DTRs are encouraged to become educated and active in implementing sustainable practices and shaping policy in an effort to promote healthier individuals, communities, and the nation as a whole.

ISSUES RELATED TO MANAGEMENT OF FOOD AND NUTRITION OPERATIONS

Food and nutrition managers have an important role in the food distribution and access sector of the food system—procuring, preparing, and serving food in large quantities. Their actions impact allocation of energy, water, and indoor air quality for labor and equipment inputs within the food production system, and their resource decisions impact both the natural environment and the US economy.1

Energy

Primary renewable energy sources include thermal, wind, water, and solar. Natural gas, coal, and oil are primary nonrenewable energy sources. Primary sources, renewable and nonrenewable, are used directly or converted to another form of energy to produce light, heat, or refrigeration for food production.2 Fossil fuel is the main energy source for the US food system. The majority of electricity is generated from coal, natural gas, or oil, all of which are forms of fossil fuel. The Energy Information Administration estimates that energy consumption for the commercial sector, which includes foodservice, will remain stable through 2035, mainly due to increases in energy efficiency for lighting, heating, refrigeration, and cooking.3 Electricity use in the commercial sector, however, is projected to increase 1.4% per year from 53% to 58% of total energy consumption. Therefore, efficiency gains in food production equipment may be offset by increasing use of non-food–related electronic equipment.4

It is important for RDs and DTRs to know how to estimate energy consumption and how that translates into expenses for the foodservice operation. The following sections will cover how to measure energy consumed and how to make comparisons between energy sources.
Energy Units  
Primary sources of energy are measured by units such as cubic feet (ft\(^3\)) and kilowatt hour (kWh). Converting energy to the British thermal unit (Btu) is one method to compare energy sources for making efficiency and cost decisions. One Btu is equal to the energy released from burning one wooden kitchen match. The Table shows the energy equivalence for common sources of energy.\(^5\)

Energy Comparison  
When deciding about equipment purchases, RDs and DTRs should take into account energy utilization and cost of energy. For example, a two-shelf electric convection oven uses 12.5 kW per hour of operation. A similar capacity natural gas powered convection oven uses 42.8 ft\(^3\) for the same time period.

- \(12.5 \text{ kWh} \times 3,412 \text{ Btu} = 42,650 \text{ Btu}\)
- \(42.8 \text{ ft}^3 \times 1,028 \text{ Btu} = 43,998.4 \text{ Btu}\)

Both ovens consume similar amounts of energy when converted to Btu. The cost of energy must be considered when making energy comparisons. For this example, the most recent commercial rate for electricity ($0.104/kWh) and for natural gas ($0.008/ft\(^3\)) will be used.
Electric oven uses 12.5 kW × $0.104/kWh = $1.30/hour at maximum capacity

- Natural gas oven uses 42.8 ft³ × $0.008/ft³ = $0.34/hour at maximum capacity

Despite similar energy consumption when measured in Btu, the natural gas convection oven costs less to operate. Foodservice directors should make operational decisions based on common energy units (Btu) and cost per unit of energy. Regional differences in energy cost and availability will influence the type of energy used by equipment. Purchase of Energy Star-certified equipment will be the most cost efficient choice for the available energy sources.

The Energy Star program was implemented by the Environmental Protection Agency (EPA) in 1992 as a result of instability of oil supplies and prices during the 1970s and 1980s. It is a government-backed symbol for energy efficiency and reduced operating cost of food preparation, cooling, and heating equipment. In order to earn the Energy Star label, equipment must offer substantial energy savings, use non-proprietary technology, and generate measurable performance.

### Energy Efficient Equipment

Energy Star has published specifications for food production equipment. The key criteria for each type of equipment are developed from testing procedures of independent organizations such as the National Sanitation Foundation and American Society for Testing and Materials. For example, Energy Star criteria state that a stationary single tank door dishwasher should consume less than 1 kWh when idle (heater only) and use less than 0.95 gal water/rack. A single tank conveyor dishwasher has idle criteria of less than 2 kWh energy (heater only) and use less than 0.7 gal water/rack. Single tank dishwashers meeting these key criteria will earn an Energy Star label. An Energy Star certified dishwasher may save 90 million Btu of energy per year and cost $900 to operate. The Energy Star dishwasher may save $200 annually for water cost and save 52,000 gallons of water per year.

Cost comparisons for each type of energy and the amount consumed will identify opportunities for conservation. Demand charge and shared utilities are two factors that can influence efficiency and cost. Electric capacity cannot be stored; therefore, supply of energy must be constant to meet periodic demand. A demand charge is a surcharge added by electric utilities to compensate for daily fluctuations in electricity consumption. The surcharge is added during high use periods such as 12 PM to 1 PM and 5 PM to 6 PM. In terms of shared utilities, unless a food production operation is the sole building occupant, climate control functions are often shared among departments. Collaborating with building engineers will help quantify heating, cooling, and air quality costs incurred by the foodservice operation itself aside from the rest of the building. The EPA and other organizations have developed energy audit forms for every foodservice segment. The link can be found in Figure 1.

### Energy Audits

Foodservice operations consume 2.5 times more energy per square foot than the rest of the commercial sector. A record of the time and length of equipment operation, including lighting, can reduce production costs and decrease greenhouse gas emissions. Figure 2 illustrates typical energy consumption for food production. An energy audit is an evaluation of energy flow throughout a foodservice operation to decrease energy consumption while maintaining food quality and safety standards. An audit is a component of an energy management plan.

Knowledge of a facility’s energy consumption patterns provides food and nutrition managers opportunities to conserve energy and control costs. Measuring energy generates baseline data, which can be used to measure performance of conservation measures. An energy audit can use several approaches; however, all audits will identify energy consuming equipment or practices by type of energy. Energy consumption for each piece of equipment is monitored for a specified time period, typically 1 week. Patterns of consumption such as time of day or type of activity are recorded. Energy consumed should be converted to Btu (refer to energy comparison example) so that all energy is compared by the same criteria.

### Water

Water is an essential natural resource that must be protected from contamination and conserved. The commercial sector, which includes health care, public institutions, and restaurants, consumes 46 million gallons of water per day—11% of total freshwater use. This is 23% of the total potable water supply. Food production water use ranges from 5 gal per child’s meal for school

### Energy Source Btu Equivalents

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Btu Equivalents</th>
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<tbody>
<tr>
<td>Gasoline</td>
<td>1 gallon = 124,000 Btu</td>
</tr>
<tr>
<td>Electricity</td>
<td>1 kilowatthour (kWh) = 3,412 Btu</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>1 cubic foot (ft³) = 1,028 Btu</td>
</tr>
<tr>
<td>Heating Oil</td>
<td>1 gallon = 139,000 Btu</td>
</tr>
<tr>
<td>Propane</td>
<td>1 gallon = 91,333 Btu</td>
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</tbody>
</table>

### Table

Btu equivalents of forms of energy used in food production

- Electric oven uses 12.5 kW × $0.104/kWh = $1.30/hour at maximum capacity
- Natural gas oven uses 42.8 ft³ × $0.008/ft³ = $0.34/hour at maximum capacity
lunch to 10 gal per meal for full-service restaurants and cafeterias. Commercial and institutional kitchen water consumption accounts for about 10% of total water use for each foodservice category. Regional population shifts as well as the development of agricultural land to commercial/residential properties has strained existing water systems. The outcomes of building new water systems to serve growing populations are increased water treatment and delivery costs. The national average cost for tap water was $1.87 per 1,000 gallons in 2008, a 36% increase from 1995 water prices, thus the need for RDs and DTRs to carefully evaluate water consumption and costs when making decisions. The next section will highlight the steps needed to perform a water audit, a necessary duty to assure water conservation and cost savings.

Water Audit  Water consumption directly affects energy use in the kitchen. Energy is needed for heating water and for operating equipment such as steamers. Utilities charge for water by the unit: one unit = 100 cubic feet or 748 gallons. The cost of water includes the water meter charge (water in) and the sewer use charge (water out). Disposing of food scraps and other organic material through the sewer can result in biological oxygen demand (BOD) charges. BOD refers to the quantity of oxygen needed to break down the organic material when it enters a body of water. If BOD exceeds available oxygen supply, algae blooms and higher treatment costs will result. This is why sewer use charge is usually higher than the water meter charge. A water audit is a method directors can use to control operational costs and minimize pollution. All water consuming equipment and water outlets need to be inventoried for flow rate and potential leakage. The flow rate, or volume of water flowing through a device, can be measured by placing a gallon pitcher below the device and observing the time required to fill the pitcher with the device completely open or at full force. The number of seconds to fill a 1 gallon container multiplied by 60 seconds is the flow rate, or gallons per minute (gpm). Equipment manuals may provide gpm or the gpm may be etched on the equipment; however, the flow rate can be determined by the method described if the information is unavailable. The higher the flow rate, the more water is consumed per time period. Knowledge of flow rates for all equipment is important for water conservation planning and for writing specifications for equipment purchases. WaterSense is a voluntary EPA–private collaboration promoting water efficient practices and water conserving equipment. A product must be at least 20% more water efficient and perform as well as conventional equipment to earn the WaterSense label. All efficiency claims must be verified by a third party. Looking for the WaterSense label is another tool that RDs and DTRs can use when evaluating equipment purchases.
Waste Management
Municipal solid waste (MSW) is defined as any solid, semisolid, or liquid substance that is a byproduct of residential, institutional, commercial, or industrial sources. In 2010, more than 249 million tons of MSW was produced from residential, business, and institutional sources, which approximates 4.43 lb per person.17

Approximately 35% to 45% of the total MSW stream was generated by institutions such as hospitals and schools in 2010. The two major solid waste categories for foodservice were packaging (30.3%) and food scraps (13.9%). The EPA has established a hierarchy of solid waste management that promotes environmentally sound strategies for MSW. Source reduction (including reuse) is the most preferred method, followed by recycling and composting, and lastly, disposal in combustion facilities and landfills. Figure 3 depicts the EPA food waste hierarchy for foodservice operations.18

Solid Waste Audit
Food and nutrition directors should understand the types of waste generated in their facility so they can manage resources more effectively. Food wastes generated from quantity food production represent 4%–10% of total food purchases. This waste category incorporates embedded energy, transport, disposal, and labor costs, in addition to the actual cost of food discarded. Approaches to measure solid waste include records examination, walkthroughs, and waste audits or sorts.

Examining records of activity such as purchases, waste removal costs, and maintenance logs can identify major sources of waste as well as opportunities for source reduction and recycling. Conducting a walkthrough assessment is an opportunity to observe processes that could be modified to reduce waste. A solid waste audit characterizes the waste stream by sorting and measuring wastes for a specified time period.19 The process of a solid waste audit involves the following steps:

- Select a time period to measure waste. The audit should be conducted over several days to accurately represent waste. Inform staff of the audit and describe the benefits of measuring waste.

- Download waste-tracking work forms and instructions from http://www.epa.gov/wastes/conserve/smm/wastewise/pubs/br-excel-instructions.pdf or develop a waste tracking sheet specific to the facility: http://www.epa.gov/wastes/conserve/foodwaste/pubs/waste-tracking-form.xls (Wastewise is a voluntary partnership with the EPA to reduce and recycle solid waste. The program has initiatives to reduce targeted categories of waste and provides resources to help commercial and institutional organizations implement solid waste management programs).20

- Place waste receptacles for both packaging and food waste in appropriate areas in the kitchen.

- Facilitate sorting by using tarps spread outside or on a table out of the food production vicinity. Place scales near the sorting area.

- Measure waste volume by using containers of known volume, such as 5 gal buckets and 30 gal trash cans.

- Record time of waste sorting for each category of waste. This is important for identifying periods of high waste generation. Volume of solid waste generated will vary by time of day and day of the week. Weigh and measure the volume of waste. Volume measurements are important for waste removal cost control. MSW removal is charged by the cubic yard. Dumpsters range from 6–9 cubic yard capacity.

- Total the weight and volume of each waste category. The data will highlight the largest waste categories. This knowledge presents options for recycling and waste reduction plans.

Recycling
The recycling rate has increased from less than 10% in 1980 to 34% in 2010.21 However, the overall recycling rate has not met the EPA’s goal of 50% of all wastes diverted from landfills. In addition to environmental benefits, foodservice operations receive several operational benefits from recycling. Waste removal and sewer use costs would decrease, moving disposal from a fixed to a controllable expense. In addition, the smaller amount of energy and water used would reduce utility costs. Food and nutrition directors have several recycling options available. The type of recycling program implemented will be influenced by factors such as storage availability, labor to clean and collect waste, and markets for recyclable materials.

Food and Packaging Waste
Food and packaging are generally the two largest waste categories. Production food waste can be used as animal feed or compost. Vegetable oils or rendered fat can be stored in designated containers for pickup by a grease recycler. Service food waste may
be recovered from pulpers or as plate waste, which can be composted. Overproduction can be donated to charities. The Good Samaritan Act protects organizations from liability for donating food if appropriate food safety guidelines are followed. Moreover, nearly all forms of packaging can be recycled. Some types of packaging waste such as cardboard can be sold to vendors, thus generating revenue.

**Source Reduction** Solid waste can be decreased by purchasing products with minimal packaging. Purchasing items with recycled content such as paper napkins diverts waste from landfills. Providing condiments on request or using bulk dispensers discourages creating unused food that must be discarded. The choice of serviceware affects volume of waste generated. Using permanentware and going trayless will reduce waste, in addition to eliminating the storage space needed for disposableware. However, the potential savings must be compared to the cost for sanitizing and replacement cost of permanentware. Going trayless may decrease plate waste, but may not reduce dishwashing costs. Service style and customer needs are factors to consider when choosing appropriate serviceware.

**Green Purchasing** Implementing a policy that specifies using products made from recycled materials, are non-toxic, can be recycled, or minimize waste plays an important role in an organization’s conservation of natural resources. A product’s environmental claims should be evaluated in the context of guidelines from the Federal Trade Commission and the EPA:

- Environmental claims should be specific. If a product or package states it is composed of recycled content, the percentage must be stated if it is less than 100%. If “recycled” means a product is made from reconditioned or rebuilt parts, it must be stated in its description.

- Vague environmental terms are red flags. Phrases such as “eco-friendly” and “environmentally safe” have insufficient information to make purchase decisions on a product’s performance or compare it to other brands. Labels such as Energy Star indicate a product has met criteria to be labeled as energy saving.

- Recyclable is not the same as recycled. A product labeled as recyclable means the manufacturer has proof the item can be used again or transformed into another item. Some processors will pick up used items. A label requesting “please recycle” means the product may be recyclable if there is a recycling program in the area.

- All things biodegrade eventually, although this process may occur over thousands of years. The time to decompose depends on a material’s exposure to air, water, or sunlight. Even toxic materials can biodegrade; however, it does not render them harmless. A product
labeled as “compostable” indicates it can biodegrade into material safe for consumer use as a soil amendment.

- Chlorofluorocarbons (CFCs) were used as propellants in aerosol cans. CFCs were found to harm the upper ozone layer and were banned in 1978; however, CFC-free products can still harm the environment. The product may contain volatile organic compounds that contribute to ground level ozone or smog. Volatile organic compounds include propane, alcohol, and butane.

Food purchased for US foodservice operations may originate from literally any location on earth. Greenhouse gases generated from food production contribute to global warming. Many factors contribute to a food’s carbon footprint; however, a controllable factor for green purchasing is the distance, or food miles, traveled from harvest to delivery. To calculate food miles, assume motor fuel produces 19.5 lb of carbon dioxide per gallon. Fresh produce from conventional suppliers travels an average 1,500 miles from harvest to delivery; locally grown produce averages 56 miles from harvest to delivery. The following formula may be used to calculate transportation carbon footprint:

\[
\text{Miles from harvest to delivery/mpg} = \frac{\text{gallons fuel used} \times 19.5 \text{ lb CO}_2}{2}\]

For example, a truck averaging 20 mpg to carry the same load would generate 1,462.5 lb and 54.6 lb of carbon dioxide to deliver conventional (1,500 miles) and local produce (56 miles), respectively.\(^2^5\)

The total cost of a product should be considered, not just the purchase price. Packaging, food waste, water, and energy consumption should be compared when evaluating the cost of convenience or made from scratch foods. In addition, considering the carbon footprint of purchases is important and should be taken into account whenever possible.

**Hazardous waste**  Subtitle C of the Resource Conservation and Recovery Act defines a solid waste as hazardous if it “shows ignitability, corrosiveness, reactivity, or toxicity.” State or local governments also may designate waste as hazardous. Staff often encounter solvents, compounds, and solutions that could cause physical or environmental harm if used improperly or accidentally. Both the Occupational Safety and Health Administration and the Joint Commission require health care facilities to develop an emergency management plan that includes chemical isolation and decontamination.\(^2^6,2^7\) The Hazard Communication Standard (“Hazcom” or “employee right to know”) requires copies of all Material Safety Data Sheets for potentially harmful substances to be on file in a facility. RDs and DTRs often are responsible for maintaining these files and for educating employees about hazardous substances. The Medical Waste Tracking Act of 1988 provides information about chemicals and other hazardous materials in the workplace\(^2^8\) and establishes criteria for packaging and storage of medical waste and requires tracking of medical waste from cradle to grave.

**Indoor Air Quality**

Human impact on air quality has been the subject of much debate in recent years. Issues such as air pollution, depletion of the ozone layer, and global warming all have implications for the food system. Air pollution is defined as the presence of substances in the air that are in concentrations interfering with human health, comfort, and safety. The Clean Air Act, promulgated by the EPA, resulted in the introduction of policies and regulations designed to improve air quality. The EPA’s Office of Quality Planning develops strategies to control pollutant emissions from a variety of sources, including foodservice operations. Particulates from foodservice equipment such as broilers, fryers, smokers, and grills can generate air pollution. The vents and hoods that direct these particulates to outdoor air are regulated by the EPA. Service vehicles used by foodservice operations also may generate air pollution. The cost to purchase and maintain service vehicles must be included in the cost to transport goods.

Food and nutrition directors can evaluate indoor air quality (IAQ) of their food production operation using checklists developed by the EPA, which include the following steps:\(^2^9\)

- Review existing records for heating, ventilation, and air conditioner maintenance, system performance, and IAQ complaints. Material Safety Data Sheets should be on file in both the kitchen and maintenance department.

- Conduct a walkthrough of the kitchen to identify potential source and ventilation pollution such as odors, visible mold, uneven temperature, and blocked vents.

- Evaluate adequacy of preventative measures such as cleaning schedules, pest management, and storage of hazardous materials.

- Have procedures in place for responding to IAQ complaints.

Figure 1 has resources to evaluate IAQ for hospitals and schools. Maintaining air quality conserves energy and minimizes pollution. It is important for employees’ health because people spend the majority of their day in buildings with mechanical heating, cooling, and ventilation systems.\(^3^0\) RDs and DTRs need to collaborate with other departments within their organization to receive support for ecologically sustainable operational practices.
Scientific research provides compelling evidence to suggest that consuming a diet rich in fruits, vegetables, and dietary fiber promotes health and prevents chronic disease. Continued promotion of a diet rich in fruits, vegetables, and whole grains should remain a priority for RDs and DTRs. In addition, RDs and DTRs are uniquely positioned to meet the growing needs of clients seeking guidance on food choices as they relate to ecological sustainability.

In an effort to promote ecologically sustainable diets, it is important to consider natural resources as they relate to food production, transformation, distribution, access, and consumption. A sustainable diet is composed of foods that contribute to human health and also encourage food system sustainability (Figure 4). RDs and DTRs have opportunities to influence natural resource conservation through the variety of roles they serve. RDs and DTRs who provide dietary guidance have the potential to influence consumer food choices and are, therefore, key players in the consumption sector of the food system. The aim of the dietary guidance portion of the current paper is to provide information and resources to RDs and DTRs so that they may advise clients who are seeking guidance relating to food choice options in support of ecological sustainability.

The Food System and Conservation of Natural Resources

The modern industrialized food system provides for the production of an abundance of relatively inexpensive food. The US Department of Agriculture (USDA) has described some common characteristics shared by “industrialized” or “conventional” farming operations:

“Rapid technological innovation; large capital investments in order to apply production and management technology; large-scale farms; single crops/row crops grown continuously over many seasons; uniform high-yield hybrid crops; extensive use of pesticides, fertilizers, and external energy inputs; high labor efficiency; dependency on agribusiness; and most livestock production from confined, concentrated systems.”

It is important to continually evaluate current food system practices and promote practices that support and sustain natural resources and the environment. Food system sustainability is dependent, in part, upon the protection and conservation of soil, water, energy, and the preservation of biodiversity. Promoting food system sustainability can be an admirable goal among RDs and DTRs. The Sustainable Agriculture Research and Education division of the USDA identifies three pillars of sustainability: 1) profit over the long term; 2) stewardship of our nation’s land, air, and water; and 3) quality of life for farmers, ranchers, and their communities. According to the USDA, some current ecological concerns associated with agriculture include the decline in soil productivity; water scarcity and pollution stemming from sediments, salt, fertilizers, pesticides, and manures; elevated levels of carbon dioxide and greenhouse gasses; pesticide resistant pathogens; and loss of genetic diversity.

Natural Resources: Soil

A sustainable food system is dependent upon fertile soil and the mitigation of soil erosion. The Natural Resources Conservation Service reported that, in 2007, 99 million acres (28% of all cropland) were eroding above soil loss tolerance rates (“the maximum rate of annual soil loss that will permit crop productivity to be sustained economically and indefinitely on a given soil”). However, this is down from 169 million acres in 1982. Erosion can deplete the soil of organic matter and nitrogen. To enhance soil nitrogen content, synthetic nitrogen fertilizers are often used. In addition, loss of soil carbon through erosion, management, and decomposition can contribute to atmospheric carbon dioxide, a greenhouse gas associated with climate change. Agricultural management practices which conserve or sequester soil carbon can help mitigate the rate of increase of atmospheric carbon dioxide.

Soil conservation methods developed to reduce the rate of soil erosion include the use of biomass mulching, crop rotations, no-till, ridge-till, added grass strips, shelterbelts, contour row crop planting, and various combinations of these. When possible, consumers with concerns about soil conservation in agriculture can support growers who integrate conservation techniques into their farming systems. Production techniques could be identified via certification labeling or may be provided by the producer.

Natural Resources: Water

Agriculture is heavily dependent upon water, with the largest use of freshwater in the US dedicated to irrigation. In addition to water intensive use, agricultural activities can be potential water polluters. Agricultural activities (such as crop production, grazing, and animal feeding operations) are among the top sources of impairment in US rivers, streams, lakes, ponds, and reservoirs. According to the EPA, common sources of water pollution can be naturally occurring and others may result from human activities such as: bacteria and nitrates from human and animal wastes—septic tanks and large farms, fertilizers and pesticides, heavy metals, industrial products and wastes, household wastes, lead and copper (from household plumbing), and water treatment chemicals.

If water is contaminated with microorganisms from fecal contamination, water suppliers issue notices to boil water to the public. If water is contaminated with excessive nitrates (commonly found in fertilizer and manure), this water should
be avoided, as it can be fatal especially to infants, as nitrates are converted to nitrites in the intestines and once absorbed, can prevent hemoglobin from transporting oxygen, leading to “blue baby syndrome” without immediate attention.\[^{40}\]

Consumers may be interested in ways that they might ensure consumption of safe drinking water and support water conservation. To obtain more information about the safety of their drinking water, consumers can obtain a copy of their Consumer Confidence Report (available annually to people with a community water system) online at [www.epa.gov/safewater/dwinfo.htm](http://www.epa.gov/safewater/dwinfo.htm). If consumers obtain water from a household well, they should work with their county health department to test their water annually for coliform bacteria, nitrates, total dissolved solids, and pH levels.\[^{40}\]

**Natural Resources: Energy** The industrialized food system (agricultural production, processing, packaging, and food preparation) is energy intensive and utilizes a considerable proportion of the nation's fossil fuels.\[^{41}\] Greenhouse gas (GHG) emissions should be taken into account when thinking about ecological sustainability. Food system sectors contributing to GHG emissions include the following: carbon dioxide derived from manufacturing, transportation, and energy supply; methane from ruminant enteric fermentation; and nitrous oxide (N\(_2\)O) from fertilizers.\[^{41–43}\] In a report prepared by the Food and Agriculture Organization, global livestock was estimated to contribute 18% of world anthropogenic GHG emissions;\[^{42}\] however, reported estimates have ranged from 10% to 51%.\[^{43}\] This is one reason why many feel that the practice of consuming a plant-based diet benefits the environment. Consumers who wish to decrease their impact on GHG emissions may consider choosing to consume a diet richer in plants and plant-based proteins, going meatless one day a week, eating less meat per meal, choosing organic or grass fed meats, eating seasonally and locally, reducing food waste, and reducing packaging.

**Ecology, Pesticides, and Genetically Engineered Crops** Pesticides are commonly used in an effort to provide for an efficient, consistent, and affordable food supply. To promote crop quality and yield, farmers commonly use pesticides to protect against various pests including animals, insects, weeds, fungi, bacteria, and viruses.\[^{44}\] In the United States, the EPA, USDA, and Food and Drug Administration (FDA) work to ensure food safety as it relates to pesticides. The EPA regulates pesticides for specific uses and can cancel registration if a pesticide poses an unreasonable risk to human health or the environment. Pesticide residues on foods are monitored by the USDA Pesticide Data Program\[^{45}\] and FDA Pesticide Residue Monitoring Program.\[^{46}\]

Although pesticides are strictly regulated, some concerns remain with regard to their impact on the environment.

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**Figure 4.** Sustainable food system model. Reprinted from reference 32.
The use of pesticides in agriculture may have a negative impact on wildlife and the wider environment (water, soil, air) if leaching, runoff, or spray drift occurs. In an effort to mitigate adverse environmental exposures, consideration should be given to alternative cropping systems less dependent on pesticides, the development of pesticides with improved safety profiles and formulations, and appropriate use of spraying equipment.47

With regard to the environmental concerns about genetically engineered crops, advocates of biotechnology argue that genetically engineered crops can confer environmental benefits such as decreased reliance on toxic pesticides and reductions in soil erosion resulting from decreased tillage. However, concerns relating to risk of ecosystem disruption remain. Critics urge caution highlighting research suggesting that introduced genes may transfer to wild and non-genetically modified plants. In addition, there is a concern that introduced genes can lead to herbicide and pesticide resistance in non-target species of weeds.48 Findings from a survey of American Dietetic Association members indicated that dietetics practitioners hold divergent viewpoints related to genetically engineered foods and crops; however, investigators reported that survey respondents were in agreement that dietetics practitioners should employ critical thinking skills to communicate implications of incorporating genetically engineered foods and crops into the food system.49

RDs, DTRs, and consumers have the responsibility to become educated and informed about food system production practices and policies that promote the conservation of soil, water, and energy and support producers who integrate conservation techniques into their farming systems.

FOOD PURCHASING OPTIONS AVAILABLE TO THE CONSUMER

United States government agencies such as the EPA, USDA, and the FDA continually adapt and revise policy to improve public access to a safe, healthful food supply in support of natural resources and the environment. RDs, DTRs, and consumers have an opportunity to become knowledgeable and involved with influencing government policy in support of a healthful and sustainable food system. They can review policies, contact legislators, and become active in their communities by promoting efforts that encourage conservation and ecological sustainability. While the modern industrial food system provides the majority of food that most people consume, community-based food system alternatives exist if a consumer is interested in seeking these out.

Growing numbers of consumers are seeking a closer connection to the farmers who produce their food. The USDA has recently established an initiative titled “Know Your Farmer, Know Your Food,” which promotes the importance of understanding how and where our food is produced46. The market for locally produced food has expanded over the past decade.51 Consumers seek out local foods for a variety of reasons including: freshness, taste, quality, value, support for local economy, fair farm labor, and knowing the source of the product52. Local foods may be marketed direct-to-consumer (farmers’ markets, farm stands/on-farm sales, pick-your-own operations, and community supported agriculture operations) and to retailers, restaurants, and institutions (eg, hospitals, schools, government offices, prisons, colleges).52

In recent years, there have been deliberate efforts to connect local farmers with a variety of institutions including schools and hospitals. RDs and DTRs planning to bring local food to area schools or hospitals can access an exceptional array of information and resources to support this effort. As of January 2012, the National Farm-to-School Network reported programs in all 50 states and involvement in an estimated 2,305 school districts and 9,807 schools.53 Opportunities associated with farm-to-school efforts can extend beyond sourcing locally produced foods to include nutrition and agricultural education, farm tours, and community gardens. Information and resources are available to parents, food service professionals, and concerned citizens interested in promoting child health and integrating regionally produced foods into school menus. Cost is a commonly cited barrier to implementing farm-to-school programs; however, factors contributing to program success include: 1) active leadership/champions, 2) complementary partnerships with diverse stakeholders, and 3) creative, resourceful use of assets.54 In addition to farm-to-school efforts, farm-to-hospital efforts are expanding. Foodservice professionals working in hospitals and health care settings planning to source healthy, local, sustainably produced foods can access information, resources, and support at www.noharm.org.55

Efforts to Increase Accessibility Food access for the citizens and residents of the United States is a priority and sustained action is needed to obtain food and nutrition security for all.56 In certain areas of the nation, both urban and rural, people may experience limited access to healthy affordable foods; these areas are sometimes identified as food deserts.57 While increased consumption of fruits and vegetables from any source remains a priority of community health promotions, efforts dedicated to improving access to locally produced foods may offer expanded opportunities for those with limited incomes. Farm-to-school programs, community gardens, and farmers’ markets may offer increased accessibility as additional venues for healthful food purchases.

Increased Accessibility at Schools Within schools, qualifying children have the opportunity to access free or reduced cost
breakfasts and lunches. This venue may provide an opportunity for children from limited income families to access locally produced fruits and vegetables at a reduced cost. RDs and DTRs can bolster support for student consumption of fruits and vegetables within the schools through the promotion of farm-to-school programs by connecting students to local farmers, farms, and gardens. A new public health program, “Let’s Move Salad Bars to Schools,” may also provide an opportunity to promote increased fruit and vegetable consumption among all students within schools.58

Increased Accessibility at Home, School, and Community Gardens Gardens can offer an abundance of fresh produce, often for the cost of inputs and time. A variety of resources are available to those interested in starting up and maintaining home and community gardens.59 RDs and DTRs can play an important role in supporting efforts among individuals, schools, and communities desiring to start up and maintain gardens.

Increased Accessibility at Farmers’ Markets Farmers’ markets are experiencing success in communities across the country. Many of these markets are offering innovative ways to promote purchases of healthy affordable foods using Supplemental Nutrition Assistance Program (SNAP) benefits, and some offer additional financial incentives to SNAP recipients each time they shop at the farmers’ market. RDs and DTRs have the opportunity to support initiatives promoting the acceptance of SNAP benefits through electronic benefits transfer cards.60 In addition to SNAP benefits, vouchers to purchase food at farmers’ markets may be obtained through the Supplemental Nutrition Program for Women, Infants, and Children farmers’ market nutrition program (available to low-income pregnant, breastfeeding and non-breastfeeding postpartum women, and to infants and children up to 5 years of age, who are found to be at nutritional risk)61 and the senior farmers’ market nutrition program (available to low-income seniors).62 At present, these programs do not provide sufficient assistance to recipients to continually purchase locally grown foods, and increased support for these efforts may be warranted. It remains a priority to educate consumers about a variety of convenient venues available to purchase healthful foods.

Another resource available to RDs and DTRs interested in promoting healthy affordable food is the cooperative extension service.63 The extension service provides many resources including information about food, nutrition, cooking, and gardening to all community members. Furthermore, programs exploring ways to make healthy food choices on a limited budget are often offered free of charge to people with limited incomes and most of the foods suggested for those on a limited budget incorporate ecologically friendly ingredients like beans, lentils, and locally grown fruits and vegetables.

RD AND DTR PROFESSIONAL PRACTICES IN SUPPORT OF ECOLGICAL SUSTAINABILITY

RDs and DTRs are encouraged to evaluate their personal and professional practices and take action to more effectively conserve natural resources and support the ecological sustainability of the food system. Included in the resource figure (Figure 1) is a link to the document “Healthy Land, Healthy People: Building a Better Understanding of Sustainable Food Systems for Food and Nutrition Professionals,” which provides wide-ranging recommendations for RDs and DTRs to incorporate professional practices in support of ecological sustainability in the food system. RDs and DTRs are encouraged to utilize this valuable tool to identify practical examples within a variety of practice areas. Wilkins and colleagues contend that the economic, ecological, and social sustainability of the food system matter as much as the nutritional value of its products and encourage RDs and DTRs to practice “civic dietetics” by integrating food system awareness into their work.64 RDs’ and DTRs’ knowledge of the complex issues associated with environmental concerns should be increased through participation in continuing education activities and research. Knowledgeable Academy members should be proactive in advocating for and implementing programs in their workplaces, homes, and communities to conserve natural resources and protect the environment. They should also participate in the legislative process within their states and communities.

SHAPING THE FUTURE OF OUR FOOD SYSTEM

RDs and DTRs have an opportunity to shape the future of our food system and are uniquely poised to meet the growing needs of clients seeking guidance on food choices as they relate to human health and ecological sustainability. It is essential that the dietetics community take a more active leadership role in support of ecological sustainability and social responsibility. Opportunities exist to join the growing number of RDs and DTRs who are becoming involved with supporting environmentally responsible industry efforts and influencing public policy at the community, local, state, and national levels. RDs and DTRs have the opportunity to become educated and active in shaping public policy in an effort to promote healthier communities and a healthier nation.

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