CHAPTER 1

THE CHALLENGE OF SUSTAINABLE INNOVATION IN AGRI-FOOD SUPPLY CHAINS

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ABSTRACT

Purpose: This chapter introduces the volume’s theme by describing the challenges of sustainability in the agri-food industry and the critical role of agri-food supply chains. Following a description of traditional and sustainable supply chain management practices, we discuss the likely characteristics of sustainability oriented innovations and how organizations pursuing higher levels of economic, social, and environmental performance will need to adapt their capabilities.

Design/Approach/Methodology: Drawing on the emerging concepts and practices from sustainable supply chain management as well as traditional and emerging concepts from innovation, we develop general propositions and expectations about how organizations might address sustainable effectiveness in their supply chains. The importance of the agri-food industry to all three pillars of sustainable effectiveness and predictions about the inability to feed future populations gives the discussion a certain urgency.

Findings: Sustainability oriented innovations in the agri-food supply chain are different from traditional innovations. We develop propositions regarding the driving motivations, their nature and scope (i.e., more radical and systemic than incremental and focused), and the importance of a multi-stakeholder approach. The ten cases presented in the volume are summarized.

Keywords: Sustainability, agri-food industry, sustainable supply chain management, sustainability oriented innovation
INTRODUCTION

Organizations -- and the economic system of which they are a part -- are finding new ways to match their economic logics and operations with the protection of those resources that are essential to the planet and its population to survive. The challenge of sustainable development is particularly compelling in the agri-food industry because of its relative impact on the environment, the amount of natural resources it consumes, and its structural interrelatedness with the health and well-being of humanity. Far too many studies predict that the industry will not be able to provide enough food in the future given current operating methods and expected dynamics in the world population.

Within the food industry, the agri-food supply chain produces, processes, distributes, and consumes products through a complex network of interrelated actors. A major source of unsustainability in the industry is the current structure and logic of these supply chains (Marsden, Murdoch, & Morgan, 1999). Although each single actor in the chain can contribute incrementally to the overall sustainability of the final product, a much more systemic effort is required to achieve significant improvements. Thus, actors in agri-food supply chains must look for ways to become more sustainable but must also look beyond their boundaries and include many different other actors in their innovation process. Often, these actors are not the primary stakeholders of the firm, but less traditional actors, such as NGOs, governmental bodies, or research institutes.

Modern day supply chains – including modern day agri-food supply chains – are no less a product of history than modern day organizations. The history of management and organization has been well documented (e.g., Piore & Sabel, 1984; Stout, 2012; Williamson, 1995), and most organization design models identify economic performance as the primary measure of effectiveness and growth as the primary strategy. When the measure of performance and effectiveness is economically or financially based, a strategy of growth allows firms to access cost efficiency, value-add, and productivity through scale and leverage. Scale and leverage are a by-product of the overriding concern for efficiency, productivity, and shareholder wealth (Albert, 1993). Sometimes efficiency and productivity can serve the cause of providing safe, varied food to a larger share of the
world population. However, scale and leverage are also the causes of many unsustainable models of production, processing, delivery, and consumption. The never-ending search for efficiency results in larger farms, massive feedlots, increasing chemical usage and greenhouse gas emissions, longer supply chains, centralized distribution centers, and more transportation. Thus, the emergence of alternative indicators, such as environmental sustainability and social/community engagement, suggests taking a step back from the logic of scale and leverage to consider alternative new business logics and their supply chains.

Research on these new logics is in general agreement (Pullman & Wu, 2012). Innovation will be a key lever to change current systems, allow companies to apply more sustainable models of production, and foster more sustainable models of consumption. Innovation can be developed at different levels and can be pushed by different drivers. In particular, innovation can target products, processes, and organizational models in one or many stages of a complex supply chain. In addition, sustainability oriented innovation (SOI) can address one or more sustainability dimensions and produce more or less radical departures from the traditional models.

This volume in the Organizing for Sustainable Effectiveness Series is aimed at presenting and discussing a variety of supply chain SOIs in the agri-food industry. They are all aimed -- in a more or less radical way -- at improving the sustainability of the companies or the systems involved. The ten cases are very different in terms of the scope of innovation, the dimension of sustainable performance targeted, the levers used to change the supply chain model, and the level of maturity and success achieved by those innovations. This variety allows us to appreciate the alternative patterns that can be followed to achieve sustainability in this industry and the challenges and opportunities associated with them.

Despite this variety, there are two common threads.

First, a common feature of the cases presented here is the strong strategic focus behind the solutions proposed. Most of the innovations analysed lay in the strategic arena rather than at the level of tactical solutions. Although they may be aimed at incremental improvements of a single
sustainability performance dimension, most of the innovations are pushed by a strong belief that the company can create more value by finding ways to produce the same or better products though more sustainable systems. The main push to innovate does not always come from regulations or market opportunities, but also arise from an enlightened awareness of the role played by an organization in society.

Second, in keeping with the theme of this Series, all of the cases address the organizational capabilities needed to develop and adopt the proposed innovation. That is, successful innovation does not solely rely on the quality and nature of the solution proposed, but also on the ability to implement it effectively. Besides analysing solutions that address sustainability problems in the agri-food supply chains, these chapters also discuss the organizational assets and routines required to make them work. The appropriate organization design, resources, and capabilities are essential.

To better frame the cases presented in the book, we describe the challenges posed by the agri-food industry in terms of sustainable development and the range of answers that have been proposed in the literature. The structure of the agri-food supply chains and their central role when looking for sustainable models in this industry is discussed next. This section also categorizes state of the art sustainability practices and innovation in food supply chains. We then discuss the concept of sustainability-oriented innovation (SOI) and propose it as an overarching concept to make a company more sustainable. The chapter closes with a summary of the questions that arise from the literature and the practice of sustainable innovation in the agri-food supply chains. We try to address those questions when analysing and comparing the cases in Chapter 12, where we try to provide some answers and show some possible ways forward. A short synopsis of the ten cases is also presented.

THE CHALLENGE OF SUSTAINABILITY IN THE AGRI-FOOD INDUSTRY

The food industry is undergoing unprecedented challenges and pressures. No other industry like the agri-food industry represents, in such a complete and dramatic way, the challenge of sustainability.
It is a central economic feature of many countries around the world and accounts for a significant share of production, consumption, and employment. In Europe, the food industry represents 14.5% of total manufacturing revenues, 15.5% of the employment, and 12.5% of value added in manufacturing. But it is also a fragmented industry. On the one hand, European multinationals competing in the international foods market are few in number but sell a wide variety of products. On the other hand, 99% of the companies and 63% of employment is accounted for by small and medium enterprises (SMEs) (ECSIP Consortium, 2016; Fooddrink Europe, 2015).

In the U.S., agriculture and agriculture-related industries accounted for 4.8 percent of the country’s gross domestic product (GDP) in 2014. Farming output represents about 1% of GDP, although that understates the overall contribution of agriculture because other sectors, including food service, catering, and drinking establishments, among others, depend on agricultural inputs for their value-added contributions (USDA, 2016).

The above figures suggest that the food industry reflects the characteristics of a highly competitive, commodity industry. Many suppliers, especially farmers, are price takers and have little bargaining power. Downstream producers and retailers have some opportunity for differentiation, but they too are under intense and effective pressures to lower prices that can take their toll on sustainability (Lawrence, 2013). As pressures for sustainability evolve, one source of differentiation is the food itself and farmers may have a window to adapt innovative practices to create branded products. For example, Driscoll’s, the California-based berry producer, is aggressively and successfully working to create a unique and worldwide brand in this category. Similarly, illy has been one of the first coffee producers to transform a typical commodity – coffee – into a strongly differentiated product associated with a highly reputed brand. The centrality of food to the economy, to life, and to human cultural identity, and the volatility brought on by consumer concern for food security, safety, and sustainability, have created a more dynamic industry, sometimes referred to as “the new oil” (Bradsher, 2008).
In addition to its economic centrality, the industry is also and obviously tightly connected to the natural environment. Farming, for example, is one of our oldest technologies, delivers an original and essential raw material for human life, and is completely dependent on basic resources, such as land, air, and water. The industry is among the largest users of surface water and energy. Despite its deep connection with the earth and human existence, an increasing body of evidence demonstrates that many of our current food production systems are harming the planet and its inhabitants (Gerbens-Leenes, Moll, Uiterkamp, 2003; Godfray, Beddington, Crute, Haddad, Lawrence, Muir… & Toulmin, 2010). The excessive and thoughtless use of chemicals compromises the natural rhythms of the Earth and its capability to produce food in the coming years (EU Standing Committee on Agriculture Research – SCAR, no date). Food systems as a whole contribute between 15 and 28% of overall greenhouse gas emissions in developed countries (Garnett, 2011). As important contributors to climate change and global warming, these activities threaten the stability of the whole food system, including negative impacts on food production, food prices, food utilisation, access to food, and supply chain infrastructure (Schmidhuber & Tubiello, 2007; Wheeler & von Braun, 2013). The exploitation of natural resources and changing land use patterns have led to biodiversity losses, especially in agriculture and fisheries, and to the inability of nature to regenerate resources at the same pace as their depletion.

Finally, the agri-food industry is a social issue. The world’s population is expected to increase to 8 billion by 2030 and to exceed 9 billion by 2050 (UN, 2013). This forecast includes the projected growth of a middle-class that will demand more varied and high-quality food products requiring additional, differentiated, and more costly resources. Such a population will require 60% more global food supplies (Global Commission on the Economy and Climate, 2014) and utilize up to 45% of global energy and 30% of global water demand exclusively for agricultural activities (Foresight, 2011). However, in too many countries, more food is produced than can be consumed. Research shows that one third of the global food production is wasted or lost annually (Gustavsson, Cederberg, Sonesson, Van Otterdijk, & Meybeck, 2011). On the other hand, there is wide
agreement that without waste, through the responsible use of available resources, and thanks to expected scientific progress, the food system will be able to feed the world’s population (Aiking & de Boer, 2004).

The increasing gap between the poorest and wealthiest parts of the population (Piketty, 2014) suggests that an increasing percentage of the global population may suffer from hunger. Today, estimates suggest that there are more than 900 million people worldwide suffering from hunger. Although undernourishment has fallen from 18.7 to 11.3 percent globally, the problem is far from solved, with Sub-Saharan Africa and Southern Asia still having severe undernutrition problems. Many other factors, such as price volatility, access restrictions, the interconnectedness of global commodity markets, increasing vulnerability of food production systems to climate change, and loss of agro-biodiversity, will further increase the food insecurity and inaccessibility for poor people in the future.

At the same time, the average Western diet includes high intakes of meat, fat, and sugar posing a significant risk to individual health in this area of the word. Worldwide 1.9 billion people are overweight and of these over 600 million are obese. Worse, the worldwide prevalence of obesity more than doubled between 1980 and 2014. But both hunger and obesity are critical social issues that affect up to a quarter of the world’s population (Aiking & de Boer, 2004).

In sum, sustainable development in the food sector faces three main and integrated challenges. The first challenge is that food production significantly impacts and strongly depends on environmental, human, and physical resources. Respecting, protecting, and regenerating this interdependency is fundamental to sustainable development. The second challenge involves the vital role that food holds for humans. Consumers are increasingly aware of and concerned with the negative impacts that unsustainable production methods, food miles, and food origin can have on their health. They are expecting and requiring more information and transparency on production processes and food sources (Bourlakis, Maglaras, Aktas, Gallear, & Fotopoulos, 2014). As a result,
consumer and regulatory requirements will become central to sustainable development, but this will increase the complexity and challenges faced by manufacturers, suppliers, and the entire chain.

The third challenge reflects the peculiar characteristics of the food supply chain. The actors involved in the chain often belong to different companies that are diverse in terms of size and approaches toward sustainability and their participation in a process that is time sensitive. The interdependence of the actors – with different motivations and the threat of perishability/spoilage - increases the possibility that conflicts will arise from the adoption and implementation of sustainable practices by any one actor in the food chain (Hartmann, 2011).

**THE AGRI-FOOD INDUSTRY AND SUPPLY CHAIN**

Food tends to be produced in a complex system made up of mainly industrialized and mass production processes, diverse actors, and layers of complexity. The sustainability of the food industry is intrinsically dependent on the sustainability of its many agri-food supply chains -- from the sustainability of the actors that grow or produce the food through the complex actor interactions that make the food available to the final consumer. In addition, many supply chain stages have been internationally integrated to form global food supply chains. Globalization, along with changing marketing techniques, consumption trends, and modern technology, has raised concerns regarding economic, social, and environmental sustainability. These concerns are pushing organizations to develop systems that ensure the control of the entire supply chain, guarantee quality and food safety, and track/trace practices and products (Gulati, Minot, Delgado, & Bora, 2007).

As food sector sustainability comes under increasing scrutiny, the management of supply chains as a potential differentiating competency has become a forefront issue for organizations all over the world (Fritz & Schiefer, 2008; Validi, Bhattacharya, & Byrne, 2014). There is wide consensus that coping with the challenge of a more sustainable food production and consumption system will require a holistic solution that comprises the whole supply chain.
In fact, the food sector was among the first to explore sustainability issues (Fritz & Schiefer, 2008) and is constantly looking for innovative supply chain solutions to decrease the impact on the natural environment and improve social and ethical dimensions. For example, the European Sustainable Production and Consumption policies are aimed at creating more sustainable food supply chains, protecting the environment, increasing the competitiveness of the European food sector, and contributing to economic and social welfare (European Commission, no date).

**Agri-food Supply Chain Characteristics**

Food supply chains have specific and challenging inventory and production characteristics compared to other types of supply chains (Akkerman & van Donk, 2007; Zavanella & Zanoni, 2009), including:

- Production processes characterized by frequent setup cycles that are highly dependent on timing, season, and sequence;
- Limited storage times due to expiration issues, but also because specific products require dedicated techniques; and
- Short processing times that require sophisticated tracing, monitoring, and quality systems to assure final consumers about quality, food safety, and authenticity.

Improper attention to these issues can affect human health if various hygiene, temperature, or production standards have not been respected. Regulations and regulatory enforcement can push the development of new procedures and managerial systems for the food chain (Zanoni & Zavanella, 2012).

Reflecting these characteristics, a food supply chain or food system comprises a set of processes and the economic, institutional, and political actors that determine how food reaches the final consumer starting from its cultivation or breeding (Saccomandi, 1999). It is made up of different actors and organizations operating in diverse markets and selling a variety of food products (Figure
According to the UK Department for Environment, Food, and Rural Affairs, a food supply chain consists of agricultural production, food processing, food wholesaling, food retailing and food catering (DEFRA, 2006). When we consider food sustainability, we need to add food consumption and waste at the consumer stage.

These actors can be classified in three main sectors: agriculture, food processing, and distribution. The agricultural sector engages in mainly crop production and livestock breeding activities. Organizations belonging to this sector sell their products to the food processing sector, to their own sector in the form of feed for animals, but also to distributors (exporters/wholesalers/retailers) and in some cases even directly to food catering, final consumers, or alternative markets (biofuels).

The food processing sector includes a highly diverse set of organizations and activities, such as cutting or drying (related to fruit and vegetables), slaughtering and disassembling (related to livestock), or roasting (related to coffee). In most cases, the final activity is packaging, after which products are delivered to customers, including distributors, food services/catering, or final consumers. This sector is also involved in marketing and new product development activities.

The distribution sector (wholesale/retail) is the primary channel through which food is sold to customers and consumers. A special case of food distribution is hotels, restaurants, and catering (Ho.Re.Ca), which buy either processed or non-processed food and delivers it to consumers after final, on-site, and on-demand processing. Since the distribution sector has direct contact with consumers, another important activity that can be carried out is the promotion of the food products (Bukeviciute et al., 2009).

These sectors can be configured in a variety of different ways. Several supply chain classifications have been proposed and here we adopt the classification proposed by Smith (2008).
It provides an effective framework for highlighting the different sustainability implications of food supply chains:

- **Local Food Supply Chains**: These are short-distance, small-scale supply chains, generally involving medium/small companies and traditional products. They are particularly suitable for fresh, highly perishable products that require a very short time from the field to the table.

- **Conserved Food Supply Chains**: Through a variety of conservation techniques (canning, pasteurization, freezing, chilling, controlled atmosphere, etc.), food can be stored for longer times and transported over long distances. They are generally operated on a large scale and involve large organizations. Today, “fresh” fruit and vegetables and dairy produce can be traded as “conserved food.”

- **Manufactured Food Supply Chains**: This involves processed food, often through large-scale, industrialized processes, utilizing a variety of ingredients derived from multiple sources, often scattered around the globe and pre-processed. Supply networks are typically complex and dynamic, often overlapped with those of competitors.

- **Commodity Food Supply Chains**: Simple conserved foods, including coffee, wheat, and cocoa, are defined by standard specifications worldwide, often bulked for low costs, easy transportation, and simple storage, traded on a global scale according to market prices, and shipped using sea freight.

*Sustainable Food Supply Chain Criteria*

To be considered sustainable, the UK Sustainable Development Commission (DEFRA, 2006) proposed a comprehensive set of supply chain features and characteristics:

- “Produce safe, healthy products in response to market demands and ensure that all consumers have access to nutritious food and to accurate information about food products.
o Support the viability and diversity of rural and urban economies and communities.

o Enable viable livelihoods to be made from sustainable land management, both through the market and through payments for public benefits.

o Respect and operate within the biological limits of natural resources (especially soil, water, and biodiversity).

o Achieve consistently high standards of environmental performance by reducing energy consumption, minimizing resource inputs and using renewable energy wherever possible.

o Ensure a safe and hygienic working environment and high social welfare and training for all employees involved in the food chain.

o Achieve consistently high standards of animal health and welfare.

o Sustain the resource available for growing food and supplying other public benefits over time, except where alternative land uses are essential to meet other needs of society.” (Smith, 2008: p. 850)

This framework focuses mainly on production and processing phases. With increased awareness that a food supply chain’s footprint and sustainability derives from the consumption phase, at least two other dimensions should be added to the framework.

o Encourage consumers to adopt healthier and more sustainable food behaviors through education on healthy diets, responsible consumption, and awareness of food’s impact on sustainability;

o Consciousness regarding food security by educating consumers to adopt more sustainable lifestyles concerning food consumption, reduction and disposal of food waste, food preparation (cooking), consumption, and recycling.
When these criteria are applied to Smith’s (2008) food supply chain classification, the possibilities and challenges for sustainability and sustainable oriented innovation become apparent.

- **Local Food Supply Chains** can be considered relatively sustainable. They support “mixed” and organic farming and reduce emissions thanks to short-distance transport. Local food supply chains sustain rural enterprises, regenerate rural communities, and break agribusiness monopolies. On the downside, they can struggle in achieving economic sustainability and can offer only a limited range of products.

- **Conserved Food Supply Chains** can be moderately sustainable because, historically, they have been important for reducing losses and degradation during transport from rural areas to urban populations, and allowing people to enjoy a nutritious and varied diet throughout the year. However, the economic benefits often disrupt local food supply chains by bringing high quantities of low cost food from far away, with additional negative impacts due to long-distance transportation.

- **Manufactured Food Supply Chains** are among the least sustainable. Mixing and substituting ingredients along complicated dynamic supply networks can limit traceability and the flow of information and influence along the chain. The complex industrial processes and the growing sophistication of products may hamper their healthiness and drive unhealthy consumption behaviors. They are economically attractive but environmentally and socially problematic – an area ripe for innovation.

- **Commodities Food Supply Chains** are extremely volatile. When production exceeds demand, prices tend to be low, making commodity-based foodstuffs widely available, but having catastrophic impact on the lives of farmers. This in turn may lead to lower investments and production in subsequent years, thus creating the opposite situation, with insufficient production and high prices, thus impacting food availability, in particular for poor people. This too is a system with innovation possibilities.
Sustainable Food Supply Chain Practices

The sustainable supply chain management literature highlights the differences between practices aimed at “harm reduction” and those oriented to “harm elimination” (Pagell & Shevchenko, 2014). In particular, the literature underlines that most current practices and studies focus on making unsustainable supply chain and business models less unsustainable, rather than on creating “truly sustainable supply chains.” Truly sustainable supply chains are economically viable and do not harm (and may actually aid) the natural and the social environment (Pagell & Wu, 2009). Studying what is different and what is new about sustainable supply chain management, and what completely new practices and business models are arising to create truly sustainable supply chains underlines the importance of studying different, new, unconventional cases alongside more traditional ones. That is one of the aims of the research cases presented in this volume.

To achieve the desired sustainability performance, a broad variety of practices have been identified and adopted by various actors involved in the food supply chain. Several authors have proposed possible practice classifications to help synthesize this complex domain (e.g., Maloni & Brown, 2006; Smith, 2008). However, such classifications are often incomplete or contradictory, and we therefore summarize and integrate a variety of proposals according to the well-known pillars of environmental, social, and economic sustainability.

Environmental sustainability practices attend to natural resources conservation, green processing, packaging, and transportation, and animal welfare. Natural resources conservation practices reduce the consumption of land, water, and energy, reduce emissions into the air, land, and water, and preserve the soil and biodiversity. Green processing, packaging, and transportation practices reduce the impact of industrial and logistic processes through reducing and recycling waste, reducing energy consumption, and using renewable energies; reducing packaging or using recycled, recyclable, or reusable packaging materials; and reducing fuel consumption and emissions during transportation. Animal welfare practices deal with the establishment of breeding conditions
that eliminate cruelty, handle and house animals safely, and slaughter and transport animals humanely.

Social sustainability in a food supply chain is approached through health and safety practices, health and human rights policies and procedures, and community development practices. **Health and safety** practices improve food product quality and safety for the consumer. It considers the controlled handling, processing, transportation, and traceability of food in the chain and the promotion of healthy life styles, consumer education, and responsible consumption. **Work and Human Rights** practices ensure safe and respectful working conditions along the whole supply chain and lead to higher levels of motivation and performance. **Community** development practices are aimed at improving the relationship with the community in which the supply chain operates. This can include economic development activities, educational practices, childcare, and employee volunteering as well as philanthropic investment and aid.

Economic sustainability is supported by sustainable procurement and fair trade practices. Downstream actors in the supply chain, such as industrial processors and large distributors, should adopt **sustainable procurement** practices in managing their supply base to ensure ethical purchasing processes (fairness, transparency, confidentiality, no power abuse), and to foster supplier development and collaboration. **Fair Trade** practices ensure a proper distribution of profits along the supply chain, monitor the economic sustainability of all the actors involved, and enable the pursuit of other pillars of sustainability. Practices aimed at monitoring and certifying the sustainability of the whole chain, as well as increasing consumer awareness, should also be adopted to obtain a premium price on the market.

**SUSTAINABILITY ORIENTED INNOVATION IN AGRI-FOOD SUPPLY CHAIN**

Despite the research and practice on how to build more sustainable food supply chains, the previous sections also suggest that current food supply chain configurations and practices are putting future development at risk. Innovation – the introduction of new processes, products, or organizational
methods to an existing system (OECD, 2005; Tornatzky, Eveland, & Fleischer, 1990; Utterback, 1996) – is required to enhance sustainable effectiveness (Hansen, Grosse-Dunker, & Reichwald, 2009; Horn & Brem, 2013; Schaltegger & Wagner, 2011). These innovations will range from developing new technologies and processes, to establishing goods and services in new ways, to discovering fundamentally new business models. Each of these approaches is important because they attempt to overcome the challenges of inherent trade-offs among sustainability dimensions. That is, gaining traction in environmental issues often threatens economic outcomes. Overall, the sustainability practices discussed above represent significant innovations compared to traditional supply chain management in the food sector.

In this section, we describe how sustainability oriented innovations (SOIs) differ from traditional innovation and how the diverse determinants of SOIs will require novel organizational approaches and capabilities.

**Characteristics of SOIs**

Sustainability-oriented innovation can be defined as the establishment of new products, processes, and/or management systems that have an overall positive net effect on the capital stock of the company, by addressing environmental, social, and economic goals (Hansen et al., 2009). Extant research suggests that innovations aimed at sustainable development differ from conventional innovation in four important ways (Hall & Vredenburg, 2003; Van Kleef & Roome, 2007).

First, SOIs are more likely to have multidimensional objectives (De Marchi, 2012) because they address product or process improvements along social, economic, and environmental dimensions (and the specific multiple aspects within them). Packaging innovations, for example, can save products from damage, lower environmental footprints, and reduce costs.

Second, SOI’s involve a higher level of complexity and uncertainty (Sarkis, Cordeiro, & Brust, 2010) because the outcomes from integrating or trading off the social, economic, and environmental dimensions are unknown. Shortening the supply chain can successfully increase
social and environmental benefits but may struggle to demonstrate economic sustainability.

Similarly, when the overall concept of sustainability is tackled, SOIs generally require innovation not just in a specific product, but rather a product-service system (Carrillo-Hermosilla, Del Rio, & Könnölä, 2010). The product-service system perspective stresses the relevance of the entire supply chain during the production, processing, consumption, and disposal of the product (Linton, Klassen, & Jayaraman, 2007), thus leading to increased complexity.

Third, SOIs are fundamentally riskier (Hall & Vredenburg, 2012) because they require adjustments in the configuration of the supply chain, its members, and the way practices and activities are managed. The more radical the product/process innovation in one part of the system, the more likely that interventions in the supply chain will meet with resistance from other supply chain members.

Finally, and also as a consequence of the above distinctive elements, SOIs generally require more collaborative and/or open system approaches (Chesbrough, 2010). To date, most open innovation research has addressed traditional types of innovation. There is less knowledge on the specific challenges of this approach when used for SOI. Because of its complexity, the diverse types of knowledge needed, and its risk uncertainty, especially in terms of market acceptance, SOIs require the involvement of a number of different actors, especially non-conventional ones, including customers, NGOs, and other stakeholders such as local communities (Foster & Green 2000; Hall and Vredenburg, 2003).

**Drivers and Motivations for SOIs**

Although SOIs are different from traditional innovations, their sources, determinants, and motivations are both similar and different. For example, the traditional innovation literature recognizes two main drivers of innovation: technology push and market pull (Martin, 1994). Technology push innovation is driven by internal investments in R&D that contribute to the evolution of a product or process through learning and scaling (Sahal, 1981). Technology push
innovation is recognised as an important driver of eco-innovation by reducing the environmental impact of production processes, their energy consumption, or polluting emissions (e.g., Horbach 2008). Technology push innovation also includes organizational routines or specific knowledge developed within the company that can be exploited by producing more sustainable products (Horbach, 2008).

Market pull innovation starts from the recognition of more or less explicit needs in the environment among customers or other traditional players in the market. Those demands result in efforts to develop new solutions, also at the level of technology. Customers and consumers are increasingly concerned with the environmental and social sustainability of the products they buy. For some product categories where sustainability can be seen as an added value, consumers might consider it as a product differentiation dimension (Kammerer, 2009). As a consequence, market pull forces generate a demand for products that are supplied, produced, and distributed in more sustainable ways.

The research and debate surrounding these two approaches is well documented (see e.g., Di Stefano, Gambardella, & Verona, 2012) and a full review is beyond the scope of this chapter. However, a clear conclusion of this debate is that while most innovations have a main driver, push or pull, the presence of both factors allows the development of technically advanced product and process solutions that address the explicit or tacit needs of the market. That is, successful innovation requires both internal and external resources.

More recently, three additional approaches to innovation have been proposed: design-driven innovation (Verganti, 2008; Verganti 2009), regulatory push/pull innovation (del Rio Gonzales, 2009; Rennings, 2000), and values-driven innovation (Hart, 1997; Walker, 2014). Design driven innovation is the opportunity to propose and attach new meanings to products, thus addressing latent needs descending from socio cultural changes. In this type of innovation, languages, semantics, and rhetoric are the key components of innovation and technology is an important enabler. Buying a product at Whole Foods has a completely different meaning compared to buying
food in an unattractive, niche, organic store where only highly environmentally conscious customers would shop (Verganti, 2009).

Regulatory push/pull innovation (del Rio Gonzalez, 2009; Rennings, 2000) is driven by the need to comply with existing regulations, changing regulations, or by the willingness to anticipate future regulations (Khanna, Deltas, & Harrington, 2009). Although this might be viewed as a variation on market pull innovation, it is different because it opens up the numbers and types of stakeholders involved. It suggests, given that sustainability involves understanding and meeting the needs and the demands of a number of different stakeholders (Carroll & Buchholtz, 2014; Steurer, Langer, Konrad, & Martinuzzi, 2005), that SOIs are driven by the more or less stringent requirements from external actors, from governmental bodies and local communities, from demanding customers or suppliers, or from NGOs and other non-governmental bodies. The company’s approach could be reactive to the stimuli coming from stakeholders or proactive by anticipating or even pushing needs and expectations.

Finally, there is an additional driver that plays an important role in many of the cases in this volume. Why would Italian pasta producer Barilla develop a new kind of pasta that cooks with much less water compared to the traditional one? Why would Unilever develop a tea bag that results in exactly the same flavour of its traditional product but without the need to boil water? Why would an entrepreneur decide to use prisoners as a main workforce for its production activities? There is no market need, no technological advance, and no change in meaning that can explain where these innovations sprung from. Nor are there any current regulatory or stakeholder requirements behind these innovations. Although one might argue that consumers are demanding more sustainable products that use less water or energy, or that firms are always looking for a cheaper source of labor, these would only be a partial answer. The cases in this volume point to yet another force: the conscience of a single individual or individuals (sometimes the owners or top managers within the organization) or the whole company about the role of the business in the society. This driver is
often been referred to as vision-pull (e.g., Day, 1998; Hart, 1997) or values-based (e.g., Walker, 2014).

Another recurring aspect in SOI innovation is that companies thinking about more sustainable ways of managing their food supply chains are increasingly looking to the past for inspiration. Retro-innovation designs new products, services, and processes by combining approaches from the past and present (Loucanova, Parobek, & Kalamarova, 2015; Stuiver 2006). Walburn noted that “…not all innovation needs to be about high tech to contribute to economic growth, and much innovation can be achieved by drawing on existing technologies, or re-visiting former ways of doing things” (cited in Loucanova et al., 2015, p. 3). Retro-innovation is instead based on valuing traditions, heritage, technologies, processes, recipes, and ingredients that were developed and have endured over time.

The way food products were sourced, produced, distributed, and consumed in the past were more sustainable. Supply chains were, in most cases, shorter and local. Produce was cultivated without the use of chemical, animals were bred naturally and without unhealthy living conditions, and farming systems did not deplete the soil. Everyone in the community participated in sustaining the society. Food consumption was more responsible and conscious, for one’s own health and with a balanced distribution of resources. Although production was likely less efficient, the countervailing social and ecological benefits produced an overall higher level of sustainability. Many of the innovations chronicled here harken back to these issues. They favor local production, shorter supply chains, and local community development.

This approach is considered appealing not only for its possible solution of a number of sustainability problems, but also because market acceptance is often higher than with breakthrough innovations. The methods of production, processing, and distribution are well-known, more transparent, more easily trusted, and require less investment (Loucanova et al., 2015). These are the antithesis of scale and leverage.
Retro-innovation does not simply borrow from the past while innovating, it contains elements of design-driven innovation that require finding ways to connect the past to the present in order to develop solutions for the future (Castellano, Ivanova, Adnane, Safraou, & Schiavone, 2013). It represents “yesterday’s tomorrows, today” (Brown, 1999). Traditional food producers, for example, value the historical origins of the products, their link with the local territory and traditions, the purity of the food, and recipes as key values and differentiators.

The Scale and Scope of SOIs

As a result of the characteristics described above, SOIs – to borrow two traditional innovation dimensions – are likely be more radical and systemic rather than incremental and focused in nature. SOIs that are radical and systemic can require the complete rethinking of the firm’s business model, and business model innovation is required to obtain such radical shifts in sustainability performance. Business model innovation, in the context of sustainability, refers to completely rethinking the way a business is run, abandoning the logics related to traditional economic models, such as scale and leverage. Bocken, Short, Rana, and Evans (2014) provide an overview of potential business models for sustainability. Some examples – that are particularly relevant for the food industry – include fair (or ethical) trade approaches, the creation of value from waste, bottom of the pyramid solutions, scaling up solutions through collaborative approaches or open innovation, as well as more general models of leveraging renewable resources, natural processes, or maximizing material and energy efficiency. Business model innovation can be a powerful way to obtain significant improvement in sustainability at both the firm level and the economic system level as a whole. Schaltegger, Lüdeke-Freund, and Hansen (2012) emphasize the importance of “creating economic success through (and not just along with) a certain environmental or social activity” (p. 98). They underline that proactive sustainability strategies often require the complete redesign of the business model to continuously create business cases for sustainability.
Such radical business model innovation can face relevant barriers, including conflicts between new and existing business models that create inertia to change; conflicts with the current asset configuration of the company; and uncertainty about the “right” business model, especially as a consequence of the multidimensional nature of sustainability and the difficulty in assessing it (Chesbrough, 2010). As suggested by the innovation literature (Christensen, 2013; Utterback, 1996) as well as the SOI research (e.g., Montabon, Pagell, & Wu, 2015), introducing new business models with a sustainability orientation may come more easily for new entrants in the market. Incumbents face a high level of risk in changing their traditional way of operating. However, new entrants often find it more difficult to scale up their innovation due to lack of resources and assets to diffuse innovation.

**The Capabilities Required to Implement SOIs**

The development and implementation of SOIs, the ability to incrementally or radically change an organization’s business model, will place new demands on an organization’s competencies, processes, and management (Carrillo-Hermosilla et al., 2010). In particular, the nature of SOIs will require organizations to implement many of the sustainable supply chain management practices described above, innovate their traditional supply chain tools, and be more able to engage in collaborative, multi-stakeholder problem solving and learning.

The ability to implement the new sustainable supply chain management practices or to innovate on traditional tools to improve sustainability will require organizations to acquire new skills and knowledge, develop new architectures, designs, processes, and systems, and learn to balance, integrate, or trade off a variety of outcomes. The new practices will require new competencies, such as chain-level analysis knowledge, a global orientation, and an awareness of the interactions among social, technical, and environmental factors, in addition to traditional logistics and operations management, contracting, and lean/continuous improvement skills. These skills will interact with new tools and frameworks to better understand how to replicate and reinforce
sustainable processes over time. Finally, implementing these new sustainable supply chain practices will require practice. Many of the practices defined above represent real innovations in an organization and cannot be simply dropped into place. They require learning, testing, and adjustment to make them fit an organization’s culture and strategy.

Perhaps most importantly, and because of the nature and characteristics of SOIs, a collaborative stakeholder integration capability may be key to successfully develop and implement these innovations (Sharma & Vredenburg, 1998; Van Kleef & Roome, 2007). However, although stakeholder diversity provides greater potential for learning and for developing innovative solutions to complex problems (Boons & Berends, 2001), there is also the risk that actors do not share common perspectives and are unfamiliar with one another. This can create more integration problems, and in the context of sustainability-oriented innovations, implies the need for and the importance of effective stakeholder integration capabilities (Worley, Feyerherm, & Knudsen, 2010). A stakeholder integration capability refers to the ability to establish trust-based, collaborative relationships with actors both inside and outside of the firm (Sharma & Vredenburg, 1998, p. 735).

In the apparel design, manufacturing, and retailing supply chain, Worley, Feyerherm, and Knudsen (2010) showed how a multi-stakeholder collaboration and problem-solving capability helps Gap, Inc. develop important innovations in their sustainability journey.

Involving multiple stakeholders offers important potential benefits (Sharma & Vredenburg, 1998). First, it facilitates the inclusion of missing knowledge or new insights about issues ranging from technological to sustainability-related inputs (Ayuso, Rodriguez, & Ricart, 2006; Hansen et al., 2009; Laperche & Picard, 2013). To the extent that information asymmetries or the lack of transparency exists in a supply chain, bringing the system actors together allows them to see potential unintended consequence more clearly. Second, stakeholder involvement can enhance the strategic orientations and consciousness of firms to sustainable development (Ayuso et al., 2006; Sharma & Henriques, 2005; Van Kleef & Roome, 2007), and better address stakeholder satisfaction, trust, or commitment (Grafé-Buckens & Hinton, 1998; Strong, Ringer, & Taylor,
2001). Third, a more systemic view can be a crucial instrument for directing stakeholder behaviors toward sustainability, especially when stakeholders are users (Jelsma, 2003; Lockton, Harrison, & Stanton, 2008) and/or suppliers (Carter & Rogers, 2008). For example, the EUInnovate project studied the role of stakeholder involvement, especially users, in developing SOIs oriented to more sustainable lifestyles. The project showed that in many cases the involvement of users was fundamental in promoting more sustainable behaviors (http://www.euinnovate.com/en/ourprojects).

KEY QUESTIONS AND CASE SUMMARIES
Improving the sustainability of current food supply chains or designing completely new supply chains that are truly sustainable is a complex challenge. There are different dimensions and different drivers at play, economic viability and fair profit level must be maintained, and different actors need to be coordinated. This volume hopes to provide some answers to the relevant questions about sustainability-oriented innovation in the food industry raised in this chapter. Those questions include:

- What types of innovation are needed to create truly sustainable food supply chains?
  - What motivates firms to pursue SOIs?
  - In what ways do successful SOIs utilize radical vs incremental approaches, narrow vs. broad stakeholder engagement, push/pull/design driven/regulatory push, or values-based processes?
  - Are SOIs more likely to target multiple dimensions of sustainability or narrow objectives?
- How and when do SOIs pay off?
  - What are the business case drivers for sustainability?
  - Can sustainability be “cheap” for the customer?
  - Does change in the business model always need to be “radical?”
Are the economic benefits of SOIs equally distributed along the supply chain?

- How can truly sustainable supply chains be scaled up or scaled down?
  - What alternatives exist to the scale & leverage paradigm?
- What learning/development mechanisms are needed?
  - What capabilities need to be present?
  - What is the role of external stakeholders?
  - What are the relative roles of standards and learning processes in helping companies develop sustainable supply chains?

The general questions discussed above will be addressed by describing and comparing ten different supply chain-related case studies in the agri-food industry. These cases are purposefully diverse in terms of industry, type of innovation performed, stage in the supply chain in which they operate, dimension of sustainability that has been targeted, and country where the initiative was developed.

We organized the cases according to the innovation’s primary focus as follows:

- Product innovation
- Upstream, Supplier management innovation
- Downstream, retail/distribution and catering innovation
- System-wide innovation (local and country level)
- Social innovation

The Alcass case and the TRADEIT case address product innovation. The Alcass case (Chapter 2) describes how different types of product innovation affects supply chain practices and configurations. Incremental product innovation within existing product lines required adjustments in the existing supply chain and improved an organization’s sustainability. These adjustments were aided by a narrow and often well-understood set of dynamic capabilities that allowed change to
occur without much disruption. More radical new product development efforts required new supply chain configurations and relied on a more complex and sophisticated set of dynamic capabilities. León-Bravo, Caniato, Moretto, and Cagliano suggest that increasing sustainability in the supply chain is dependent on the availability of these dynamic capabilities. Organizations that lack the ability to change may find productive product and supply chain innovation and sustainability more difficult.

Chapter 3 presents and discusses the development of a learning network among traditional food producers. The network was built through the support of an EU funded action learning project (TRADEIT). Coughlan, Coghlan, O’Leary, Rigg, and Barrett discuss how traditional food producers must be able to share knowledge to overcome the limits and difficulties of size, to preserve their sustainable way of producing, and to remain viable without being swept away by the large competitors. The use of action learning appeared to facilitate and foster knowledge exchange. As a formalized, externally funded approach, the key challenge that emerges from the case is the extent to which this learning network can be self-sustained and durable.

Two cases explore examples of supplier management innovation. The illy case (chapter 4) describes a program to reconstruct, develop, and sustain the coffee supply base in Brazil. Inefficiencies, price volatility, and quality issues had depleted the suppliers. The company deployed a long-term, systematic effort to build social capital into the local supply network and to improve both quality and sustainability by offering premium prices and knowledge sharing. Longoni and Luzzini suggest that supply chain relationships are a crucial asset for the buying company, the local supply base, and the community at large. The advantages of a relational governance process in the context of a global commodity food supply chain is a key contribution of this case.

Formentini, Sodhi, and Tang use the Barilla case (chapter 5) to show how innovative supply contracts were used with durum wheat suppliers in Northern Italy to pursue sustainability objectives. The company wanted to reconstruct, develop, and sustain a local supply base of high quality, durum wheat so that a secure supply, stable prices, and reduced transportation costs could
be achieved. Local, small-scale growers were offered economic incentives and knowledge sharing opportunities to create the conditions for local community development and to improve environmental performance through traditional cultures and sustainable growing practices. This case demonstrates how traditional supply contracts can be used in innovative ways to pursue triple bottom line objectives simultaneously.

A trio of downstream innovation cases are presented next. The Google case (chapter 6) shows how the company used its food program – one that provides food to all its associates – to develop a range of initiatives to minimize food waste. Pullman and Rainey describe initiatives that included systematically measuring food waste, providing feedback and fostering more conscious behaviors in the workforce, and working with suppliers and employees to use normally wasted food to co-create innovative food products. The case builds upon stakeholder influence, new product development through co-creation and pro-environmental behavior theories and models to discuss how food waste can be minimized along the supply chain (involving producers, processors, catering and consumption), thus improving the overall sustainability.

The Buon Fine program at Coop Lombardia is the subject of Chapter 7. Sert, Garrone, Melacini, and Perego describe the development, step-by-step, of a surplus food redistribution process to reduce food waste. Contrasting the benefits of this process to traditional food banks provides an important addition to the tools available to fight the paradox of food insecurity. The simplicity of the process keeps retailer costs low, the socially oriented mission of the cooperative form of organization, and the proactive involvement of the government make for a compelling example of sustainability within reach.

Singh, Shani, Femal and Deif provide one of the truly unique chapters in this volume (Chapter 8) by presenting data on the economic costs and social benefits of re-usable plastic containers (RPCs) in the food supply chain. Their data suggest that improvements in productivity and food waste/security are greatly aided by this packaging innovation and raise the provocative question: When do fossil fuel based tools provide a more sustainable solution than tools based on renewable
resources? In contrast to recyclable cardboard packaging, the RPCs sheer durability may more than offset the energy required to produce and recycle them, and their clear contribution to reducing food waste is compelling.

The Origin Green and Northeast Ohio Food Network cases describe processes of system-wide innovation. The Origin Green case (Chapter 9) presents a unique nation-wide effort to brand agri-food products from Ireland as sustainable. Shelman, McLoughlin, and Pagell describe the effort of Bord Bia, the national food board, to use the Irish agri-food industry as a key resource to improve national exports and contribute to the country’s economic recovery. The topo-down program of extensive certification based on standards and declared improvement goals involved a vast majority of farms, food processing companies, and retailers. A group of ambassadors, with a specific training in sustainable management, was used to advocate the quality of Irish produce in the most important food multinational companies. Overall, the program’s success was a function of the extremely high percentage of companies involved and to the increase in the national exports. The case thus shows the value and importance of associating a brand to the effort of supply chain risk mitigation through sustainable innovation.

In the Local Foods Network in Northeast Ohio case (chapter 10), Mohrman, Parker, Palacpac, and Wilk utilize complex adaptive systems theory to explain the emergence of a network of small food producers, entrepreneurs, government initiatives, institutions, retailers, and consumers. Aimed at supporting the economic revitalization of the region through a sustainability focus, the case describes the robust development of social and environmental programs within a fragile economic framework. The viability of the system – whether it can achieve economic sustainability alongside the impressive social and environmental gains – raises the challenging question about the role of values in design.

The cases conclude with a chapter on social innovation. In an innovative case of social inclusion, entrepreneurship, and sustainability, Mapelli, Arena, and Strano (Chapter 11) use a model of network development as a lens to explore the growth of Semi di Libertà, an artisanal beer
brewing operation staffed by prisoners, guided by master brewers, and involving disadvantaged
groups. Four drivers of innovation and resistance – institutional, organizational, market, and
informal norms – are shown to operate formally and informally, intentionally and unintentionally on
this entrepreneurial effort to reduce recidivism and increase social inclusion. How to scale up the
benefits of this small scale operation presents interesting implications.
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Fig. 1. Components and Relationships in the Agri-Food Supply Chain