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Research article

Extending the scope of eco-labelling in the food industry to drive change beyond sustainable agriculture practices

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ABSTRACT

New consumer awareness is shifting industry towards more sustainable practices, creating a virtuous cycle between producers and consumers enabled by eco-labelling. Eco-labelling informs consumers of specific characteristics of products and has been used to market greener products. Eco-labelling in the food industry has yet been mostly focused on promoting organic farming, limiting the scope to the agricultural stage of the supply chain, while carbon labelling informs on the carbon footprint throughout the life cycle of the product. These labelling strategies help value products in the eyes of the consumer. Because of this, decision makers are motivated to adopt more sustainable models. In the food industry, this has led to important environmental impact improvements at the agricultural stage, while most other stages in the Food Supply Chain (FSC) have continued to be designed inefficiently. The objective of this work is to define a framework showing how carbon labelling can be integrated into the design process of the FSC. For this purpose, the concept of Green Supply Chain Network Design (GSCND) focusing on the strategic decision making for location and allocation of resources and production capacity is developed considering operational, financial and environmental (CO_2 emissions) issues along key stages in the product life cycle. A multi-objective optimization strategy implemented by use of a genetic algorithm is applied to a case study on orange juice production. The results show that the consideration of CO_2 emission minimization as an objective function during the GSCND process together with techno-economic criteria produces improved FSC environmental performance compared to both organic and conventional orange juice production. Typical results thus highlight the importance that carbon emissions optimization and labelling may have to improve FSC beyond organic labelling. Finally, CO_2 emission-oriented labelling could be an important tool to improve the effects eco-labelling has on food product environmental impact going forward.

1. Introduction

New consumer awareness and behaviour favouring *greener* products and services is shifting industry towards more environmentally sustainable production systems. Eco-labelling influences the market force of consumer by incentivizing the producer to provide greener products that consumers value differently than conventional ones. Eco-labelling is a means to inform consumers of specific characteristics of products and has been used to target how client preferences for greener products change the value of a product based on the *green* attribute. It has somewhat recently been used to introduce information on environmental performance of products and the production systems they come from in more detail. Depending on the product and key environmental damage, product eco-labels inform the consumer on measures taken by the producers to minimize environmental impact. One example of a product would be paper coming from a managed forest, in the case of a service, airlines market carbon emissions offsetting services as an added service to transport (i.e. planting a tree with your flight). One type of eco-label that has gain traction is the *organic* eco-labels for food products. This type of labelling focuses on promoting *organic* farming, mainly targeting the agricultural stage of the food supply chain. A second one is *carbon labelling* that is used to inform consumer of the carbon footprint produced due to the production and consumption of products and services. These two labelling strategies help consumers and producers set the value of the

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products in a different way than that adopted for conventional products. By using this strategy, producers are incentivized to adopt innovative and more sustainable practices in order to gain access to these consumer markets. The effects on overall performance of supply chains have just started to be studied (Beske et al., 2014; Brindley and Oxborrow, 2014).

Agrofood supply chains have all the stages and characteristics of any consumer product supply chain. It is made up of suppliers, focal companies, clients, distribution routes and centres. Key differences are that the products are consumed by humans and animals, and that the raw materials are grown through agricultural practices and land use. But while many supply chains for different products may be studied and improved, in order to use eco-labelling strategies, food products have restrictions. Depending on the region or country, these restrictions focus on different aspects of the product/production life cycle of food products. In a globalized economy many food products are globally sources and processed. This is due to many reasons, one key issue is the environmental conditions that allow for the efficient production of some food products. Favourable climates for some cultures are limited to specific regions of the globe. This in term makes the agrofood supply chain one that is globally distributed, where many steps for getting food from orchard to plate are not only related to agriculture but also to processing, manufacturing and transportation.

Environmental impact of agrofood production is thus not limited to the initial stage of production, where organic labelling applies a market pressure for improvement, but also extends to stages farther downstream. Green supply chain management paradigm provides a framework to study the full life cycle of product or service and integrates operational, economic and environmental indicators, with the aim at improving overall performance. In particular, Green Supply Chain Network Design is a process which facilitates strategic decision making on issues related to the location, installation, and allocation of resources and production capacity, through the scope of GSCM paradigm (Eskandarpour et al., 2015). Through this scope, measuring CO_2 emissions for instance along key stages in the life cycle of a product can be captured and integrated into a decision framework. This allows the decision makers (e.g. managers and executives) to improve performance and allows for the use of eco-labelling strategies targeting demanding consumers. It allows the marketing departments to take advantage of new consumer awareness (e.g. consumers having a good idea of what "CO_2 emissions/unit of product" means) in order to differentiate and add value in a commodity driven market.

This paper presents the development and deployment of a GSCND strategy that targets economic and environmental objectives through a Multiobjective Optimization formulation and solved through the use of Genetic Algorithms. The approach is applied to an orange juice supply chain case study. The finding of the study shows that Organic labelling can be complemented with Carbon labelling in order to improve key emissions hotspots outside of the scope of Organic labelling. The results of the optimized results of the supply chain network are compared with those of some reference values taken from LCA studies on conventional and organic orange juice supply chains.

2. Background

Eco-labels are defined by the International Organization for Standardization (ISO) as: "… a voluntary method of environmental performance certification and labelling that is practiced around the world. An "ecolabel" is a label which identifies overall, proven environmental preference of a product or service within a specific product/service category". The goal of Eco-labelling is to promote sustainability managed production and consumption, categorized in three types: A) Type I – a voluntary, multiple-criteria based, third party program that awards a license that authorizes the use of environmental labels on products indicating overall environmental preference of a product within a particular product category based on life cycle considerations. B) Type II – informative environmental self-declaration claims. C) Type III - voluntary program that provide quantified environmental data of a product, under pre-set categories of parameters set by a qualified third party and based on life cycle assessment, and verified by that or another qualified third party.

The scope of the case study (that is presented further down) is geographically defined by the regions that make up the SC, mainly the raw materials sourcing region (i.e. Mexico and Brazil in Latin America) and consuming regions (i.e. France and Germany in the European Union). As eco-labelling is intended to inform the consumer - the marketed region is the determinant in what labelling policies apply. In the case study these fall within the European Union (EU) policy structure.

In the EU there is a distinction between Eco-labels and Organic labels. The EU Eco-label scheme was launched in 1992 to promote the production and consumption of products that have a reduced environmental impact in comparison to existing products on the market. Through these labels transparency, reliability and scientific credibility is guaranteed to the customer without the need of any technical understanding to interpret the label. This allows the consumer to make environmentally friendly choices when purchasing products, and by this, promoting the product providers to adhere to this standard to maintain competitive stands. While Eco-labels (under the EU definition) can be applied to different product groups (e.g. cosmetics, hygiene, cleaning, clothing, paints, electronics equipment, building materials, household appliances, etc.), they do not apply to food and feed products. According to the EU Eco-label website referencing a report commissioned by the EU (Oakdene Hollins Research and Consulting, 2011) on the feasibility of developing Eco-label for food and feed products with very interesting and important conclusions.

> "… *the Commission is not intending to develop Ecolabel criteria for food and feed products at this time. The Commission could, however, revisit this question at some point in the future considering the possible role of the EU Ecolabel within the framework of the development of any wider EU food strategy, in particular in light of developments in methodologies, and other tools, for measuring the environmental impact (including by, for example, environmental footprinting) of products*."

Two main points are to be noted from this statement. First and foremost is that food products are outside of the scope of Eco-labels in the EU under their definition. The second is that, this could change, and there is a suggestion of taking (organizational) *environmental footprinting* (OEF) as a candidate strategy.

In (Pelletier et al., 2013), some OEFs are compared in terms of four criteria that define the European Commission Organization Environmental Footprinting (EC OEF) scheme. These are: (1) multicriteria, (2) life cycle-based approach that considers all organizational and related activities across the supply chain, (3) provides for reproducibility and comparability over flexibility, and (4) ensures physically realistic modelling. According to (Pelletier et al., 2013) only Global Resource Initiative (GRI) takes a broad scope of environmental impact, and states that all other methods refer to single impact categories while the EC OEF proposes a multiple criteria approach.

This paper assumes the possibility of the inclusion of Food category within the EU Eco-label scheme. To illustrate the

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