1 Introduction to Sustainability

INTRODUCTION

In the 1990s the term *sustainability* emerged as a concept to reduce humans’ environmental footprint and a way to assure the preservation of natural resources for future generations. The concept did not pick momentum steam until the last few years, when due to public scrutiny, many companies integrated the word *sustainability* into their corporate marketing strategies. Since then, many individuals have embraced the sustainability concept even without a complete understanding of the extent of its meaning. Others have been looking at sustainability as a new fad, which will soon fade. However, sustainability is here to stay.

By definition, sustainability is a simple concept, but it is difficult to implement. Sustainability is not just becoming more efficient in the use of energy and natural resources; it is a change in business practices. Likewise, total quality management (TQM) has changed the mind-set of many organizations by placing the customer first; sustainability is the challenge of minimizing humans’ environmental impact and reducing dependence on nonrenewable resources.

TQM was the industry response to customers’ demand for better products. Most companies adopted this program voluntarily to gain an edge over competitors. In the case of sustainability, pressure from declining resources will compel industries to implement real sustainability programs, thus making sustainability not just one more trend but instead, a concept that will need to be truly embedded in companies’ core values for their long-term survival.

SUSTAINABILITY: A TERM TO STAY

Not long ago, a sustainable company was one that simply turned profits year after year (Simmons, 2008), and the term *sustainability* as it is known these days was a foreign word in most people’s vocabulary. Today, sustainability and its associated jargon, including triple bottom line, social and environmental responsibility, green workplace, and such, have become part of everyday life of corporate managers, scientists, and engineers.

Conferences on sustainability and related subjects have sprouted around the world in nearly all technology fields. (See Sustainable Development Conferences Worldwide website http://www.conferencealerts.com/sustain.htm for a list of upcoming events.)
Even when, some business leaders see this as a trend that will end soon; the food industry is quickly catching up with the topic of sustainability as a response to stakeholders’ pressure, new regulations (e.g., cap and trade that is being implemented in some industrialized countries), and mainly the depletion of natural resources that the whole economic system is based on.

In the last part of the twentieth century, satisfying customers by incorporating quality in products was the paradigm. In the twenty-first century the new paradigm is the environment and social responsibility (Hitchcock and Willard, 2002). The quality movement changed the world by providing companies with management tools that allowed them to embed quality in their products, to reduce production costs, and to expand their business.

Quality management has placed customers first in terms of satisfying their needs and reducing defects in their products to levels that before were unimaginable. In the case of the food industry, despite some isolated cases, the food supply chain has become safer than ever in the industrialized world, which is the result of remarkable efforts. However, new stakes that require immediate attention have been raised for the twenty-first century. The new challenge still requires satisfying customers by providing them with safe products to eat while complying with laws and regulations, but this needs to be done in a framework of responsible behavior toward the community and the environment (Hitchcock and Willard, 2002).

Not all industries can become sustainable from the environmental perspective. Petroleum extraction and mining, for instance, are not sustainable by definition (Siegal and Longsworth, 2009); and unfortunately, most other industries, including food production and distribution, strictly depend on the use of natural resources, and therefore, the food industry as a whole has the imperative challenge of lessening its environmental impact. Issues, such as efficiency, substitution of nonrenewable resources with renewable ones, minimization of waste, use of renewable energy, efficient logistics, and minimization of water use and wastewater, are some of the challenges that food company will have to face in the near future.

**DEFINING A SUSTAINABLE COMPANY**

The definition of sustainability, as well as the whole concept, has become a controversial issue. Since the term was prevalently defined by the United Nations World Commission on Environment and Development (WCED)—also known as Brundtland Commission in honor of his chair, the Norwegian Gro Harlem Brundtland—definitions, promoters, and detractors of sustainability have sprung up (Table 1.1). The topic has turned into a political issue for many, an opportunity for others, and a cause of concern for many scientists and scholars around the world.

The turmoil that the concept of sustainability inflicts in many individuals can be understandable because sustainability and sustainable development challenge the status quo and the way that most industrialized countries conduct business. Typically, the main focus of the food business has been to concentrate on the economic aspects as well as safety and compliance with regulations. Recently, the new sustainability dimension has been added to the equation, which significantly increases the complexity of doing business.

Time and again it is claimed that the definition of sustainability is a subject of personal interpretation. Paradoxically, the term is often used quite precisely in the context of everyday life. In any event, **sustainability is about long-term survival**, or in other terms, prolonged existence, permanence, durability, and resilience. Sustainability is a term currently applied to business practices, but its reach extends to any activity or organization, including, countries, animals, plants, and humans.
When talking about sustainability, it is important to define the time frame in which a practice is sustainable because it is unlikely that any activity perpetuates indefinitely in time. The current economic system, which includes food production and distribution, is based on the use of limited natural resources and we can expect the system will last as far as those resources are available unless we find substitutes.

A sustainable company is an organization that keep itself alive in time. To be viable and lasting, a company needs profits; resources, including capital, energy, and raw materials; and customers and a workforce. These three needs are also called by some the “three dimensions of sustainability,” and there is fair consensus among organizations about its validity. These days most corporations talk about the three components of sustainability as economic, social, and environmental.

Going back to our working definition of a sustainable company, since the main objective has been the generation of profits, decisions about investment have been based on one dimension: the return on investment (ROI). So, it is fairly understandable that the addition of two new dimensions can increase management complexity. Furthermore, the two new dimensions—social and environmental—cannot be reduced to one indicator, like the ROI, that is easily understandable.

The challenge for companies to stay in business in the future will not be only to make money but also to react to serious social and environmental issues. Examples of social aspects include stakeholders’ distrust in response to adverse socioeconomic impacts, such as widespread poverty, lack of education, and social disintegration due to displacement of traditional lifestyles; and environmental aspects, such as depletion of natural resources to climate change (World Bank, 2001).

**Example of an unsustainable food industry**

Monterey is a beautiful coastal community located 115 miles (72 km) south of San Francisco, California. In the 1850s, Chinese settlers immigrated to the area attracted by the harvesting of abalone. They soon were followed by Japanese fishermen in the 1890s, who established the first abalone canneries in the area. Italian immigrants moved to the Monterey bay from 1870s through 1910s and brought new fishing technologies that helped to develop the sardine canning industry (Winter & Company, 2004).
In 1900, the first two fish canning plants, H. R. Robbins and Frank Booth’s Cannery, were opened in the area known as Monterey’s wharf. Then in 1903, Booth bought Robbins and started the sardine canning industry in Monterey. Sardine canning plants multiplied in number in the next few decades in the area known today as “Cannery Row.” This rapid expansion of the industry ended abruptly in the 1950s when the sardine industry completely collapsed because the fish were virtually gone (Historic Monterey, n.d.).

The most likely cause of decline was overfishing, but it was later found that a natural boom-and-bust cycle caused by small changes in water temperature in the Pacific Ocean significantly affect the population of sardines (Cascorbi, 2004). Behavioral issues of sardines have also been also cited as a contributing factor of the decline of the sardine population (Glantz and Thompson, 1981).

Regardless the real causes of the decline in the sardine population, it is important to note the collapse of Monterey’s industry was fueled in part by lack of knowledge but more significantly by the assumption that natural resources were unlimited and would last forever. At those times there was a strong belief that “oceans were inexhaustibles and that man could not affect the species at sea” (Glantz and Thompson, 1981, p. 113).

Even though the drop of sardine catches that wiped out the industry in 1950 was somewhat sudden, there were signs of decline after the amount of fish landed peaked in the 1941–1942 season. However, these signs were not taken seriously enough by the sardine fishing industry, whose attitude—not only in Monterey but on the whole Pacific Coast of California—was to buy time when state regulators tried to enact laws to protect the resource. To make matters worse, federal scientists from the National Marine Fisheries Service challenged the story of state scientists, who represented the California Department of Fish and Game, on what was the cause of decline of the Pacific sardine. According to state scientists the reason was overfishing. Federal scientists noted other reasons, and the industry sustained that there was not enough data to make any definite conclusions. (Glantz and Thompson provide excellent discussions on the collapse of California’s sardine industry and other fishing industries.)

Today the sardines are back in California’s Pacific Coast waters, and their harvesting is strictly regulated. However, what was left of the famous Monterey’s canning industry—its buildings—have been transformed into restaurants and shops and home to the dazzling Monterey Bay Aquarium.

The promoted three dimensions of sustainability

These days, sustainability is often seen as the combination of three factors: economic, social, and environmental; and the interaction of these three factors is represented by a triangular diagram with the three dimensions located in the vertices or by three equal pillars as shown in Figure 1.1.

With a triangular diagram, the relationship between sustainability and the three dimensions could be explained in a semi-quantitative way (Fig. 1.2): Point 1 in the diagram represents an organization that pursues purely economic goals; Point “a” is one that has purely social objectives, and Point “b” pure environmental goals. The closest examples of pure Points a and b would be nongovernmental organizations (NGOs). However, it is unlikely to find pure forms of any organization. For instance, NGOs are by definition nonprofit organizations; however, they need financial support that is obtained through fundraising and contributions, and in that case it would move to somewhere in between Points a and 1, let’s say Point a.1 in the diagram for an organization that support social causes.

Going back to an only profit organization, Point 1 is the type of company at times of the industrial revolution. The main objective was purely economic with no regard for social issues or the environment. As time passed, understanding of the importance of social issues grew, and companies moved to Point 2 by addressing aspects such as number of worked hours, benefits, health, and such. In those times, natural resources were virtually unlimited, and the disposal of effluents did not present a problem. But as industries got surrounded by cities and rivers became more polluted, environmental regulations were enforced and companies moved to Point 3 in the diagram.

The three factors in the diagram are not interdependent. For instance, the progression from purely economic objectives toward the inclusion of social aspects in many cases brought economic benefits because workers were more motivated. The efforts to comply with environmental regulations created cleaner air and water, which had a positive impact in peoples’ lives and better images for companies, which may have benefited from the economic point of view.

Concerns about depletion of natural resources and climate change are challenges that will push companies to make the most significant adaptation of this evolutionary pathway by moving the organizational goals from Point 3 to 4, where Point 4 represents “the sustainable company.”

The sustainable company is one that can last a long time without being disrupted by economic, social, or environmental reasons. And using vocabulary from strategic management, the sustainable company will have to make a profit and at the same time act upon “threats” that can disrupt the business from the environmental and social points of view.
General Concepts

A central location of the sustainable company in Figure 1.2 indicates a balance of one-third each of economic, social, and environmental components. So the question is: is this what it takes to be sustainable? Unfortunately, it is not. It will depend on the business of each company. Going back to the petroleum and mining industries, companies that rely exclusively on nonrenewable materials are inherently nonsustainable from the environmental perspective. They work with resources that are limited and increasingly difficult to extract, their impact on the environment is significant, and are resented to a great extent by many stakeholder groups (society). So, no matter how many social contributions they make to mitigate their environmental impact, these companies are destined to not to survive in the long term because of their environmental unfeasibility.

In the case of food companies, true sustainability could be achieved only on the basis of replacing materials and energy that are currently obtained from nonrenewable resources, which can be a huge task. This comprises not only processing but also the whole supply chain, including food production in the fields, transportation, distribution, and final disposal of packaging material.

**Shortcomings of three-dimensional representation**

The weakness of portraying sustainability as a mix of three dimensions is that they are all taken as interchangeable and of equal weight. From a business perspective, a perfectly valid claim is that for the business to be sustainable all it needs is to make money. From whose who are in defense of social views, the needs of people should be placed ahead of environmental and economic aspects. The environment on the other hand has no voice, except when natural disasters occur. What is forgotten is that the environment is the ultimate system that supports both the social and economic systems (Fig. 1.3).

In fact, the social and economic systems are subsystems of the environmental system (Fig. 1.4). In this context, a food company takes energy, water, minerals, and land from the environmental system; labor from the social subsystem; and capital from the economic subsystem. In return, the food company produces income for the employees and food for the social subsystem; and the food company and employees pay taxes that benefit the economic system (these taxes go back to the social subsystem in the form of education, social projects, and infrastructure [public buildings, roads, bridges, and so on]).
**Figure 1.3** A more realistic view where the environmental pillar supports the social and economic dimensions.

**Figure 1.4** A food company in the context of the environmental system that supports the social and economic subsystems. Adapted from Tyteca (1998).
General Concepts

Education impacts communities, which are part of the social subsystem, and also impacts the economic subsystem by offering qualified labor. In many cases, education means higher incomes, which allow house purchases in the suburbs that negatively impact the environmental system in terms of land use, lost of agricultural land, environmental diversity, and distance driven.

Food from the food company benefits the population in that humans today do not have the burden of producing food as previous generations had; instead, humans can pursue different interests in life, such as independent professions, the arts, writing a book on sustainability for the food sciences, and so on. On the down side, abundant, inexpensive food promotes population growth that impacts the environmental system through loss of land, ecosystems, water, and need of waste disposal. Also, like in many developed countries these days, available food combined with lifestyles is producing an epidemic of obesity that will eventually affect the social, economic, and environmental systems.

A QUEST FOR THE ENVIRONMENT

A case has been made for the interrelation of the three aspects of sustainability and that the environment is the fundamental system that supports the social and economic subsystems. Without a healthy environmental system, the other two subsystems will eventually come to an end. Therefore, this book will focus almost exclusively on the environmental aspects of sustainability.

We, humans, have developed an economic system based on nonrenewable energy and resources that were buried as fossil fuels and concentrated deposits of useful minerals. We cannot ignore the fact that eventually these resources will be depleted, will become too expensive to extract from the earth crust, or the by-products of their use will change the global climate and disrupt business as usual. Readers interested in the other two dimensions need to consult specialized literature on economic and social aspects of sustainability.

NONSUSTAINABLE VERSUS SUSTAINABLE

The nonsustainable food company

To define a sustainable food company, let’s first define a nonsustainable one. Figure 1.5 is a simplified version of the food supply chain that contains the “processing facility” with inputs of energy and raw materials and outputs of products, air emissions, wastewater, and solid waste emissions. What makes this system nonsustainable in the long run is the reliance on fossil fuels and nonrenewable resources in every single stage of the process. Arguments can be made about the amount of fossil fuels left, but they are essentially nonrenewable resources. Additionally, the resulting emissions of greenhouse gases may produce changes that may affect the planet in unpredictable ways.

The main raw materials for food processing plants are ultimately fruits, vegetables, and grains that are grown in the fields and used directly as raw materials to produce food products or used as animal feed to produce animal protein, milk, eggs, and so forth. At first, a case can be made that these are renewable resources because they are living organisms that capture energy...
from the sun and can be grown over and over again. However, the problem with industrialized agriculture is that it relies on the high input of energy from fossil fuels in the form of fertilizers, herbicides, and fuel for tractors and machinery.

Extra nonsustainable elements in the production of raw materials phase are the manufacture of plastics for packaging from petroleum and natural gas, petroleum-based ingredients, and materials obtained from mining. Water is an issue in many parts of the world because of shortages and the energy from fossil fuels used for its extraction, treatment and purification.

In the processing phase, vast amounts of heat and mechanical energy are used to process the food. All this energy comes from natural gas and electricity that is largely produced by burning fossil fuels. Processing produces solid and liquid wastes that need treatment using energy from fossil fuels. Products generated by the processing facility need transportation, proper storage in warehouses, and distribution to grocery stores; and all these steps use nonrenewable energy.

Once the food products are purchased, the consumer transports the food home and uses energy for storage and preparation. The environmental impact exerted by the consumer may be significant depending on the product. Food products that require extensive cooking, such as pasta and potatoes, use more energy in the household than in processing. A study in Sweden has reported that energy expenditures during cooking represent up to 55 percent of the total energy spent during the whole life cycle of spaghetti (adapted from Foster et al., 2006). Another study on organic potatoes (also in Sweden) has found that 16 percent of energy is spent during transportation from the retailer to home and 29 percent in preparation (Mattsson and Wallén, 2003). Consumption is then followed by the disposal of packaging materials and waste generated during preparation.
The sustainable food company

In contrast with a nonsustainable one, a long-term 100-percent sustainable food company including its supply chain, processing, distribution and postconsumption disposal would have the following attributes:

1. Relies exclusively on renewable energy.
2. Depends on ingredients and materials made from renewable resources with renewable energy.
3. Is water neutral.
4. Has net-zero air emissions.
5. Produces completely biodegradable liquid and solid wastes at a rate and level that could be easily degraded by nature.

These characteristics look unreasonably challenging, don’t they? Sure, they are. Almost certainly, it will be the biggest challenge we will face in the next decades to move from business-as-usual practices to a more sustainable system.

Reliance on renewable energy

Unless the generation of power by nuclear fusion soon becomes feasible, renewable energy will likely come from solar, wind, hydroelectric, biofuels, biomass, geothermal, biogas, or tidal sources (see Chapter 11). Affordable and available renewable energy would not only power processes but also cut emissions, alleviate water shortages in many parts of the world, and be used to produce nitrogen fertilizer, a needed element for the production of raw materials. With inexpensive renewable energy, low-quality water could be treated with membranes and used for processing. Wastewater could be treated and returned to the process in a closed loop. However, finding replacements for fossil fuels with renewable energy is the most significant challenge because of its short in supply. Moreover, fossil fuels are so energy dense, still inexpensive, transportable, and easy to use that it is difficult to find a straight renewable replacement for them.

Replacing fossil fuels with renewable energy would produce the highest contribution toward sustainability because of its virtually net-zero emissions and permanence. But this needs to be done in a way that the solution has a lower net impact than the problem. For instance, if the answer is cutting trees (that act as carbon sink) to plant energy crops then it is not a good solution.

Ingredients and materials from renewable resources

With exceptions of glass, metal, wood, paper, cotton, cellophane, and polylactate, the rest of packaging materials used by the food industry are made from fossil feedstocks. Steel and aluminum are not made from fossil feedstocks but from minerals that are not renewable; but recycling of metals moderates the rate of depletion of mineral ores. Aluminum cans, for instance, can be recycled over and over into new cans with a minimal yield loss. Glass is made of silica, which is an abundant material, but it requires energy for its manufacture and its extraction may have important environmental impacts depending on where the mine is located.

Some chemical ingredients are made via fermentations (aminoacids, vitamins, etc.) or extracted from plants (flavors, enzymes, natural colors, gums, etc). Salt is an ingredient
obtained from mining (nonrenewable) or by evaporation of seawater that could be considered renewable. Other ingredients are obtained through synthesis from fossil-based raw materials. However, independent of whether these materials or ingredients come from renewable or nonrenewable sources, they all have the common denominator that are produced using nonrenewable energy. In a 100-percent sustainable food company all the ingredients and materials would come from renewable sources and would be made using renewable energy.

**Water neutral**

Food production is an water-intensive operation. Considerable amounts of water are used during food processing, but agricultural operations to produce raw materials in the fields are even more water intensive. Part of the water used for processing and agriculture comes from superficial water (rivers, lakes, and in some cases, from desalinated seawater) and the rest from aquifers. Aquifer depletion is a problem in many areas of the world where agricultural production has benefited from the abundance of subterranean water for many years. Water from some aquifers has been pumped at a rate higher than the rate or replenishment, which makes water extraction nonsustainable in the long run.

A sustainable food company would use primarily surface water with minimal tapping of subterranean water to allow aquifers to replenish. Water use would be optimized to avoid unnecessary waste, thus creating a low water footprint for the company’s products.

**Net-zero air emissions**

In the food production system, air emissions come from agricultural activities, transportation to the processing plants, processing, transportation to distribution centers, storage, transportation to selling points, and storage at selling points. The system would not be complete without the emissions generated by transportation of the food by the consumer and its storage and preparation at home (see Chapter 9 for more on air emissions).

In this discussion, air emissions means anthropogenic emissions of the greenhouse gases relevant to food production with the potential of a global climate effect. These are carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons (HFCs). Other environmental pollutants, such as carbon monoxide, lead, nitrogen dioxide, ground-level ozone, particulate matter, and sulfur dioxide that have a more local and regional effect, are regulated by laws in many countries. Ozone-depleting substances including chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), halons, methyl bromide, carbon tetrachloride, and methyl chloroform are in the process of being phased out after the signature of the Montreal Protocol.

Air emissions come in different forms at each step of food production. Methane is produced mainly during the agricultural phase through enteric fermentation, animal waste, rice cultivation, and to a less extent, during crop residue burning. In the processing and consumption phases, methane is produced during decomposition of solid and liquid wastes.

Carbon dioxide is produced at the agricultural phase, during processing, at all transportation and storage phases, and preparation of food at home. Carbon dioxide is the main by-product of burning any type of carbon-containing material and decomposition of carbon-rich materials in the fields or as wastes.

In food production, the largest amount of nitrous oxide is released during fertilization of soils, followed by animal solid wastes, and stationary combustion to produce power, electricity, and transportation. Treatment of human sewage has important nitrous oxide emissions that
correlate with population size and consumption of protein (Environmental Protection Agency [EPA], 2010). When compared with carbon dioxide and methane, nitrous oxide is released in small amounts from human activity, but its 100-year global warming potential of 310 makes it an important contributor as a greenhouse gas (Intergovernmental Panel on Climate Change [IPCC], 2001).

HFCs emitted in food production come from stationary and mobile refrigeration equipment. HFCs are a replacement of CFCs and HCFCs, which were found to deplete the ozone layer. However, it has since been found that HFCs have a global warming potential much higher than carbon dioxide. Just to illustrate, HFC-134a, one of the most used HFCs, is 1300 more powerful than carbon dioxide as a global warming potential gas (EPA, 2008).

In a sustainable food company, emissions of greenhouse gases would be eliminated or reduced to levels manageable by the Earth systems. At the agricultural phase, carbon dioxide emissions would be reduced by changing agricultural practices and the use of soil as a carbon sink for carbon sequestration. Carbon dioxide emissions during processing, transportation, and waste treatment would be virtually taken to zero by using renewable fuels and renewable energy.

Methane production could be reduced by changing agricultural practices and the use of wastes to produce renewable fuel through anaerobic fermentation. The only promising approach to reduce methane from enteric fermentation is to improve productivity and efficiency of livestock production (EPA, 2007).

Nitrous oxide emissions from fuel combustion and nitric acid production (use for production of fertilizers) could be addressed by technical modifications. Excess emissions of nitrous oxide from overuse of synthetic fertilizers could be reduced by better management practices.

Refrigeration systems using HFCs and other refrigerants with high global warming potential could be replaced with systems that use carbon dioxide or ammonia as working fluids. Despite its toxicity, ammonia is used in many food-processing plants these days. For distribution centers and supermarkets, transcritical refrigeration is turning into a mature technology and becoming a reality. Several supermarket chains in Europe are pilot testing transcritical carbon dioxide systems in many of their grocery stores.

**Biodegradable liquid and solid wastes**

Liquid streams from food-processing plants are in all cases biodegradable. High contents of dissolved solids contained by the streams, though, require mechanical energy to promote their degradation before being discharged into water bodies. This mechanical energy comes from electricity that is generated with nonrenewable fossil fuels.

This practice would become sustainable by either using renewable energy or using alternative technologies to degrade organic materials. Anaerobic digestion is an alternative to the traditional aerobic systems that would not only save mechanical energy but would also open the possibility of harvesting biogas for energy generation. Anaerobic digestion is a mature technology that is suitable for streams with high biochemical oxygen demand like the ones from food-processing plants.

A second alternative for wastewater treatment without high-energy expenditures is the use of engineered natural systems that use an assortment of plants, solids, and microorganisms to reduce or eliminate the pollutants in water. More on “green” wastewater treatment methods is covered in Chapter 8.

With the exception of packaging, solid wastes from food processing are biodegradable and the amount of solid wastes and applications varies from industry to industry. The meat industry,
for instance, generates little solid waste because most of it is treated as by-products at rendering plants; therefore, virtually no solids are wasted. An exception to this statement is solids mixed with polymers that are recovered from flotation cells designed to remove suspended solids and fat from wastewater streams. As a rule, these solids cannot be reintroduced in the rendering process or used for other applications such as animal feed and are placed in landfills.

In the vegetable-processing industry, wastes come from sorting, trimming, and peeling or the extraction of juices from fruits vegetables. All these wastes—that in many cases are considered by-products or coproducts—have use as animal feed.

The largest impact of solid food wastes that reach landfills comes from food preparation and scraps either produced at home and or by the food service sector. These materials are biodegradable and therefore compostable, but a difficult logistic and lack of composting facilities make these materials more likely to reach a landfill than being composted. A more comprehensive discussion of solid wastes is presented in Chapter 10.

Is a 100-percent sustainable food company attainable?

A 100-percent sustainable food company would be desirable, but unfortunately it is unrealistic at the moment. The first road block to 100-percent sustainability is the lack of renewable energy. There are many initiatives to produce renewable energy from wind, solar, and biomass sources. However, it is far from being enough to satisfy the demand of the food industry and the industries that support food production.

The second road block to attain 100-percent sustainability is the lack of ingredients and packaging materials made from renewable resources. Many ingredients used by the food industry are renewable based, but they are produced with nonrenewable fuels and with the use of petroleum-based precursors and solvents.

The third road block is water use. During the processing phase, water use can be minimized and water even reused if it is treated with membranes using renewable energy. However, water use for crop irrigations is having a devastating effect on aquifers in many parts of the world. One solution is switching to surface water, but the problem is that surface water is not available in most places where fertile soils exist.

The fourth road block is the intrinsic nature of food production. Many emissions of greenhouse gases such as nitrous oxide and methane come from the field where raw materials are produced. Nitrous oxide resulting from livestock, production of nitrogen-fixing crops, cultivation of high-organic content soils, and the application of livestock manure to croplands and pasture are difficult to address. Methane from enteric fermentation, which is the main emission from milk and meat production, can be minimized with better diets (Leng, 1993), but it cannot be eliminated or captured.

So, the idea of zero emissions may be possible from the viewpoint of burning renewable fuels in stationary systems where nitrous oxides can be captured, and because fuels are renewable the net carbon dioxide balance would be zero. But the idea of having zero emissions from the production of raw materials is a more difficult proposition.

The fifth road block is lack of degradable packaging made from renewable resources. To a great extent, secondary and tertiary packaging is made from cellulose fibers. However, with the exception of polylactide, most primary packaging still relies almost exclusively on plastics made from nonrenewable fossil raw materials.

Polylactide is not the only plastic made from renewable resources, but it is the only one that is price competitive with homologous petroleum-based polymers. However, polylactide is not a direct replacer for all plastic packaging materials. Its use is mostly limited to food products
of fast consumption after preparation including prepared foods, sandwiches, fruits, and bakery products. Some applications include sandwich boxes, salad bowls, hinged-lid clamshell containers, straws, cups, and utensils. More recently the use of polylactide as a packaging material has been expanded to potato chip bags and water bottles.

**A short-term approach to sustainability**

The fact that 100-percent sustainability is not attainable under current circumstances does not mean that we should not dedicate efforts to move in that direction. A sustainability initiative can use “100-percent sustainability” as the ultimate goal to achieve.

A good way to start working toward sustainability is by making efficiency improvements as the first step, which are reducing consumption of energy, water, raw materials, and packaging. Chapter 5 presents a management approach to work on improving efficiency, and Chapters 8 to 13 elaborate many technical ideas.

A second step toward the sustainability efforts is the gradual incorporation of renewable energy by purchase or self-generation. When renewable energy is not an option (i.e., needs of natural gas for heating, transportation fuel, or air travel), offsetting emissions can be a short term alternative. However, offsetting has not to be taken as a blank check to continue with a business-as-usual approach. Offsetting without being efficient is like having an unhealthy lifestyle and trying to compensate for it by making donations to the American Heart Association (renewable energy and carbon offsetting are discussed in Chapter 7).

Unfortunately, efficiency cannot be improved indefinitely. At some point, results from the efforts made toward efficiency improvements come to an end. From there, additional gains on the minimization of a process or service’s environmental impact can be done only by swapping the current process with a different technology. This step is definitely harder than improving efficiency because it requires capital investment and research to develop technologies that are nonexistent or are not mature enough to be bought off the shelf (this is discussed more in Chapter 6).

**Defining boundaries**

When food companies start with sustainability initiatives, it is likely to focus only on the processing facilities: Boundary 1 in Figure 1.6. But as progress is made, the processor may soon realize that the boundaries need to be expanded to include transportation from the field to the plant and distribution from the plant to selling points (Boundary 2). For food products with minimum processing (e.g., potatoes and carrots) most of the impact happens during the agricultural phase and consumption. For food products coming from animals (e.g., milk and meat), the largest impact takes place at the agricultural stage; therefore, the incorporation of the agricultural phase is crucial for a comprehensive analysis. A step further is the incorporation of the disposal phase by the consumer including food scraps and packaging (Boundary 3). Even when the food manufacturer is not directly responsible for the storage, preparation, and consumption stage at home this can be seen as an opportunity for the manufacturer to create food products that require less energy in preparation by the consumer.

Setting boundaries will depend on the objective of the analysis and the accuracy of the intended results. For instance, if the objective is to assess the global warming potential per gallon of milk delivered to a grocery store, then the analysis needs to include all the steps
from production to retailer. Cows are high emitters of methane and carbon dioxide, so the production of milk in the field will have the highest impact.

**Differentiating efficiency from sustainability**

Efficiency taken as a synonym of sustainability is a common mistake. Efficiency is an important step of the sustainability effort, but it is not just that. As described previously, improving efficiency is the first step that most companies take in their sustainability initiatives, but it takes more to create a sustainable food industry.

We are in the “era of green.” Widespread television series and the printed press show people how to be “green” by composting, recycling, insulating homes, and driving hybrid vehicles. These are all good examples of improving efficiency. However, more efforts will be necessary to create a sustainable society. From this example, a parallel can be drawn for the food industry. Efficiency is important but it is just an initial step in the road toward a sustainable food industry.

**SUSTAINABILITY FROM THE BUSINESS POINT OF VIEW**

Reaching true long-term sustainability is not an easy initiative. So the question is: Why would I have interest in starting a sustainability program in my company? The answer depends on the point of view. From an ethical perspective, it is the right thing to do because everyone is a cohabitant of the same planet and all are consuming nonrenewable resources at a rate that cannot be perpetuated indefinitely. This practice is eating the natural capital of generations to come and it may be producing changes in the planet with potential devastating consequences for the future.

If an ethical reason is not compelling enough, then business motivations may be more persuasive for the following reasons:

1. It is becoming important in public perception.
2. Regulations are being enacted in most developed countries.
3. Heavy reliance on the used nonrenewable resources creates a serious threat to the industry.

A genuine sustainability program may bring many advantages to food companies in the form of new business opportunities, lower operational costs, and a more resilient supply chain.
**Weakness of doing nothing**

1. *Dependence on nonrenewable energy* from fossil fuels is probably the major weakness of the whole food system and food-processing industry for the following reasons:

   - Because nonrenewable energy comes from limited resources, energy prices will eventually rise due to short supply.
   - Nonrenewable fuels are controlled by politically unstable countries, thus creating volatility in prices and the potential disruption of the supply.
   - The biosphere has a limited capacity to accommodate the emissions from burning fossil fuels. This may impose a constraint well before the resources are completely exhausted (Royal Commission on Environmental Pollution [RCEP], 2000) with unpredictable effects on climate and the production of raw materials.

2. *Reliance on nonrenewable resources*. Today the food industry is a strong consumer of nonrenewable resources for the production of packaging, ingredients, chemicals, and so on. If a disruption on the supply of nonrenewable resources occurs, there are no practical alternatives for the substitution of the entire amount of nonrenewable resources consumed.

3. *Potential disruption of the supply chain*. There is a potential for the disruption of the supply chain due to adverse environmental impacts such as:

   - Depletion of natural resources including freshwater and minerals
   - Loss of agricultural land due to soil erosion and urbanization
   - Political instability. Even when not an environmental issue, disruption of the supply chain may occur due to political problems in unstable countries where raw materials are produced (Cohen, 2009).

4. *Lack of knowledge of environmental impact* (carbon footprint, food miles, and so on) is a real weakness at the moment of discussion with customers and stakeholders. A corollary of this weakness is that if people do know where they are, then they cannot come up with a plan to improve the current situation.

5. *Development of a bad reputation*. In an era of high-speed communication, companies’ behaviors are dissected and disseminated by stakeholders in real time. Thus, a bad reputation can be developed quickly by doing nothing, or doing too little, about the company’s impact on the environment.

6. *Increasing third-party pressure*. It is becoming a trend for companies to request suppliers to fill out environmental scorecards on products they supply. The purpose of these scorecards is to set a baseline on the environmental impact of products and services today and set goals for the future.

7. *Rising levels of compliance and regulations*. Developed countries are working on environmental regulations that will raise the current level of compliance. Taxes on emissions or carbon cap and carbon trading systems are in the works in several countries.
Strengths and opportunities

1. Differentiation from the competition. Many food products fall into the category of commodities with few attributes that could be used to differentiate the product from almost identical ones offered by competitors. In an era of consumers interested in companies’ social responsibility, legitimate sustainability programs are important initiatives that could differentiate the company from other players.

2. Brand protection. Usually efforts concerning band protection are focused on quality and safety. Sustainability is becoming the third item on the list, which is driven by increasing consumers’ awareness of the environment and their interest in corporate practices. So in addition to protecting the brand by acting on package tampering, bioterrorism, counterfeiting, product adulteration, and traceability, the focus on sustainability of the supply chain (e.g., fair trade, virtual water, embedded energy, renewable energy versus nonrenewable energy, and so on) will create in the end a more robust brand. However, this will not happen without risk. Sustainability initiatives will introduce changes in the process; and there is a need to make sure those changes do not affect the quality or put safety at risk.

3. Resilience in the supply chain. Resilience is the ability of a company to spring back to normal operation after a major disruption (Sheffi, 2005). Like most businesses these days, food companies have global supply systems of ingredients and supplies that are constantly threaten by natural disasters, political instability, and accidental disruption. Sustainability can be used as a powerful tool to build resilience in the supply chain because of the detailed analysis that requires the whole system. This analysis would assist to identify weaknesses and threats in food companies’ global sourcing systems and help them to incorporate two key ingredients in resilience: flexibility and redundancy (Sheffi, 2005).

4. Ability to influence suppliers. Lessons learned from TQM demonstrate the importance of having suppliers as allies and the importance of sharing the knowledge with suppliers. Working with suppliers ensures consistent quality of raw materials that translates into consistent quality of products. In a similar fashion, knowledge acquired in a sustainability program can be passed onto suppliers that would help to promote their sustainability programs.

5. Anticipation of changes in regulations. Environmental regulations have been in place in many countries for several decades, but there are no sustainability regulations as such. However, a worldwide concern about the environmental impact of human activities likely will promote regulations in the near future to force more sustainable practices.

SUMMARY

Sustainability is about long-term survival. The current economic system has been rapidly developed in two centuries by tapping into natural resources that will not last indefinitely. Depletion of those resources will make the system come to an eventual stop unless the commitment to transform current practices is made. However, this is not an easy
proposition. Fossil fuels, minerals, and natural ecosystems provide materials and services that are not easily replaceable, at least at the level needed today with a population approaching 7 billion.

A key aspect to guarantee long-term sustainability is the transition to renewable energy and materials, while preserving natural ecosystems that provide vital services to the planet. However, with an economic system that is based on continual growth and the shortcomings of renewable energy and materials production, the idea of creating a sustainable economy will be a difficult task.

REFERENCES


