Food Waste Reduction in Supply Chains Through Innovations
What Factors Affect the Decision to Adopt Innovations

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Abstract

Purpose – Agri-food supply chains are facing a number of challenges, which cause inefficiencies resulting in the waste of natural and economic resources, and in negative environmental and social impacts. To deal with such inefficiencies, food supply chain actors search for economically viable innovations to prevent and reduce food waste. This paper analyses the factors that affect the decision of supply chain operators to adopt innovations to reduce food waste.

Design/methodology/approach – The analysis has been carried out using a four step approach that included: 1) a systematic literature review to identify economic factors affecting the decision to adopt these innovations; 2) an inventory of food waste drivers and reduction possibilities along food supply chains through innovations; 3) a mapping of the results of step 1 and 2; 4) deriving conclusions regarding the factors affecting the adoption of a specific innovation to reduce and prevent food waste.

Practical implications – This study analyses the drivers of food waste generation together with the factors affecting the decision to adopt innovations to reduce food waste, and provides solutions to supply chain operators to prevent and reduce food waste through different types of innovations.

Originality/value – Literature did not addressed systematically innovation aiming at the reduction of food waste yet. This paper provides a novel view on the problem of food waste reduction by means of innovation, by linking factors affecting the decision to innovate with food waste drivers.

Keywords – supply chain, food waste, technological and organizational innovation

Introduction

Supply chain inefficiency contributes significantly to the 1.3 billion tons of food waste generated each year globally. In the EU-28, annual food waste amounts to 180 kilograms per person, which is 25% of the food purchased by households (Canali et al., 2017; Gusavsson et al., 2011). In China, $32 billion worth of food is thrown away every year, as food scraps comprise 70 percent of all waste nationwide, while 128 million Chinese live below the poverty line, and often lack sufficient food (Zhou, 2013). In US 40 % of food goes uneaten, which is equivalent to $165 billion each year (Gunders, 2012). According to recent literature
on the topic of food waste (del Río Gonzalez 2005; Gusavsson et al., 2011; Aramyan and Valeeva, 2016; Canali et al., 2017), different types of innovation have a high potential in reducing and preventing food waste in the chain. The need for technological innovations to prevent or reduce food waste has been highly emphasized (Canali et al., 2017). Hereby, one can think of investments in new technologies (e.g. refrigerators/cooling, storage environment, packaging), new services (e.g. redistribution of surplus food), marketing and branding (e.g. promotion on “wonky” products) that can prevent and reduce food waste.

Sometimes, companies may be willing to address food waste but, from a business perspective, wasting food makes sense because:

• the costs of reducing food waste are higher than the financial benefits derived from decreased food waste;
• reducing food waste may not be (very) cost-effective;
• pay-back time to investments may be long;
• investments may not be possible due to constraints in resources (business priorities);
• there may not be a ready market for the extra produce to be sold (high costs to establish new market-outlets);
• investments may lead other supply chain actors to benefit as well, reducing the potential of the investor to recover the investment costs.

Thus, there would be a trade-off between the level of investment in innovations (e.g. new technologies) and the levels of food waste. Consequently, exploring the factors that influence businesses’ choices in the adoption of a certain innovation for preventing and/or reducing food waste is essential. To this end, the objective of this paper is to analyze the factors influencing the decision of agri-food supply chain operators whether to adopt or not a certain innovation to reduce food waste in supply chains. The study also suggests solutions to reduce food waste in supply chains through different types of innovations.

Methodology

The analysis has been carried out using a four-step approach that included:

a. A systematic literature review to identify different types of innovations (i.e. technological and organizational innovation) and economic factors/drivers affecting businesses’ decision to adopt these innovations;
b. An inventory of food waste drivers and of reduction possibilities along the food supply chain through innovations;
c. A mapping of the results from steps a) and b) to analyze the links between factors of innovation adoption and food waste reduction possibilities (food waste drivers);
d. Deriving of conclusions regarding the factors affecting the decision of food supply chain operators to adopt a specific innovation to reduce and prevent food waste.

Results

Findings from Technological and Organizational Innovations

In this study, innovation was defined as “the process of translating an idea or invention into a good or service that creates value or for which customers will pay” (Business Dictionary, 2017). In turn, an idea can be called an innovation if it is replicable at an economical cost and satisfies a specific need. According to literature (OECD, 2005), the following types of innovation can be distinguished:

1) technological innovation (process and product innovation);
2) organizational innovation;
3) marketing innovation;
4) non-technological innovation (e.g. social innovation).

This study has mainly analyzed technological and organizational innovations. The traditional concept of innovation in firms distinguishes product and process innovation. Since both are typically associated with the development or application of new technologies, these innovations are often called technological innovations (Schmidt and Rammer, 2007).

An organizational innovation is the implementation of a new organizational method in the undertaking’s business practices, workplace organization or external relations (OECD, 2005).

The main findings as for technological innovation\(^1\), based on literature (Aramyan and Valeeva, 2016; del Río Gonzalez 2005; Fagerberg, 2005; Schmidt and Rammer, 2007), can be summarized as follows:

1) The main factors affecting the decision to adopt technological innovations are based on economic incentives
2) Factors hampering innovation adoption are mainly related to costs/finance, and to risks associated with the costs. For instance investing in innovation to reduce food waste may not be (very) cost-effective or pay-back time to investments may be long;
3) Next to the availability of the finances for innovation, consumers’ willingness to pay/acceptance of the innovation is also one of the major factors affecting the adoption decision. For instance, investments in technologies to extend shelf life of fresh products might not always be accepted by consumers, since it may induce the feeling of less freshness of the products.
4) The speed of action is an important factor affecting the diffusion of innovation (innovators, early adopters, etc.). This relates to how fast the innovation takes up and can be spread.
5) The adoption and the diffusion of innovations depends also on territorial specificities, where the strength of the social, legal and cultural context plays crucial role. A good example of this issue is represented by the current trends of food waste prevention and reduction activities throughout the EU, whose countries can be considered either innovator-adopters (e.g. UK, Sweden, Denmark), early adopters (e.g. Italy, France, the Netherlands), or lagged (e.g. Eastern European member States)

The main finding as for organizational innovation, based on literature (Fagerberg, 2005; OECD, 2005, Schmid. and Rammer, 2007; Teece,1996), can be summarized as follows:

1) The ultimate reason of organizational innovation is to improve firm performance, productivity and competitiveness (these are economic motivations);
2) Research on organizational innovation is still highly dispersed and empirical findings are hardly comparable;
3) There are two perspectives on the role of organizational innovation: (1) organizational innovations occur in the course of process or product innovations, and (2) organizational innovation could be a necessary precondition for technical innovation.

Furthermore, a number of general factors affect firms’ innovation:

1) R&D has a positive effect on product innovation in manufacturing, while it is less relevant for organizational innovation;

\(^1\) For a detailed literature review on technological and organizational innovation, see Aramyan and Valeeva (2016).
2) ICT is particularly important for organizational innovation. The introduction of information technology is combined with a transformation of the firm, investment in intangible assets, and a change in the relations with suppliers and customers.

3) Other factors include: (1) firm’s internal context (size, workforce, education level of the workforce, market-geographic scope), and (2) the external search for new knowledge.

Finally, specific factors affect firms’ innovation:

1) Firms’ characteristics, managers’ characteristics, inter-organizational ties and intra-organizational ties;

2) Drivers of organizational innovations are reorganization of the management, possibilities for collaboration (supplier, retailers, customers), and vertical integration;

3) Barriers of organizational innovations are: low trust levels, pressure of retailers, costs, differences in expectations, vertical integration, and the regulatory environment.

Food waste drivers in agri-food supply chains

Drivers of food waste have been studied recently. Canali et al. (2017) identified a total of 286 causes of food waste generation, based on 171 literature references and on the direct experience of interviewees. The drivers of food waste were categorized in five main sources:

(a) *Inherent characteristics of food, and ways of its production and consumption.* Examples are perishability of food, difficulties with predictability of supply and demand leading to overproduction, limited possibility for consumers to accumulate individual stocks of food, etc.

(b) *Social and economic factors and dynamics in population habits and lifestyles that are non-readily changeable.* Examples include single-person households, young couples with small children, growing urban population, increased consumption of meals out of home, low price of food products, increasing wealth. All these factors and long-lasting trends contribute to food waste generation and cannot be modified in the short-medium term.

(c) *Individual non-readily changeable behaviors of consumers.* This refers to behaviors related to general expectations of consumers towards food, such as: high quality, freshness, possibility of accessing to broad quantities and varieties of food independently from the place, season, and time, etc. These expectations are picked up by agri-food chain actors in their marketing strategies, to stimulate them even more in order to stay competitive and keep satisfied customers coming back to shops.

(d) *Other priorities targeted by private and public stakeholders.* This refers to the fact that food waste reduction and prevention may be a minor concern with respect to other priorities of private and public stakeholders. For most private companies, food waste is a good business (e.g., it generates profits due to sale volumes), so that they have no incentives to reduce it. FAs for public authorities, legislative provisions to improve aspects like food safety, food security, consumer information, and animal welfare may overcome the concern for potential food waste generation derived from such legislation.

(e) *Diversified factors,* such as mismanagement, inefficient legislation, lack of awareness or information, and sub-optimal use of available technologies, which could be more promptly changed. This group of factors includes a wide range of food waste causes that could be considerably addressed by improving the technological and organizational efficiency.
of supply chain operators, the quality of legislative provisions potentially impacting on food waste, and consumer behaviors and attitudes towards food.

**Innovations affecting food waste drivers**

The technological and organizational innovations affecting food waste drivers are described here. The *technological innovations* for reducing or preventing food waste include:

1) Selective fishing gear to reduce bycatch (the incidental capture of non-target species such as dolphins, marine turtles and seabirds, which turn into fish waste): modifying fishing gears so that fewer non-target species are caught or can escape will reduce fish waste by a significant amount;

2) New technology for improving storage, such as smart climate control systems to preserve perishable products;

3) Access to modern equipment & techniques: perishability of fresh roots and tubers makes these products easily damaged during harvest and postharvest activities;

4) Better measurement systems to measure food wasted along the chain;

5) Electronic ordering systems & automatic ordering for predicting demand accurately to avoid overproduction and surplus.

The *organizational innovations* for reducing or preventing food waste include:

1) Reduction of production errors, improper stock rotations, grading and sorting of products by adopting business practices such as:
   a) Employee development and improvement of worker retention;
   b) Codifying knowledge, e.g. establishing databases of best practices, lessons & other knowledge;
   c) Better quality control & logistics mechanisms;
   d) Better management systems.

2) Solving (cold) chain inefficiencies through workplace organization: e.g. build-to-order production systems (integrating sales and production), or integration of engineering and development with production;

3) Improving inefficient relationships between suppliers and re-distributors by adopting new external relation schemes: e.g. new types of collaborations, new methods of integration with suppliers, and the outsourcing or subcontracting of business activities in production, procuring, distribution and additional services.

**Decision making to adopt innovation**

Although innovations could play a crucial role in preventing and reducing food waste, they still have to be economically feasible in order to be adopted by decision-makers in the food supply chain. The literature review showed that the ultimate reason for innovation is generally related to economic factors, which can be classified as follows: (1) improve firm performance, (2) improve productivity; (3) improve international competitiveness. Cost factors, and the risks associated to these costs, appear to be the most important determinates of technological as well as organizational innovation. Besides, it has been found that product and process innovations do not have a positive effect without organizational innovation, and that the combination of technological and non-technological innovation activities determines productivity gains.

When it comes to food waste prevention and reduction, a good example of combining technological and organizational innovation may be observed in the retail sector. Here, innovative smartphone apps (technological innovation) to promote the sale of products nearing their expiration dates (organizational innovation) were developed and adopted via different retailing channels, leading to the creation of a new business model.
Geographic scope or territorial specificity is another important determinant of both technological and organizational innovations. Cultural difference increases the difficulty of implementing new management practices, especially if the cultural distance is large. Depending on the enabling environment, technological innovation can be quickly adopted and spread in one place, while adoption and diffusion may be restricted in other places. In general, innovation is not likely to follow the same process of diffusion in different places, and is not likely to lead to the same outcomes.

Conclusions

The objective of this paper was to analyze the factors affecting the decision of agri-food supply chain operators to adopt or not to adopt a certain innovation to reduce food waste. The study focused mainly on technological and organizational innovations. Although innovations could play a crucial role in preventing and reducing food waste, they still have to be economically feasible in order to be adopted by businesses of the food supply chain.

The main reasons for business to innovate (technologically and/or organizationally) are related to three main economic factors, which are aimed to be improved: performance, productivity, and competitiveness. Cost factors, and the risks associated to these costs, are crucial aspects of technological as well as organizational innovation.

Product and process innovations do not have a positive effect without organizational innovation, and the combination of both technological and non-technological innovation determines productivity gains.

Geographic scope (or territorial specificity) is another important driver of technological and organizational innovations. In general, innovation is not likely to follow the same path of diffusion in different places, leading to different local outcomes. A good example of this is represented by the current trends of food waste prevention and reduction throughout the EU, whose countries can be considered, respectively, innovators (e.g. UK, Sweden, Denmark), early adopters (e.g. Italy, France, the Netherlands), or laggards (e.g. Eastern European EU Member States).

So, what can supply chain operators do to reduce food waste? Companies can raise awareness/train employees on the handling of fresh perishable product (e.g. fruits and vegetables), improve planning, improve the quality and timing of inputs, implement or adapt technologies (packaging, storage, transport), change marketing standards and reduce errors in production, influence consumer behavior by, e.g., scrapping promotions such as “pay one get 2” and re-distribute the surplus/overproduction through other marketing channels (e.g. donations, or selling at a lower price, selling via apps/Internet).

In this context, the role of the government becomes essential. Governments can not only change regulations or introduce strict rules, but also make a use of Market Based Instruments and economic incentives. A good mix of regulatory and voluntary instruments increases the success of food waste prevention and reduction policies.

Overall, the adoption and diffusion of innovation to prevent and reduce food waste is an on-going process and, like in other sectors, business will divide into adopters of new technologies and organizational innovations, and those lagging behind.
References


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