LEARNING OBJECTIVES

This article provides an introduction into sustainability and health, with a focus on food. When health professionals integrate concepts of sustainability into life and work, cobenefits can be leveraged, as health-promoting services then also serve a greater cause — that of environmental protection, social justice, and economic viability. Regarding food, this may begin by simply considering the decision-making process when purchasing food. However, the process does not stop there, as considerations surrounding a more sustainable lifestyle in general, and adjusting eating patterns specifically, can be eye opening, while getting involved in the local food movement is life changing. The four environmental hotspots, meat, fish, biodiversity, and waste, will be discussed to raise awareness and build knowledge in health professionals. Resources and examples are given to help mobilize learners to take action.

Key Words:
Food, Healthy Lifestyles, Sustainability, Farmers’ Markets, Urban Farms

INTRODUCTION AND GLOBAL PERSPECTIVE

The earth is warming rapidly because of increased greenhouse gas (GhG) emissions, whereas the rising air and ocean temperatures in the Arctic and Antarctica are responsible for the increasing ice loss, resulting in sea level rise. This process often is characterized as earth’s energy imbalance, and climate scientists are calling on all of us to help reduce GhG emissions to protect young people, future generations, and nature (25,28).

Climate-related extremes, such as heat waves, droughts, wildfires, or storms, have already increased across the past decades and show disruption of infrastructures such as food production and water supply with risk to human well-being and even ecosystem stability (28). Furthermore, there will be considerable inequity to those affected, especially from lower socio-economic status, and geographical regions most exposed (coastal regions and developing nations) are likely the most vulnerable (28).
Recognizing the rise in population growth, current trends in hunger and malnutrition in the developing world, and food insecurity and obesity in developed nations, it is clear that climate change probably is the biggest global health threat of the 21st century (7).

As health professionals, we are concerned about the enormous economic cost of the current trends in obesity and related chronic diseases. Is earth’s energy imbalance associated with the energy imbalance of its people? From a health professional’s point of view, we must recognize this crossroad. Although we act interdisciplinarily within our fields, we need to consider the bigger picture — the link between the health of the people and the planet. Where is the connection between the food we eat, our health, and sustainability?

**WHAT IS SUSTAINABILITY?**

Most commonly, sustainability is defined as “meeting the needs of the present generation without compromising the ability of future generations to meet their needs (42). Sustainable development and resilience are two terms often used to describe more contemporary and dynamic phenomena that may imply a paradigm shift or adaptation to a new situation (see Table 1 for definitions). Sustainable development often also is expressed by the three Es that stand for Environment, Economy, and Equity. Theoretically, these key fields are important to consider when addressing sustainability; however, there exists considerable debate how this is achievable on a global level (32).

How would you define sustainability and what does it mean in an applied sense, especially related to the health professions and on a local rather than a global level?

A good entry point may be this example. Visualize a community that incorporates easy access to services, such as city parks and open space for leisure and sports surrounded by walkable neighborhoods, including businesses and grocery stores, schools with school gardens, a hospital, food bank and pantry, an urban farm, post office, and a year-round farmer’s market. Ideally, this community also uses alternative energy such as solar and wind.

This community meets the three Es:

- **Environment**: through establishment of various ecosystems, enhancing biodiversity and natural beauty in an urban setting.
- **Equity**: through access to physical activity, healthy and secure food, and a social network.
- **Economy**: through local businesses and promoting to keep dollars in the community.

From this example, we quickly connect the dots and see that such a sustainably developed community also facilitates health-promoting behaviors. Unfortunately today, such environments still are rare and inaccessible or not affordable to everyone. A further issue is that the connection between sustainability and health is not clear and, thus, these topics are tackled separately — locally, city planners may work with ecologists but forget about the health professional who focuses on the built environment inviting citizens to walk, run, and bike. Likewise, health promotion initiatives often fail to include sustainability. For example, health and fitness events, held in the city, may fail to address local food sourcing or waste and recycling. In schools, sustainability is only sparsely integrated, if at all, and health sciences students, including nutrition students, often lag behind those in environmental sciences in knowledge and skill pertaining to sustainable food systems. Finally, in sport nutrition, performance-based menus often lack the integration of sustainable choices, considerations of local farms, or discussions surrounding meat as a choice. In these examples, important links are missed and so are the leveraging opportunities of health and sustainability, had these two fields been integrated.

When we look at our food system, we becomes apparent how we literally have distanced ourselves, our families, students, clients, and patients from good food grown close to us, thereby losing the story of where food comes from, food traditions and

### TABLE 1: Sustainability Definitions

<table>
<thead>
<tr>
<th>Definition</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sustainability and sustainable development</strong></td>
<td>(43)</td>
</tr>
<tr>
<td>Meeting the needs of the present generation without compromising the ability of future generations to meet their needs.</td>
<td>(43)</td>
</tr>
<tr>
<td>A dynamic process, sustainable development often is described as the development of a new normative horizon that implies a paradigm shift from a development based on inequity and overexploitation of natural resources and environmental services (such as a biodiverse ecosystem) to one that requires new forms of responsibility, solidarity, and accountability.</td>
<td>(9)</td>
</tr>
<tr>
<td>Aims at improving the life quality of all people of the world without increasing the usage of natural resources above the carrying capacity of the Earth.</td>
<td>(28)</td>
</tr>
<tr>
<td><strong>Resilience</strong></td>
<td></td>
</tr>
<tr>
<td>The capacity of social, economic, and environmental systems to cope with a hazardous event or climate trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while maintaining the capacity for adaptation, learning, and transformation.</td>
<td>(13)</td>
</tr>
</tbody>
</table>
culture, farming and gardening, a biodiverse ecosystem with crop varieties unique to the area, and sharing pleasures of cooking and eating together. Wendell Berry said it correctly that “Eating is an agricultural act” (5) and, thus, without local food production, “eaters” become ever more alienated from agriculture, losing an important connection to land, people, animals, and an intact health-promoting ecosystem. Likewise, we must realize that obesity cannot be viewed simply as a health sector issue but must be related back to agriculture and the food we grow and eat today (27,41).

Recently, the Food and Agriculture Organization of the United Nations defined a sustainable diet as follows: “A diet with low environmental impacts, which contributes to food and nutrition security and to healthy life for present and future generations. A sustainable food system is protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable, nutritionally adequate, safe and healthy, while optimizing natural and human resources”(17).

Currently, there are few countries that have adopted sustainable food principles into governmental nutrition recommendations. Some of the best examples are the Mediterranean diet (2), the Health Council of the Netherlands (26), and the New Nordic Diet (37).

**ENVIRONMENTAL IMPACT OF FOOD**

Although many factors contribute to GhG emissions (e.g., transportation, industries), the current food system accounts for 10% to 14% of global emissions. When deforestation is added, the numbers creep up to nearly 30% (44). Depending on the country, livestock production is estimated to account for up to 51% of global GhG emissions (18). Thus, industrialized agriculture, while highly efficient, now contributes heavily to Earth’s energy imbalance.

Agriculture contributes to GhG emissions through preproduction (e.g., fertilizer, pesticide, herbicide manufacture, energy use in feed production), production (direct emissions of agriculture, including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) and indirect from deforestation), and postproduction (processing, transport, refrigeration, cooking, waste); however, the total impact varies by region and country. Direct emissions from soil (N2O), enteric fermentation and manure (CH4), biomass burning, and rice production (CH4) and indirect from deforestation are the most burdensome (44). GhGs also differ in global-warming potential. For example, warming potential for CH4 is 72 times greater when quantified over the next 20-year time span than that of CO2 (28). Thus, short-term strategies, including those of a sustainable diet and waste recovery, targeting CH4, are gaining more in-depth attention as a low-hanging fruit.

Considering the projected population growth to 9 billion people by 2045, global food demands are expected to rise an additional 60% (16). Logically, this will result in higher food production and greater emissions for decades to come. Besides emissions, further environmental impacts of intensive agriculture include land and water use, loss of biodiversity, and pollution of waterways.

**ENVIRONMENTAL HOTSPOTS**

There are at least four environmental hotspots related to our food system that burden planet Earth, and these are discussed below. Taking action related to these four hotspots appears no longer a choice but a necessity. How we tackle these hotspots is entirely up to us (at least for now), especially if we want to safeguard long-term ecological sustainability, satisfy basic human needs, and promote cross-generational equity, good health, and longevity.
Hotspot 1: Meat
The largest environmental impact from the industrialized food system stems from meat, which accounts for about 20% of global 
GHG emissions and requires high water inputs. Livestock-based 
food production also can contribute to displacing biodiversity 
because of land clearing (12). The most polluting part of 
livestock production is its feed (e.g., corn), which is accompa-
nied by expanding needs for more land using large inputs of 
fossil fuel. Meat production’s impact on the environment is 
well documented (6,10,41), and scientists also are addressing 
animal and human welfare (8,9), antibiotic use (29), and water 
pollution from runoffs (38) and leaching fertilizer (40).

Recent research has examined livestock production and its 
effects on GHG emissions, water, and land use (12). Compared 
with plant staples (potatoes, rice, wheat), U.S. beef production 
requires 160 times more land and 8 times more irrigation water 
for feed while emitting 11 times more GHG and 19 times more 
N₂O compared with nonbeef categories. Although pork, 
poultry, eggs, and dairy fare better, they too require substan-
tially more land and water, with greater emissions than plant 
staples. Although dairy products need less input and emit less 
than beef, dairy is not necessarily cleaner than nonbeef animal 
Sources. When feed is converted to food (kcal) and protein (g), 
35 to 45 kcal are needed to produce 1 kcal of beef (compared 
with 2 kcal input for 1 kcal of plant protein). Per gram of 
protein, GHG emissions are 250 times greater for ruminants 
compared with plant protein from legumes. As expected, eggs, 
dairy, poultry, and pork exceed GHG emissions compared with 
plant protein from legumes, but they all have much lower 
emissions than ruminants (41).

Two questions arise. Is eating from the nonbeef category a 
better choice? Yes and No. Eating poultry, pork, eggs, or dairy 
leads to lower emissions and a decrease in land use than eating 
beef. However, industrial production of poultry or pork similarly 
questions animal welfare, water pollution, and health impacts on 
animal and people (e.g., antibiotics) and, thus, simply switching 
to these protein options without considering overall quantity 
and production method, while not replacing protein calories 
with nutrient-dense alternatives, such as fruit, vegetables, 
grains, or legumes, will not be a straightforward solution.

Furthermore, is sustainable meat production, such as grass-
fed beef (and dairy), a better choice? Certainly, pasture-fed 
meat (and dairy) production may well be part of an intact 
ecosystem or in areas where crop production is limited because 
of topographical issues. Furthermore, such production systems 
also promote a better-quality product and reduce food insecurity 
(11). However, GHG emissions and land use are still of 
concern, especially if the aim was to meet current and projected 
meat demands using sustainable production.

Considering the rise in meat consumption patterns across the 
world, including the United States and European countries, with 
a per capita intake often exceeding 200 lbs per year (13), and 
many Asian countries increasing meat consumption, the first 
approach should be to eat less meat (and other animal 
products). According to a recent study, cutting meat, dairy, 
and egg intake by 50% would achieve a 40% reduction in N₂O 
emissions, a 25% to 40% reduction in GHG, and a 23% per 
capita reduction in cropland use that could be cultivated for 
food rather than feed (45). In addition, reducing intake also 
would benefit health, especially cardiovascular health and 
diabetes (20,45,41), promote weight loss (4), and reduce all-
cause morbidity and mortality (39,41). Lower meat consump-
tion would still enable athletes and active individuals to meet 
their protein needs, especially if meat calories were replaced by 
a plant-based equivalent (e.g., beans, grains, nuts).

For solutions to eating less meat and associated tricks to 
keeping balance on the plate and resources, see Tables 2 and 3.

Hotspot 2: Fish
Environmental impacts of dietary choices vary across food 
groups and changes are needed across multiple sectors. In the 
past 50 years, fish consumption per capita nearly doubled (20). 
Two thirds of the world’s fish consumption occurs in Asia, 
with the highest consumption in China. Similar to China, in 
Europe, the United States, and Australia, fish consumption 
exceeds 44 lbs per capita per year and nearly 50% of this fish 
supply comes from aquacultures. Despite the fact that sustain-
able practices in aquacultures are rising, there still are 
considerable issues related to traditional nonrecirculating 
aquacultures, including high GHG emissions and adverse health 
effects (41). Currently, the supply of sustainably farmed or wild 
captured fish is inadequate to meet consumer demand without 
leaving deep environmental marks (19).

Water contamination (eutrophication) from industries, in-
cluding agriculture, and overfishing practices, with consequen-
tial marine stock exploitation, have put seafood resources and 
fishing livelihoods at risk and question the viability of marine 
life worldwide. Of available fish stock today, 80% are fully 
exploited or overexploited, requiring careful management (19).

Major environmental groups are calling on consumers to eat 
less fish and purchase fish caught using sustainable practices 
(these also reduce GHG) while awaiting cleaner technologies of 
aquacultures to meet rising demands of fish. Further disruption of 
ocean ecosystems is inevitable, considering rising levels of 
CO₂, which will lead to further loss of marine zones and 
biodiversity and eventually irreversible changes in commer-
cially available fish stock (19).

Eating less fish, fish lower on the food chain (e.g., smaller 
fish), and choosing from consumer guides such as the World 
Seafood Watch may be the only way to save our oceans. The 
developed world consumes a lot more fish than those who 
depend on it for protein (e.g., coastal regions). Per capita fish
### TABLE 2: Problems, Solutions, and Resources for a Sustainable Diet Along the Four Hotspots (Meat and Dairy, Fish, Biodiversity, Waste)

<table>
<thead>
<tr>
<th>Hotspots</th>
<th>Problems</th>
<th>Solutions for Eaters*</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meat</strong></td>
<td>GhG, N₂O</td>
<td>Eat less meat. Make smaller portions.</td>
<td>Sustainable Table (<a href="http://www.sustainabletable.org">http://www.sustainabletable.org</a>)</td>
</tr>
<tr>
<td></td>
<td>High water use</td>
<td>Choose pasture-fed meat and protein from nonbeef options.</td>
<td>Cowspiracy Movie (<a href="http://www.cowspiracy.com">www.cowspiracy.com</a>)</td>
</tr>
<tr>
<td></td>
<td>High land use</td>
<td>Be an advocate for humane treatment of animals.</td>
<td>Environmental Working Group (<a href="http://www.ewg.org">www.ewg.org</a>) (<a href="http://www.ewg.org/meateatersguide/">http://www.ewg.org/meateatersguide/</a>)</td>
</tr>
<tr>
<td></td>
<td>Animal and human welfare</td>
<td>Choose pasture-fed meat and protein from nonbeef options.</td>
<td>Non-GMO Project (<a href="http://www.nongmoproject.org/learn-more/">http://www.nongmoproject.org/learn-more/</a>)</td>
</tr>
<tr>
<td></td>
<td>Obesity</td>
<td>Be an advocate for humane treatment of animals.</td>
<td>Meatless Monday (<a href="http://www.meatlessmonday.com">http://www.meatlessmonday.com</a>)</td>
</tr>
<tr>
<td></td>
<td>Diabetes</td>
<td>Be an advocate for humane treatment of animals.</td>
<td>Vegetarian Resource Group (<a href="http://www.vrg.org">http://www.vrg.org</a>)</td>
</tr>
<tr>
<td></td>
<td>Cancer</td>
<td>Be an advocate for humane treatment of animals.</td>
<td>Healthy People, Healthy Planet, WWF (<a href="http://livewellforlife.eu">http://livewellforlife.eu</a>)</td>
</tr>
<tr>
<td></td>
<td>Mortality</td>
<td>Be an advocate for humane treatment of animals.</td>
<td>NPR story on meat (<a href="http://www.npr.org/blogs/thesalt/2012/06/27/155527365/visualizing-a-nation-of-meat-eaters">http://www.npr.org/blogs/thesalt/2012/06/27/155527365/visualizing-a-nation-of-meat-eaters</a>)</td>
</tr>
<tr>
<td><strong>Fish</strong></td>
<td>GhG</td>
<td>Eat less fish. Make smaller portions</td>
<td>Monterey Bay Aquarium Seafood Watch (<a href="http://www.montereybayaquarium.org/conservation/research/seafood-watch">http://www.montereybayaquarium.org/conservation/research/seafood-watch</a>)</td>
</tr>
<tr>
<td></td>
<td>Overfishing</td>
<td>Choose sustainably caught or farmed fish.</td>
<td>Marine Conservation Society (<a href="http://www.mcsuk.org">http://www.mcsuk.org</a>) and (<a href="http://www.fishonline.org">http://www.fishonline.org</a>)</td>
</tr>
<tr>
<td></td>
<td>Eutrophication</td>
<td>Be an advocate for marine conservation.</td>
<td>Marine Stewardship Council (<a href="http://www.msc.org">http://www.msc.org</a>)</td>
</tr>
<tr>
<td></td>
<td>Possibly reduced omega-3 intakes</td>
<td>Identify plant sources of omega-3.</td>
<td>Health impact?</td>
</tr>
<tr>
<td><strong>Biodiversity</strong></td>
<td>Loss of biodiversity</td>
<td>Learn about plant and animal biodiversity, seasonality of food.</td>
<td>Food and Agriculture Organization, Sustainable Diets (<a href="http://www.fao.org/food/sustainable-diets-and-biodiversity/en/">http://www.fao.org/food/sustainable-diets-and-biodiversity/en/</a>)</td>
</tr>
<tr>
<td></td>
<td>Pollinators and insects</td>
<td>Learn about gardening, farming, and permaculture from your University Extension Services or online.</td>
<td>Farmer’s Market Directory (<a href="http://www.localharvest.org">www.localharvest.org</a>)</td>
</tr>
<tr>
<td></td>
<td>Crop and animal varieties</td>
<td>Grow something!</td>
<td>Eat the Seasons (<a href="http://www.eattheseasons.com">http://www.eattheseasons.com</a>)</td>
</tr>
<tr>
<td></td>
<td>Loss of culture and knowledge</td>
<td>Cook and eat together.</td>
<td>Edible Communities (<a href="http://www.ediblecommunities.com">www.ediblecommunities.com</a>)</td>
</tr>
<tr>
<td></td>
<td>Micronutrient deficiencies</td>
<td>Improved health, decreased morbidity, mortality risk</td>
<td>Examples of Extension Services (<a href="http://www.ext.colostate.edu">http://www.ext.colostate.edu</a> and <a href="http://extension.oregonstate.edu">http://extension.oregonstate.edu</a>)</td>
</tr>
<tr>
<td></td>
<td><strong>Waste</strong></td>
<td>Learn about composting.</td>
<td>Permaculture Principles (<a href="http://permacultureprinciples.com">http://permacultureprinciples.com</a>)</td>
</tr>
<tr>
<td></td>
<td>30% to 40% of food wasted</td>
<td>Only buy what you can and will eat.</td>
<td>Food and Agriculture Organization Food Waste Initiative 2014 (<a href="http://www.fao.org/save-food/savefood/en/">http://www.fao.org/save-food/savefood/en/</a>)</td>
</tr>
<tr>
<td></td>
<td>Loss of resources (e.g., water, energy)</td>
<td>Bike to grocery store.</td>
<td>Contact extension services (see above)</td>
</tr>
<tr>
<td></td>
<td>Adds to GhG</td>
<td>Rethink, Reduce, Reuse, Recycle!</td>
<td>Environmental Protection Agency (<a href="http://www2.epa.gov/recycle">http://www2.epa.gov/recycle</a>)</td>
</tr>
<tr>
<td></td>
<td>Adds to food insecurity and hunger</td>
<td>Learn about composting.</td>
<td>Find your local food rescue like this one! (<a href="http://www.coloradospringsfoodrescue.org">http://www.coloradospringsfoodrescue.org</a>) and 2nd Harvest Food Bank (<a href="http://www.no-hunger.org">www.no-hunger.org</a>)</td>
</tr>
</tbody>
</table>

GhG, greenhouse gas; GMO, genetically modified organism; CVD, cardiovascular disease.

*See reference (39) for more information on sustainable food production.*
consumption in Sub-Saharan Africa has not changed in the last three decades (19) most likely caused by increased exports to meet the demand of the developed world. Fish has become the food of the rich, whereas various organizational and national nutrition guidelines continue to push for multiple servings of fish per week, despite the issue of dwindling supply. There is no better example to illustrate the disconnect between health and sustainability than with the case of fish.

How much fish is really needed for health and does a sustainable option exist in the absence of reducing overall intake? Research shows that 250 mg of omega-3 fatty acids is needed to favor cardiovascular health (34). This amount of fish oil is found in one serving of oily fish. Thus, eating more than one serving of fish per week may not be needed. With the current state of marine ecosystems, consumers are asked not to eat more fish (26). In addition, using guides for sustainable fish is valuable and replacing fish with alternative sources of essential fatty acids also may offer some benefit. Recent data point to wild plants, berries, seeds, and nuts (1).

For solutions to eating less fish and resources, see Tables 2 and 3.

**Hotspot 3: Biodiversity**

Of edible plant varieties, 75% have been lost irreversibly in the last century (14). Today, 60% of our energy (kcals) is supplied by the world’s main crops: wheat, rice, and corn. It is estimated that, of the 10,000 plant species once supplying the nutrients of our diets, 75% of what we eat today is generated from 12 plants and 5 animal species. Loss of biodiversity means loss of diet quality, which increases the risk of micronutrient deficiencies, as limited plant varieties no longer provide the nutritional profile (27,46). The industrialized food system has altered nutritional diversity while it added unwanted chemicals (3). Thus, to understand food’s contribution to dietary variety, how, when, and where it was grown need to be considered. Relying on a few crops to meet the nutrient needs of people is short sighted because dietary variety has long been recognized to boost human health (17).

Biodiversity provides the building blocks of a working ecosystem and contributes to local livelihoods. One of the best examples of a fragile food system is the example of the Irish Potato Famine in 1845 that led to starvation and deaths because only one variety of potatoes was planted. This potato was affected by a fungus and resulted in crop loss for years. Loss of biodiversity may mean reduced pest resistance, food insecurity, and hunger, as well as loss of cultural diversity. Ultimately, human health depends on biodiversity and should be viewed as its foundation and, thus, conservation, while a global priority (17), should link to the local community (e.g., reawakening the biodiversity of a regional and local food system).

There are many factors responsible for biodiversity loss. One of the biggest threats is the conversion of natural habitats, rich in animal and plant life, to uniform monocultures. Mono-cultures (e.g., wheat, corn, soy, rice) are typical in today’s industrialized agriculture and especially found in intensive

**TABLE 3: Pathways to a Sustainable Diet for Health Professionals**

<table>
<thead>
<tr>
<th>1</th>
<th>Download a seasonal calendar, the Dirty Dozen list, and GMO-free shopping guides*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Find Grow or Eat Local labels in your grocery stores.</td>
</tr>
<tr>
<td>3</td>
<td>Identify a local farmer’s market* or neighborhood coop.</td>
</tr>
<tr>
<td>4</td>
<td>Identify a Community-Supported Agriculture (CSA) Farm in your area.*</td>
</tr>
<tr>
<td>5</td>
<td>Source sustainably raised meat, dairy, and eggs and incorporate meatless days, learning to create balanced vegetarian meals.</td>
</tr>
<tr>
<td>6</td>
<td>Make meat the side dish and add more fruit, veggies, grains, and legumes.</td>
</tr>
<tr>
<td>7</td>
<td>Download a suitable seafood guide/app to make sustainable fish choices.*</td>
</tr>
<tr>
<td>8</td>
<td>At your work place, integrate sustainable food options (e.g., seasonal and local fruit, local yogurt, sandwiches with local goat cheese, and hard-boiled eggs) and source local or organic snack foods such as granola bars, granolas, dried fruit; make smoothies with locally sourced ingredients.</td>
</tr>
<tr>
<td>9</td>
<td>If you live where water is scarce, grow food where you water.</td>
</tr>
<tr>
<td>10</td>
<td>Start a compost bin and recycle/reuse what you can.*</td>
</tr>
</tbody>
</table>

*Use Table 2 for resources and suggested readings to build your knowledge. GMO, genetically modified organism. See reference (22) for further guidelines.
farming systems. This production usually occurs with large areas of land use and heavy inputs. In the United States, less than 1% of agricultural land is cultivated using certified organic methods and, thus, the majority of U.S. farmland grows crops using conventional means (43). Intense farming systems use agrochemicals, which affect pollinators necessary to maintain an intact ecosystem and to supply food to people. The recent declines in bee populations have affected pollination greatly (17), especially in pollinator-dependent crops, ultimately leading to a decline in yields (21). Conventional farming systems also are characterized by reduced soil quality (nutrient density) and biodiversity, greater erosion leading to increased \( \text{N}_2\text{O} \) emissions, and leaching of synthetic fertilizers into waterways, causing pollution and loss of further ecosystems.

For more information on any of these case studies, contact Nanna Meyer (nmeyer2@uccs.edu).

### TABLE 4: Case Studies Linking Health and Performance With Sustainability

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Description</th>
<th>Additional Information</th>
<th>For more information on these case studies, contact Nanna Meyer (<a href="mailto:nmeyer2@uccs.edu">nmeyer2@uccs.edu</a>).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy Campus Initiative</td>
<td>Transition of University of Colorado’s (UCCS) food environment to a self-operated sustainable food system. Emphasis is on student employment, a menu in line with a sustainable diet (13), including plant-based menus and education to link health with sustainability. Besides servicing campus with fresh, seasonal, and locally grown and humanely raised food, the focus is on the link between a sustainable food system in Dining and Food Services, campus garden and greenhouse, and academic programs and the greater Colorado local food shift. To accomplish a transition in institutional food service, all stakeholders must be involved. Although the transition is slow, each step forward is meaningful. Barriers include cost, education of food service staff and “eaters,” state and institutionalized procurement rules and regulation. Cost associated with sustainable food procurement should be integrated into retail and menu plan pricing. From consumer surveys at UCCS, students are willing to pay between 5% and 10% more for better food.</td>
<td>This program is in its second year. Please visit the following sites for updates on progress: <a href="https://www.facebook.com/uccsfood">https://www.facebook.com/uccsfood</a> <a href="http://www.uccs.edu/~dinningservices/">http://www.uccs.edu/~dinningservices/</a> Currently, we use one Healthy Campus Nutritionist (50%) and two Healthy Campus Graduate Students 10 hours per week.</td>
<td></td>
</tr>
<tr>
<td>Flying Carrot Food Literacy Project</td>
<td>Mission: The Flying Carrot is an innovative mobile project that fosters food awareness and empowers individuals to improve the well-being of themselves, the community, and the planet by providing creative hands-on experiences, building cooking skills, and improving access to local, seasonal, and sustainable food. The project focuses on food and sustainability literacy through taste education while accomplishing reduced food waste from local farmers, distributing CSA shares to residents. Sustainability and health constructs are integrated into environmental, social, and economic areas as introduced in “The duality of health and sustainability” (23) framework with taste education and conversation, beautiful recipes, educational cards, handouts, posters, and books.</td>
<td>Information available at <a href="https://www.facebook.com/pages/The-Flying-Carrot/349091708570998">https://www.facebook.com/pages/The-Flying-Carrot/349091708570998</a> <a href="http://vimeo.com/85737800">http://vimeo.com/85737800</a></td>
<td>For more information on any of these case studies, contact Nanna Meyer (<a href="mailto:nmeyer2@uccs.edu">nmeyer2@uccs.edu</a>).</td>
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<td>Reshaping America’s Health Professionals</td>
<td>A week-long intensive course, for undergraduate and graduate students, and transdisciplinary departments, focuses on food, culture, community, and health and introduces the concept of sustainability. The course contains lectures, panel discussions, and field trips visiting various farms, gardens, community restaurants, and schools. After the course, students do service learning at various sites. Students travel through a personal journey during the course and begin to see the holistic connection among topics of sustainability and health.</td>
<td>The project is established at the Colorado Farm and Art Market (CFAM) and also is integrated into UCCS’s Healthy Campus Initiative. <a href="http://www.farmandartmarket.com/vendors/">http://www.farmandartmarket.com/vendors/</a></td>
<td>For more information on any of these case studies, contact Nanna Meyer (<a href="mailto:nmeyer2@uccs.edu">nmeyer2@uccs.edu</a>).</td>
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<td>Sustainability in Sport Nutrition</td>
<td>When health professionals teach about nutrition, sustainability concepts will add a new dimension, even in elite sport. We transformed how Olympic athletes receive education with hands-on experiences using workshops, visiting farms, and cooking and eating together. Athletes pick up weekly bags at a neighborhood store or local farm, thereby acquiring knowledge and skill in local food, enabling a new connection between sustainability, health, and performance.</td>
<td>The project is supported by the Pikes Peak Community Foundation (PPCF) and includes a small school bus, small gas and food budget, and one graduate assistantship with lots of volunteers. <a href="http://www.ppcf.org">http://www.ppcf.org</a></td>
<td>For more information on any of these case studies, contact Nanna Meyer (<a href="mailto:nmeyer2@uccs.edu">nmeyer2@uccs.edu</a>).</td>
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Thus, biodiversity needs to become valued, conserved, restored, and carefully used so that ecosystem services can be provided more sustainably to both the planet and its people (17). For solutions to this problem and resources, see Tables 2 and 3.

**Hotspot 4: Waste**

Americans waste up to 40% of their food, equal to about 220 lbs of food per capita per year (35). This compares with a 30% food waste in Europe. In developing countries, food waste is much less and mostly pertains to preconsumer loss (e.g., lack of cold storage). In developed nations, food waste mainly occurs through postconsumer losses. Of these losses, 50% to 60% occur in households. Data show the greatest losses occur in fresh produce (40). Thus, biodiversity needs to become valued, conserved, restored, and carefully used so that ecosystem services can be provided more sustainably to both the planet and its people (17). For solutions to this problem and resources, see Tables 2 and 3.

Reasons for food waste in developed countries include:
- food is cheap
- lack of value and connection
- bulk buying at reduced price
- lack of planning
- expiration dates

Considering the costly inputs for food production, it seems that there would be enough food for everyone if waste was reduced, distribution was improved, and access was increased, even in the presence of a growing population (30). Food waste, as it turns into garbage (not compost), represents the second highest waste source in U.S. landfills and accounts for 23% of U.S. CH$_4$ emissions (35). Minimizing food waste going to landfill is considered one of the lowest-hanging fruit to decrease GhG emissions. In addition, if this waste instead is redirected to feed the many millions of hungry and food-insecure people or it is recycled in compost and reused in agriculture, both planet and people will profit. While waste is of global scale, solutions often originate at the local level. Food rescue groups, waste recovery restaurants, and community composting programs are only a few examples that contribute to sustainable solutions, and many strategies start at home. For solutions to this problem and resources, see Tables 2 and 3.

**Applications for the Health Professional**

Health and an active life with good food are more than the absence of disease. Through a better socioecological understanding of health promotion and sustainability (23,31), health professionals are able to offer their clients and patients a refreshed look at their lifestyles in the context of daily choices, and here with focus on food. Bringing health and sustainability together enables both lifestyles in the context of daily choices, and here with focus on food. Bringing health and sustainability together enables both lifestyles in the context of daily choices, and here with focus on food. Bringing health and sustainability together enables both lifestyles in the context of daily choices, and here with focus on food. Bringing health and sustainability together enables both lifestyles in the context of daily choices, and here with focus on food. Bringing health and sustainability together enables both lifestyles in the context of daily choices, and here with focus on food. Bringing health and sustainability together enables both lifestyles in the context of daily choices, and here with focus on food. Bringing health and sustainability together enables both lifestyles in the context of daily choices, and here with focus on food. Bringing health and sustainability together enables both lifestyles in the context of daily choices, and here with focus on food. Bringing health and sustainability together enables both lifestyles in the context of daily choices, and here with focus on food.

The industrialized food system accounts for up to 30% of global GhG emissions and contributes to loss of land and biodiversity, an overexploited marine ecosystem, and high amounts of food waste. Whereas many production pathways must become more sustainable, “engaged eaters” also can make an impact on the four environmental hotspots — meat, fish, biodiversity, and waste — that have a significant effect on the three Es of sustainability, environment, economy, and equity.

Integrating sustainability into the health professions, while presenting challenges at first, promises opportunities for innovative educational approaches and community engagement. Besides making better choices for home and family, health professionals may address sustainability in various other areas, including their gym’s refueling bar, product purchasing, or special events. Providing students in the health professions experiential and service learning opportunities linked to a sustainable food system gives rise to new connections, including a revitalized curriculum that is integrative, ecological, ethical, creative, reflective, and beautiful (24).

**SUMMARY**

The industrialized food system accounts for up to 30% of global GhG emissions and contributes to loss of land and biodiversity, an overexploited marine ecosystem, and high amounts of food waste. Whereas many production pathways must become more sustainable, “engaged eaters” also can make an impact on the four environmental hotspots — meat, fish, biodiversity, and waste — that have a significant effect on the three Es of sustainability, environment, economy, and equity.

Integrating sustainability into the health professions, while presenting challenges at first, promises opportunities for innovative educational approaches and community engagement. Besides making better choices for home and family, health professionals may address sustainability in various other areas, including their gym’s refueling bar, product purchasing, or special events. Providing students in the health professions experiential and service learning opportunities linked to a sustainable food system gives rise to new connections, including a revitalized curriculum that is integrative, ecological, ethical, creative, reflective, and beautiful (24).

**References**


Recommended Readings


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BRIDGING THE GAP

The industrialized food system accounts for up to 30% of global greenhouse gas emissions and impacts on soil and food quality, food safety, terrestrial and aquatic biodiversity and ecosystems, and human health. Paradoxically, 30% to 40% of food is wasted. Food insecurity, along with obesity and chronic disease, in the face of population growth and climate change, is creating great challenges to both agriculture and health sectors. Although these issues are global in scale and overwhelmingly challenging to solve, health professionals need to learn about concepts of sustainability, including related issues of our food system, and tackle health-promoting services by integrating such concepts on the local level. Although full of difficult questions to answer and barriers to overcome, addressing a sustainable diet in the context of good health awakens a socioecological understanding of eating and this gives rise to new opportunities.