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Research article

Sustainability checklist in support of the design of food processing

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ABSTRACT

To source food ingredients produced by best practice, reducing food loss in the processing line and implementation of new technologies are some examples of changes in the management in the food and drink sector that may offer advantages from a sustainability perspective. There are several tools and methods for evaluating sustainability for a food processing technology but often specific methodological knowledge is essential and many companies may not be able to carry out such a study due to time constraints and lack of data. The aim of this paper is to provide a tool with the format of a qualitative sustainability checklist, based on existing Life Cycle Assessment theory. The checklist is devoted to the design and adaptation of processing in the food industry to clarify the potential hot spots in new process design and is focused on environmental sustainability, although other aspects were conferred as well to demonstrate its potential. To identify the potential of this kind of checklist, it was tested by four food companies. The participant feedback was in general positive. The companies highlighted the benefits of creating awareness of sustainability issues within the company and providing a good overview without data collection. From a scientific point of view, the approach can help to overcome several challenges in sustainability assessment in the agri-food sector, especially some modeling issues and spatio-temporal resolution.

1. Introduction

The food and drink industry is a leading manufacturing sector in Europe (FoodDrinkEurope, 2017a) representing a central part of the agri-food chain that produce food and bio-based products (e.g. biochemicals, biofuels, biopackaging). Food processing provides added value to final products by enhancing their functional, nutritional, sensorial and safety properties. At the same time these processing steps face various challenges with regards to the sustainability of food systems such as environmental concerns (e.g. climate change, biodiversity, waste management, water and soil quality preservation), and encompassing a range of issues such security of supply, health, safety, quality, and affordability. Food production needs to increase; globally approximately 795 million people go hungry and about 2 billion people are malnourished. It is projected that world food supply will increase by 70% to feed almost 10 billion people by 2050. Simultaneously, approximately 30% of the global adult population is overweight or obese, and circa 30% of food produced worldwide is lost or wasted. The food sector has been reported to account for around 30% of the world's total energy consumption and around 22% of total Greenhouse Gas emissions (UN Sustainable Development Goals, 2018). Greenhouse gas emissions of the food supply chain have been calculated to be mainly due to the agriculture stage (70%), as has been reported for single food items (Corson and van der Werf, 2012), followed by food manufacturing (10%), logistics (about 7%), packaging (5%), use (5%), and waste disposal (4%) (Notarnicola et al., 2017).

One option to reduce the sustainability footprint of a food product is to improve or substitute the technology used in the processing step. The environmental benefits can be increased processing efficiency, but also to allow processing of raw materials produced more efficiently (Meynard et al., 2017). New food processing technology can also create new high quality food products (e.g. products with lower sugar or fat levels). A change in technology can also result in economic gains (directly on production site or indirectly by improving the performance in the food chain further downstream). To fully evaluate food processing technology changes, an assessment of the environmental, economic and social sustainability impacts would be needed, along with the more common criteria such as quality, food safety and expected return on investment.

Life Cycle Thinking, i.e. going beyond the traditional focus on the production site and the manufacturing processes per se, to include

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environmental, social and economic impacts of a product over its entire life cycle and value chain, is recognized as fundamental for addressing the sustainability of food systems (Notarnicola et al., 2017). In addition, the Environmental management standard (ISO 14001:2015, 2015), substituting (ISO 14001:2004, 2004), require that organizations identify environmental aspects of activities, products and services that it can control and curb, taking into account a life cycle thinking, and measure those having a significant environmental impact using established methods. The new version of the standard has also sharpened its requirements urging organizations to take into account other stakeholders' potential interests and needs. This change will require organizations to look at the environmental impact of their activities in a broader perspective than before. This increases the need for tools that can provide a quick and easy evaluation of the sustainability aspects of supply chains and product portfolios.

There are several tools and methods for evaluating sustainability for a food processing technology and the most recognized environmental assessment method is Life Cycle Assessment (LCA). Life Cycle Assessment is a standardized methodology (ISO 14040:2006, 2006) which allows quantifying the environmental impacts of a product, process or service along its whole life cycle. This approach is widely used for food production systems and their supply chains (Roy et al., 2009). Life Cycle Assessment can highlight hotspots (e.g., ISO 14040:2006, 2006), key stages to optimize or re-design the system, or can be a basis to compare different existing or under-development scenarios (e.g. Davis and Sonesson, 2008; Pardo and Zufia, 2012; Aronsson et al., 2012). As mentioned, sustainability performance addresses not only environmental but also economic and social issues and complementary life cycle approaches have also been developed such as CALCAS (Klöpffer, 2003), Life Cycle Costs (LCC) for economic sustainability, and more recently social Life Cycle Assessment (sLCA) for social sustainability. There is also ongoing work on how to combine all three pillars in one approach in a Life Cycle Sustainability Assessment (LCSA). The Life Cycle Sustainability Triangle developed by Hofstetter et al. (1999) and the Life Cycle Sustainability Dashboard by Traverso and Finkbeiner (2009) are two examples of this. However, the application of LCSA is still limited, and the majority of studies undertaken investigate the interface of environmental and economic aspects (Zamagni et al., 2013). Nevertheless, sustainability can be fully assessed following the triple bottom line by combining the existing LCA methods for each pillar, or by using an LCSA approach.

LCA studies require knowhow of the methodology and can be time consuming with large amounts of data to collect. A company may not have the resources to carry out such a study and subcontracting a specialized consultancy firm is not always possible, both for economic and confidentiality reasons. This is especially true in SMEs, which constitute more than 99% of food and drink European companies, and account for more than 63% of food and drink European employment (FoodDrinkEurope, 2017b). The food and drink industry is based mainly on traditional recipes, products and processes and is lagging behind other manufacturing sectors when it comes to product and process innovations (Langelaan et al., 2013). Hillary (1999) identified SME resources (mainly time, costs and human resources), attitudes and company culture (beliefs, scepticism) and low awareness (environmental legislation, support organizations, sources of information) as internal constraints and barriers for successful implementation of environmental improvements. Even though Hillary (1999) published the possible barriers almost 20 years ago they are still relevant today.

As previously mentioned data collection for a LCA analysis can be time consuming and data are not always available or reliable, either because they are difficult to acquire or because they do not exist yet, which is often the case when innovations are under development. This is a drawback, because when a new product or process is designed, the decisions taken during its early development phase widely determine its future impacts (McAloone and Tan, 2005). Will the new product or process result in a more sustainable food system? It could serve us well to reflect on this question from the very beginning (Buchert et al., 2015). This type of evaluation needs to be considered through the whole product or process development phase, regardless if it is in the development of new or the optimization of existing products or processes.

Due to the challenges stated above there is a need for less demanding eco design tools particular in the early design process (Hallstedt et al., 2013). It has been reported that three key-factors should make up an eco-design tool: early integration of environmental aspects (and, by extension, sustainability aspects) into the design process; the life cycle approach and a multi-criteria approach (Bovea and Pérez-Belis, 2012). Whereas a quantitative assessment (such as LCA according to the ISO standard) fail to fulfill this purpose when there is a lack of data, qualitative tools can meet this challenging task, by providing a better understanding of the system performance from the very beginning, even before any quantitative data becomes available.

Among existing qualitative methods, checklists have been developed for both assessment and design which include the early stages of product development (Pigosso et al., 2016). Checklists consist of a series of questions that are formulated to help designers to work in a systematic manner when addressing sustainability issues during the design process. A common approach in an eco-design checklist is to focus on environmental issues (Brezet et al., 1997). It is also common that it is life-cycle-based, that it focuses on the environmental dimension and is mainly devoted to manufactured products. Simplified guidelines have also been developed, for example eco-design of packaging (French Packaging Council, C.N.E., 2012). These guidelines include a checklist defined by experts in the packaging industry. The checklist's questions are grouped according to several key-points related to a packaged product's life cycle.

The main difficulty when developing a checklist is to identify the key-points that has to be covered. To include all three pillars of sustainability in an assessment or design tool is a challenging task but such tools are under development for certain industries (Feil et al., 2015). Generic indicators for measuring sustainability in micro and small industries have been suggested in the furniture area by combining literature review, text mining, and analysis of expert skills (Hallstedt, 2017). However, it has also been stated that sustainability criteria are company specific and most likely even branch specific (Arena et al., 2009). Furthermore, for a given sector, it is necessary to know what is meant by sustainability, how it can be achieved and how it can be measured (Arena et al., 2009). There are quantitative simplified LCA tools for the food industry (Arzoumanidis et al., 2017), but according to our knowledge there is as yet no tool for a qualitative sustainability assessment for food processing development.

The aim of this paper is to investigate the possibility to qualitatively include sustainability considerations in food processing design at early stage of the design process, and especially when a new food processing technology is implemented. With this purpose, the relevant sustainability issues for the agri-food sector have been identified, based on both literature review and practitioners interviews and surveys. The items have been formalized in as a qualitative sustainability checklist. The aim of the qualitative checklist is to be used as a first screening that will give some initial insight into what aspects are important to consider when it comes to the sustainability performance of food processing. It was structured to cover the three pillars of sustainability: environmental, social and economic, in a life cycle approach. The scientific contribution of the approach, both for practitioners and sustainability assessment science, is also discussed.