GALGOTIAS UNIVERSITY

A conceptual Project Report on

"sustainable food supply chain management"

School of Logistics and Aviation Management

Bachelor in Business Administration
(Logistics & Supply chain Management)

By

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Certificate of Approval0

The following Conceptual Project Report title **(Sustainable food supply chain management)** is here by approved as a certified study in Supply Chain Management carried out and presented by **RITIKA** in a manner satisfactory to warrant its acceptance as a prerequisite for the award of Bachelor of Business Administration in Logistics & Supply chain Management for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein but approve the Conceptual Project Report only for the purpose it is submitted to the Conceptual Project Report Examination Committee of the Galgotias University for evaluation of Conceptual Project.

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Table of Contents

6	Challenges & Future Research opportunities	
6.1	Consumer Preferences	Global Sustainable Food Chain
6.2	Sustainable regional food supply chain considering food hubs	Temperature Controlled sustainable distributions
6.3	Sustainability and the global food supply chain	Sustainable in the food supply chain
6.4	Best Embracing change for a sustainable food supply chain	Common Actions towards Sustainable Agriculture
6.5	On the Farm	On the Fork
7	Evaluation of SFSC research	

8	References

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Abstract

The National Food Security Bill 2013 which was passed by way of an Ordinance in the parliament is no small feat undertaken by the Government of India. This bill promises subsidized food grains to nearly 68% of India's 1.2 Billion

populations at a cost of nearly USD 4 Billion. The bill aims to provide quality food grains and nutritional security, to under privileged children, women and poorer sections of the society, at affordable prices. Indeed a very noble and ambitious plan but lots of supply chain issues will have to be addressed on a war footing by the government. The need to improve food quality and reduce food waste leads to increased attention for the development of Food Supply Chain Management, which considers natural characteristics of food supply chains besides traditional supply chain management objectives such as cost and responsiveness. Growing consciousness of society towards sustainable development brings additional objectives to the food supply chains and the fast evolution of sustainable development results in the development of a new fast-growing concept: Sustainability in Food Supply Chain Management. In response to these developments, researchers have developed various decision support tools that can be used for handling progressively increasing complexity along the alteration process from supply chain management to food supply chain management and now to sustainable food supply chain management. This study, reviewed literature on food supply chain management to identify supply chain key issues and relevant quantitative modelling challenges. The reviewed papers show that obtaining sustainability together with considering natural characteristics of food supply chains, there is a gap between the needs of the practice and the current available methods.

Introduction

Sustainable production and distribution is a pertinent and timely issue in production economics. This is particularly critical for the food industry, which is still the largest manufacturing sector in many developed and developing countries. Although food production and

distribution systems have become more ef cient in many aspects, the industry consumes large amounts of natural resources and faces ever increasing demands. Sustainable food supply has been constantly a global challenge in the industry. It is estimated that 175 million people in India and 130 million in China are being “fed with grain by over-pumping ” of water. 24% of families now have foodless days in India .In the mean time, food waste has been a signi cant challenge to sustainable food supply. It is estimated the “approximately one third of the global food production is wasted or lost annually . While the food industry still battles with food security, waste, farming, and public health, new challenges have emerged such as climate change, oil dependency, fair trade and localism. There is a growing concern about social and environmental sustainability of the food industry. Basic questions that had once receded from everyday life are becoming more crucial to debate –whether food can be supplied, distributed and consumed in a more sustainable way without compromising costs; how should standards be set and technologies be used to improve sustainable development, minimise food waste and reduce operating costs together; what will be the impacts of standards and technologies on the way food supply chains are operating? It is essential for stakeholders in the food industry to look beyond their organisational boundaries to develop a sustainable food supply chain involving environmental, regulatory, scienti c, market, technology, and social-economic factors. The main purpose of this special issue “Sustainable Food Supply Chain Management” (SFSCM) is to re ect recent developments made in this respect and to examine research issues concerned with analysis and decision support at strategic, operational and technical levels. In this editorial article, key issues and research challenges in sustainable food supply chain management are reviewed in sections two. Contributions presented in the papers in this special issue are discussed in detail followed by concluding remarks. Types of food products

Type of food product is categorised dependent on animal-based food products such as meat, milk, eggs, sausages and cheese, and plant-based food products such as vegetables, fruits, grains, meals, sauces and wine. Among the papers we considered, there are 15 that consider animal-based food products and 26

that are related to plant-based food products. A majority of the papers on animal-based food products deal with social issues while most papers on plant-based food products focus on environment-related issues. The main difference is that the production and supply of animal-based food products usually involve more social issues such as animal welfare and food safety risks, while those of plant-based food products incur more potential environmental problems such as ecological issues, synthetic fertilizers, as well as emission. These two streams of food supply chain face problems that have their unique characteristics, and consequently researchers need to consider these details when choosing applicable models. Research problems that involve both animal- and plant-based products generate further complications and create challenges in finding solutions.

Uncertainty

A majority of the reviewed papers focus on deterministic issues of SFSC although uncertainty is a key feature of SFSC. Only four papers consider uncertainty issues, however, none of them deal with social- or environmental sustainability related uncertainty issues. For example, Schütz, Stougie, and Tomasgard (2008) study slaughterhouse location problem considering the legal restrictions on more than 8 hours of transport for animal welfare. Although uncertainty is considered in their work, the uncertain components include only demand and cost while disregarding any sustainability issues. Animal welfare is modelled as a deterministic constraint. The sustainable uncertainty of SFSC involves the two sides of demand and supply. On the supply side, the sustainable uncertainty comes from the risk of adverse weather conditions, diseases of livestock or crops and pests, among others (Borodin et al. 2016). On the demand side, sustainable uncertainty comes from the variety of consumers' preferences for sustainable attributes and their willingness to pay for such attributes. For instance, there exist huge differences in consumer's preference for organic and fair trade attributes which may affect food production and even the entire FSC. In addition, food safety risks along the entire supply chain bring great uncertainty challenges for managerial decision-making. Therefore, knowledge on how to model the food safety risk and recover the supply chain is of paramount importance.

Challenges & future research opportunities

In this section, we present potential future research opportunities based on the above analysis. A vast number of studies address modelling sustainable issues for general supply chain, however, there still exists a great need to thoroughly consider SFSC (Seuring 2013; Brandenburg et al. 2014). The specific sustainable dimensions of FSC

are very different from those of a general supply chain, and many new issues related to the characteristics of FSC are yet to be addressed. We considered emerging trends and their sources with respect to major perspectives of the sustainable food supply chain. Overall, from the perspective of sustainability, it is urgent to develop further models that are able to integrate economic, environmental and social issues, with specific attention given to consumer preferences, global sustainable food supply chain, sustainable regional food supply chain considering food hubs, and temperature-controlled sustainable storage, transportation and distribution. Non-profit supply chain to alleviate food insecurity, farmers'welfare, animal welfare and highly integrated traceability-drivenfood supply chain belong to the social aspect. We then discuss novel modelling approaches & solution methods, applications in developing countries, digital technologies & data analytics, as well as sustainable risk management in SFSC.

Consumer preferences

Consumer preferences for sustainable food consumption is an important topic in food supply chain. While there are some empirical studies to this regard, we are not aware of any published FSC modelling studies that consider consumer preference for sustainable food consumption. With the increase in awareness on sustainability, consumers consider more sustainable issues (e.g. low energy consumption, low emission, fair trade) while making their food choices, and are willing to pay different prices for different sustainable levels of food. Almost all existing modelling studies on food supply chain consider consumer demand as a monolithic concept with no regard for differences in consumer preferences towards sustainable food consumption.

However, consumer's preferences towards sustainable food are closely related to food demand as witnessed through their willingness to pay and will affect other decisions throughout the entire FSC. Examples of these include farmers' production methods (organic or traditional), distributors' transportation decisions (low vs. high energy consumption/emission), and manufacturers' global supply chain network decision (e.g. purchasing coffee from developing countries considering fair trade). Therefore, incorporating consumers' sustainable preferences as well as their willingness to pay into the modelling of FSC is a promising research direction.

Global sustainable food supply chain

The unprecedented and widespread expansion of food supply chains farther into far-flung and international locations as a result of globalisation has resulted in increased complexity of sustainability problems. From an environmental perspective, water resource use and emissions (e.g. N, P, C) generated by agricultural production (e.g.

water, N, P, C) and global logistics (e.g. emission from shipping liners) are closely tied to food distribution along the global supply chain. From a social perspective, fair trade initiatives that link small producers (e.g. coffee farmers) in developing countries with socially conscious consumers in the developed countries has grown rapidly during the past decade. For example, the fair trade sector involved over 1.2 million farmers and workers in more than sixty countries with about 60 per cent of sales related to food products such as coffee, cocoa, wine, sugar, fresh fruit and chocolate (Raynolds 2000; Ladhari and Tchetgna 2015). Therefore, designing and modelling globally sustainable food supply chain by integrating features of food (e.g. perishability, the consumption of natural resources, emission pollution) and the above sustainable (social) issues into global supply chain models is an important research topic.

Sustainable regional (local) food supply chain considering food hubs

With a key role in regional food supply chains, food hubs are increasingly seen as vectors for economic growth and environmental and social change by diverse stakeholders due to consumers' growing demand for local/regional foods (Hardyet al. 2016). Food hubs embedded in regional food supply systems include several sustainable characteristics such as the provision of increased retail market access to outputs from small- and medium-sized farms, vested interest to improve human health since most farmers and customers are regional and are located within a 400 mile radius, close association with food donation to food banks, and the development of initiatives to ensure fair returns to farmers (Fischer et al. 2013; Hardy etal. 2016). Regional food supply systems with food hubs have received well-deserved attention from practitioners as well as policy makers. One such is USDA's regional 'food hub' services to develop regional and local food system together with farmers, wholesalers, and retailers (Etemadnia et al. 2015). However, such interest from practitioners and policy-makers has not yet successfully transitioned into academia where there are very few studies that focus on regional food supply chain, especially from the perspectives of sustainability and modelling. Interesting unanswered research questions can potentially be found in modelling sustainable regional food supply chain with food hubs.

Temperature-controlled sustainable distribution

Although a few studies consider the relationship between temperature and food safety/quality, there is a lack of studies that integrate further energy consumption, emission, and safety/quality into general food supply chain optimisation models. For example, detailed studies are needed on how to balance the goal of energy consumption, which is a foundation to guaranteefood safety/quality, by controlling the temperature, emission, as well as cost during storage, transportation and distribution of food product.

Sustainability and the global food supply chain

To understand the challenges farmers face, it's important to understand the entire food supply chain and the demands of the consumer.Before it gets to the supermarket shelves, our food passes through an extensive network of retailers, processors and producers who are responsible for transforming agricultural raw materials into safe and nutritious food that we want to eat . This network is called the food supply chain

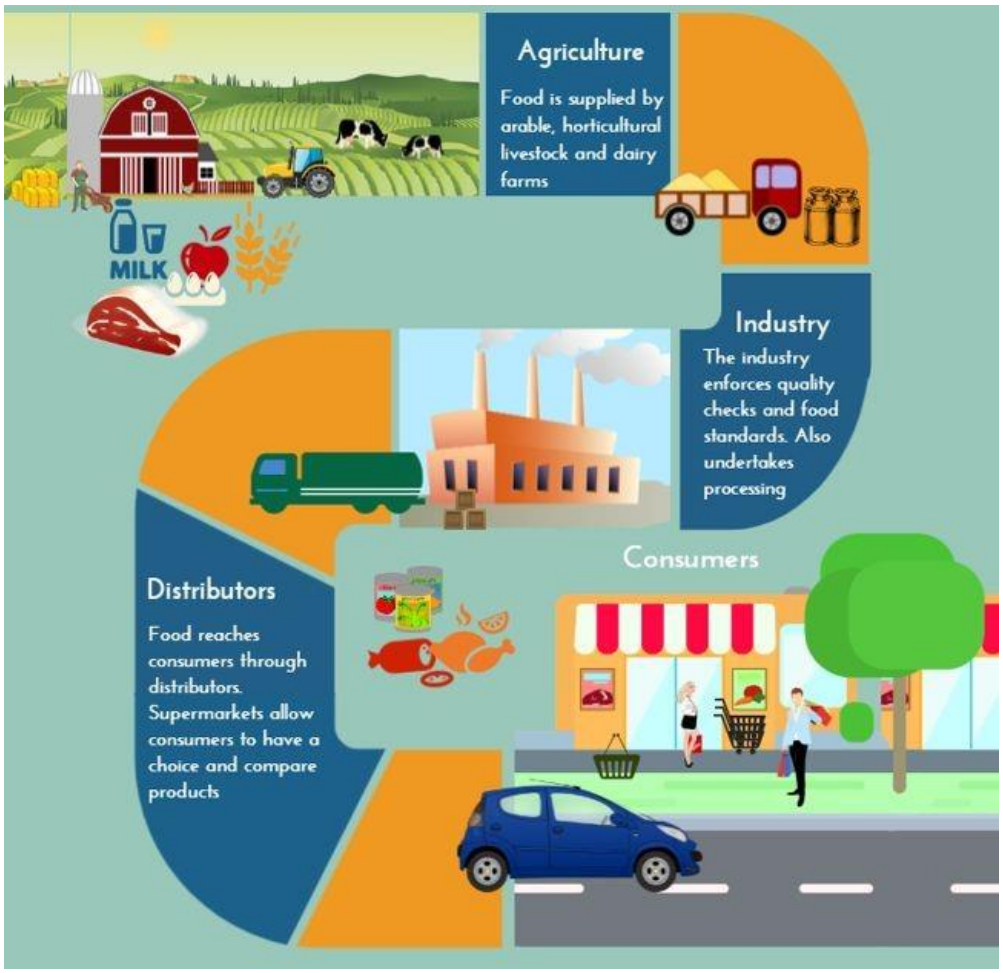


Figure 1: A conventional food supply chain

The three main stages of the supply chain are:

1. Primary production (farming)
2. Processing and manufacturing of the final product
3. Distribution

Even those products that are minimally processed, such as fresh fruit and vegetables, are nonetheless graded and packaged to meet the consumers' need for acceptable, visually-appealing food with a reasonable shelf life.

Researchers and policy makers are now focussing their attention on how to optimise each of these stages, as food waste (which you will look at in more detail later in the course) has become such a significant issue. As food travels through every stage of the supply chain it uses up natural resources (eg labour, water, energy, fuel), so each transaction requires those involved to set a price that ensures the final product is affordable for the consumer

Sustainability in the Food Supply Chain

Growers, transportation and logistics providers, and increasingly consumers, too, are making the connection between sustainable practices and how they shape a viable food supply chain for the future.

(figure3)Sustainability in the Food Supply Chain

Sustainability and protecting the environment have, of course, been in the news for a while. Driven primarily by consumers who want healthier food that doesn't damage their surroundings, sustainability is having a profound effect on the global food supply chain.

Embracing change for a sustainable food supply chain

Mechanisation and industrialisation of agriculture enabled fewer farmers to produce more food, and government policies subsidised the investment this needed to ensure consumers could still afford to buy it. However, longer supply chains resulted in declining understanding of agricultural processes, the challenges faced by farmers and the impact of our choices on the environment. Short food supply chains are one example of the potential for food to act as a driver of change [8]. Supply chains of the future need to produce healthy and nutritious food that has been grown in an environmentally friendly and ethical way, while also dealing with the significant challenges of a growing population, climate change and declining natural resources. Consumers in turn have become more health- and environment-conscious and increasingly demand more locally produced, less processed food of known origin. This is leading to a 'circular economy' where the feedback between supplier and consumer is continuous, resource consumption and waste are minimised, and the supply chain is no longer one-directional [10]. Changes in supply chain systems are bringing more transparency to the food production process, ensuring functional regulatory systems, eliminating heavy administrative burdens and costly compliance procedures, improving farmers' income and minimizing environmental impacts (Figure 2).

Food supply chains need to become smart, sustainable and inclusive and they need to support sustainable local agricultural and food production through direct interaction between producers, businesses and consumers, creating more resilient communities.

Figure 2: The changing landscape of the circular economy

Common actions towards sustainable agriculture

1. Environment

The integration of developing countries into international chains may form an extra burden on the environment in these countries, due to deforestation, increase of mono-cultivation and the increase of pesticides and chemicals usage.

Environmental sustainable development can be achieved by supply chain collaboration by companies, for example by recycling waste and packaging materials throughout the chain from consumer to farm, and the introduction of sustainable food production systems, such as reducing energy consumption, minimizing resource inputs and using renewable energy wherever possible.

2. Climate change and water scarcity

Agriculture is one of the leading causes of climate change, but it is also undeniably affected by it. Farming must change in order to keep up with global demands while reducing its environmental impact. It is estimated the impacts of climate change will be severe, causing yields to decline, and putting food availability at risk.

Many farmers are incentivized to use innovative ways of reducing greenhouse emissions and adapting to climate change. For example, farmers are encouraged to use new varieties of crops that can use less water and can be more resistant to sudden changes.

Climate change is bringing stronger dry seasons, with the decreased flow in rivers that affects agricultural productivity and food safety. Farmers are increasingly encouraged to create water reservoirs and integrate irrigation practices. Sustainable irrigation practices can increase yields per acre by more than 20%.

3. Economic viability and shared value

This refers to equitable distribution of value, or in other words, that each member of the supply chain has to be able to make a living. Increasing markets for small farmers and integrating them into valuable supply chains, such as international markets, can contribute to their economic growth and ultimately their wellbeing.

Many international food companies are integrating a fixed minimum number of small farmers in developing countries as recurrent suppliers. It is also encouraged to have transparency around price participation of all supply chain stakeholders and to understand the economic benefits that their participation brings to the supply chain. Additionally, some food companies support aggregation and storing of small volumes of produce from widely dispersed smallholder producers, by facilitating access to cold storage with supply agreements, as a way to reduce food loss and transport costs, ultimately increasing farmers' profits.

4. Social responsibility

This dimension aims that all value chain players and particularly farmers, receive fair returns and work under good labour conditions all along the supply chain, with access to education, training and health services for workers and their families. Investing in social wellbeing can ensure the continued participation of the community in the supply chain.

Some examples of corporate support are the training of farmers for compliance with international certifications, and the introduction of primary processing and value-addition, which in both cases can facilitate increased incomes for farmers and the generation of new jobs in rural communities.

On the Farm

Farmers are using a number of methods, including water conservation, renewable energy sources, more efficient use of non-renewable sources and the newest, though still a bit controversial, trend—vertical farming.

Transportation and Distribution

Transportation is a key element in any supply chain, of course, but it takes on added importance in the food and beverage industry, especially with products that must be refrigerated. Ginsberg's Foods, an independent food distributorship in Hudson, New York, can serve as a microcosm for how an efficient transportation management system (TMS) cannot only greatly reduce its carbon footprint, reduce emissions and more, but also improve the bottom line.

Family owned since beginning as a local grocery store in 1909, Ginsberg's has 35 trucks that cover more than 30,000 miles per week in six northeaster states. Like most food distributors, Ginsberg's Foods has used traditional fixed route dispatch and routing practices, delivering loads to the same customers the same day each week. The system was complicated because many customers don't have standing orders, and many of them require the distributor to adhere to a four-hour delivery window.

In 2015, the company decided that a dynamic routing system that would account for orders and delivery windows, while being fully integrated with onboard communications technology, was necessary to manage and monitor deliveries by account on a real-time basis.

After a review, Ginsberg's selected TMW Systems, a Cleveland-based transportation software provider to commercial and private fleets, brokerage and 3PLs. TMW, a Trimble Company, serves more than 2,000 customers, including many of the largest, most sophisticated and complex transportation service companies in North America.

Ginsberg's replaced its legacy routing application with TMW's Appian DirectRoute software to simplify fixed-route creation and management, and its DRTrack Operations solution to automate daily routing and enable mobile communication with drivers of each of the company's 51 trucks. The also implemented PeopleNet Solutions, TMW's sister company, for onboard technology, including real-time diagnostics and performance monitoring. The integrated solutions allow Ginsberg's sales team to monitor delivery performance by account on a real-time basis to enhance customer communication and satisfaction.

"The Appian solutions are much more user-friendly than our [legacy] software, and offer significantly greater visibility and control for our dispatcher," says Larry Bigando, transportation manager, Ginsberg's Foods. "We [are] able to compare various routing options and their corresponding costs, so we can make better, faster decisions that benefit our customers and our bottom line."

The rollout was done in three phases. Phase one included the implementation of routing and dispatch software. Phase two involved upgrading the onboard systems with PeopleNet technology. Finally, in phase three, Ginsberg's integrated handheld computers for point of delivery scanning. The process began in November 2016 and was fully operational on March 1, 2017.

The results were almost immediate, Bigando says. Comparing March 2017 to March of the previous year, delivery stops were up 5 percent, cases per route up 2 percent, stops per route up 6 percent, routes per day down 4 percent and miles driven down 6.7 percent.

The distributor is on track to save more than $571,000 annually, and recover its technology investment by the end of the first year of operation.

Technology is playing a large role to route trucks. It enables multi-load LTLs (less than truckload) and pool distribution. People are able to combine orders and make deliveries earlier, adds Foremost Quality's Feemster.

Warehouses and DCs

The energy it takes to heat, cool and light a large food warehouse or distribution center is enormous—even more for cold and frozen storage than dry goods.

“Being able to minimize energy in cold storage is a big deal,” says Feemster. “If they can do that, it’s a huge advantage in cost and pricing. And it’s good for the environment. Inside cold storage is going to LED lighting. It’s energy efficient and doesn’t generate heat. In the old environment, there was no choice—they had to have light. There also are motion sensors, so areas that aren’t in use won’t be wasting energy on lighting.” On the dry side, many companies also are going to LED lighting or T5 or T8 fluorescent bulbs, which come with one-third lower energy costs, he adds.

Yusen Logistics, a New Jersey-based 3PL, has completed an LED retrofit that will reduce electricity usage and expense by more than 60 percent at one of its Carson, California, warehouses. The company replaced 966 outdated fixtures with LEDs at the 486,000 square foot facility. The change is expected to reduce energy use on average by one million kilowatt hours (kWh), and decrease power consumption by as much as 65 percent over the previous year.

Atlanta-based Americold Logistics is a temperature controlled warehousing and transportation company specializing in the storage of perishable goods. Energy consumption is a vital part of what they do, says Daniel Cooke, director of marketing.

“We’re always looking at the most appropriate, most socially responsible practices to implement that still ensure that we can offer the temperature-controlled services our

customers need. We install motion-sensing LEDs in tacitly upgrades and new build plans, and we include fast-closing doors to keep air temperatures more constant.”

Forty-five Americold sites have been fitted with activated LED lighting systems that illuminate as-needed and switch off automatically when personnel leave. That saves

more than 14 million kWh per year. Forty-two of the company's sites have completed Cascade Energy system tune-ups to assess and fine-tune refrigeration system operations.

"We take part in every demand response program offered in the United States," Cooke explains. "When utility companies are expecting heavy power draws, they will reach out and ask us to reduce our own power draw. Our facilities are so well insulated that we're able to reduce our power need for a facility for a period of time without affecting conditions in our cold rooms. This means that utility companies may not need to fire up additional power stations, many of which are coal-burning, and so we reduce overall power generation needs."

With its sustainability initiatives, including solar power generation at a Massachusetts facility (generating up to 500,000kWh of clean energy yearly) and a turbine generator in Salinas, California, that generates up to 600,000 kWh of clean energy each year from a natural gas fuel cell. Cooke says Americold has saved 320 million kWh since 2010. That translates into 264 million pounds of CO_2 equivalents that were not released into the atmosphere.

Finding sufficient warehouse space also is a concern. Too big? Too small? Too far from customers? The latest solution is called FLEXE, an online marketplace for on-demand warehousing solutions. The platform connects shippers who need warehouse space and services with warehouse providers that have excess capacity and resources. FLEXE currently has more than 500 warehouse partners in North America. The system is designed to help with inventory overflow and fulfillment needs.

Adds Feemster, "You've got some more local 3PLs willing to do multi-client facilities. Technology and WMS allows multi-tenant inventory management. Small- and medium-size companies in the grocery 3PL space will combine multiple orders to a single distribution, maybe ship three or four [brands] to the Kroger warehouse at once."

Moving around the warehouse, forklifts also are playing their part in going green. Hydrogen fuel cells, which don't generate heat are more efficient than the former systems. They can stand cold air in a freezer or refrigerated unit, and they're easily and quickly refilled.

On the Fork

The Food Policy Research Center says that about 40 percent of the United States food supply is never eaten, among the highest rates of food loss globally. At 1,500 food calories lost per person per day, that is double most other industrialized nations and 50 percent more than was lost in the 1970s.

“Producing food uses resources and causes environmental impacts, such as water pollution, soil erosion and greenhouse gas emissions,” the FPRC report says. “Discarding food drains the food supply in a world with a growing demand.”

According to the Grace Communications Foundation, only 3 percent of food is composted in the United States. As a result, uneaten food is the single biggest component of municipal solid waste. In landfills, food gradually breaks down to form methane, a greenhouse gas that's at least 25 times more powerful than carbon dioxide. (Grace develops strategies to increase public awareness of the critical environmental and public health issues created by the current industrial food system and to advocate for more sustainable alternatives.)

Consumer food waste also has serious implications for energy usage. A study by the consulting group McKinsey found that, on average, household food losses are responsible for eight times the energy waste of farm-level food losses due to the energy used along the food supply chain and in preparation. In addition, food production releases hundreds of millions of pounds of pesticides into the environment each year and is the leading cause of fresh water pollution.

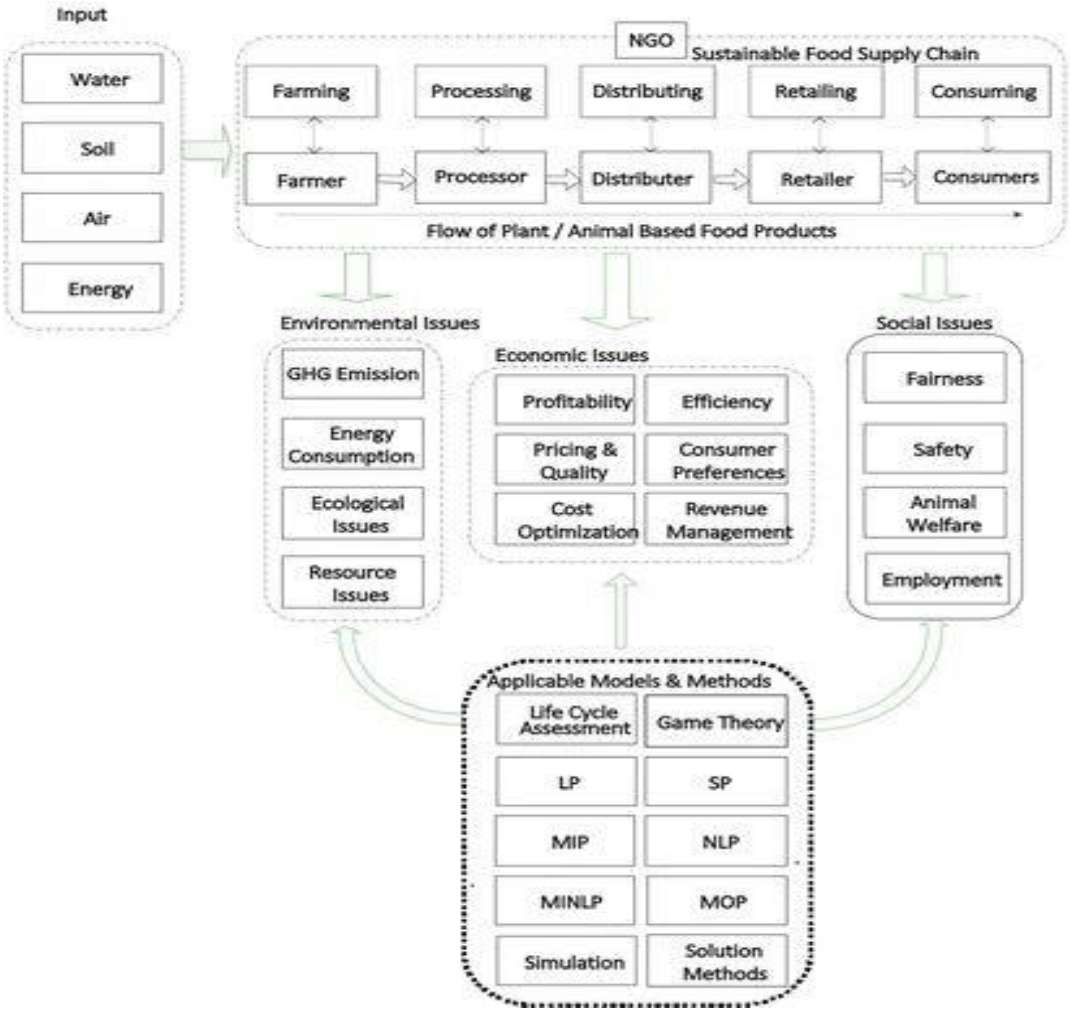
Evaluation of SFSC research

As in Figure 4, a sustainable food supply chain involves different segments that collaborate to provide end consumers with plant-based and/or animal-based products comprising agricultural production, food processing, distributing, retailing, consuming, etc., that correspond to actors such as farmers, processors, food distributors, retailers and consumers. While each actor in the sustainable food supply chain uses natural resources that include water, soil, air and energy as input, the ideal goal is to create a reverse food supply chain with a feedback loop throughout the process. Through its production and consumption activities, SFSC generates major environmental, social and economic issues (Ahumada and Villalobos 2009; Brandenburg et al. 2014; Soto-Silva et al. 2016) , as listed in Table 2. To solve optimisation problems that are associated with sustainability, including economic, environmental and social parameters, modelling approaches and solution methods are often used to draw insights and to reach conclusions.

The main social issues of SFSC include food safety, animal welfare, fairness and employment/training, as in Table 4 , which are very different from those of general supply chain (Brandenburg et al. 201 4) . The economic issues are often linked with the environmental and social issues, including profitability, efficiency, pricing on quality, consumer preferences, cost optimisation and revenue management. Existing studies that aim to solve these three major issues very often utilise quantitative models, including life cycle assessment (LCA), game theory, linear programming (LP), stochastic programming (SP), mixed integer programming

(MIP), non-linear programming (NLP), mixed integer non-linear programming model (MINLP), multi-objective programming (MOP), simulation, and corresponding solution methods. Moreover, SFSC is very context-based due to the variability of food system in different countries.

Therefore, we evaluate existing SFSC research in more detail based on the following dimensions: sustainability, SC actors, modelling approaches and solution methods, the application in different countries, and types of food products.



(figure4)

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THANK YOU