STREET FOOD TRADERS, FARMERS AND SUSTAINABLE PRACTICE TO REDUCE FOOD WASTE IN THE ITALIAN CONTEXT

Published version:

DOI:10.1108/BFJ-04-2019-0265

STREET FOOD TRADERS VERSUS FARMERS: WHAT IS THE WAY TO FAVOUR SUSTAINABLE PRACTICE?

Simona Alfiero - Department of Management, University of Torino, Italy; email simona.alfiero@unito.it
Michael Christofi - Department of Hospitality, Tourism and Sports Management, University of Nicosia, Cyprus; christofi.mi@unic.ac.cy
Alessandro Bonadonna - Department of Management, University of Torino, Italy; email alessandro.bonadonna@unito.it

Abstract
Purpose – The purpose of this paper is to focus on outdoor food market areas and related food waste management, analyzing two categories of operators i.e. farmers and street food traders. This paper evaluates and compares the main actors' efficiency performance, highlighting how optimizing food waste management characterizes the best practices and favours the development of a sustainable model.
Design/methodology/approach – A sample of 196 outdoor market operators was identified to analyze their unsold-food/food-wastage processes based on their behavior and attitude. And a consumer perception survey was also carried out to define their levels of satisfaction. The study area comprised 27 outdoor markets in Greater Torino (North-West Italy) and the data collected was analyzed and elaborated and then the efficiency performance was evaluated by Data Envelopment Analysis (DEA), in SBM version.
Findings – The two kinds of outdoor market operators have different levels of efficiency that are also due to different unsold food/food waste management. The results clearly showed that farmers operate more efficiently than street food traders and confirm that the traditional management of unsold food/ food waste is an important key for competing in this sector.
Research limitations/implications – The data was collected in a limited area of Italy i.e. Greater Torino Area (North-West Italy) and the number of variables analyzed was limited to certain aspects of selling processes and food waste management.
Practical implications – The results provided some indicators on how a more rational style of unsold food management can improve an operators' performance and help make a significant social impact.
Originality/value – to the best of our knowledge, this is the first study that analyses outdoor market operators' efficiency, concerning food waste as a variable that can affect their performance.

Keywords– Unsold food, food waste, Outdoor market, Farmers, Street food traders, DEA, efficiency

Paper type - Research paper

Introduction
As processes, organisational changes and the definition of innovative business models transit towards sustainability, they all play a key role in creating value for companies in terms of improving efficiency as well as reducing negative, external effects.
This is true for businesses in all sectors, but even more for those in the food sector where wasting food is increasingly seen as socially unacceptable. Economic crises and the current worrying development forecasts only add to its negativity. Food waste is a widespread global phenomenon that involves all phases of the food chain and brings with it economic, environmental and social consequences. The European Union defines "food waste" as "All food products discarded from the food supply chain for economic or aesthetic reasons or due to the proximity of the expiry date, but which are still perfectly edible and fit for human consumption and, in the absence of any alternative use, are finally eliminated and disposed of, generating negative externalities from an environmental point of view, economic costs and a loss of revenue for businesses "(UE, 2012). However, a possible distinction between food losses and food waste has been put forward in the past (Parfitt et al., 2010). This distinction defines food losses such as those occurring in the early stages of the supply chain, i.e. during primary production and processing. At the same time, food waste is the one that occurs in the last part of the food chain, that is to say during the phases of distribution and consumption, i.e., wholesale and logistics, retailing, the market and catering services. These authors conclude by stating that food waste can be considered food waste and loss of food as a whole. Furthermore, food losses can be classified according to degrees of being potentially avoidable or unavoidable (WRAP, 2009). Food waste may also consist of "foodstuffs discarded from the food supply chain, which have lost commercial value, but which may still be destined for human consumption" (Barilla, 2012) as their food quality requirements remain unaltered (Peri, 2006). Food waste can also take on the role of excessive nutrition of people i.e. what a person consumes and how much is actually necessary (Smil 2004). It can also be defined as the result of the lack of value attributed to food production and food itself throughout the various stages of the food supply chain (Hudson and Messa, 2014). Therefore, food waste can also start before primary agricultural production, since the quantity of food produced within the current economic system is organized on the basis of established trade agreements that do not always correspond to actual demand needs (Stuart, 2009).
All those who take part in the primary production, processing, handling, distribution and consumption of food products are involved in the genesis of this phenomena that we have tried to describe.
A subdivision of the food chain into four phases was suggested regarding food waste (Cicatiello et al., 2016), i.e. production and processing, retailing, catering and household consumption, which in other studies (Gustavsson et al., 2011; Verghese et al., 2013) were brought to 5 phases, i.e. agricultural production; post-harvest production and storage management; processing and packaging; distribution (wholesale and retail) and consumption.
This study aims to demonstrate how food waste management can seriously impact both retail and distribution operators' ability to create value and their levels of performance in terms of efficiency.
The study investigates the outdoor food market by involving two categories of operators, i.e. farmers and street vendors of outdoor markets (street food traders) and related unsold food and food waste management. Specific focus was put on goods that were unsold at the end of the day and could not be sold the following day, therefore becoming unquestionably, food waste.
A Data Envelopment Analysis (DEA), in Slack Based model (SBM), is used to evaluate and compare these operators' efficiency performance. So, based on the information gathered, the following research questions are:
RQ1: How efficient are individual outdoor market operators, taking into account multiple inputs and outputs?
RQ2: Do the two classes of operator have different levels of efficiency?
RQ3: Which factors impact efficiency?
This study includes a "Literature review" section which provides a review of literature published on food waste and related issues underlining dimensions, causes, effects of this phenomenon and

the operators involved, the circular economy and related main characteristics, food waste generated in the distribution phase i.e. outdoor food markets. The "Methodology" section shows the selected methodological approach i.e. Data Envelopment Analysis (DEA) and related systems of collecting data. The "Findings" section describes the main results achieved. The "Discussion and conclusion" section is the final part of the paper and puts forward the main considerations in light of results and related literature review. The "Implications, limitations and future research" section gives stakeholders some suggestions and outlines the direction to take in order to improve the research.

2. Literature review

Food waste

Food losses and food waste occur at every stage of the supply chain and may depend on specific factors in a given country such as economic and climatic conditions, production systems and infrastructure, the market and consumption trends. Numerous studies have been conducted on the analysis of food waste at different stages of the supply chain, their costs and negative externalities e.g. the retail sales phase (Lebersorger and Schneider, 2014; Eriksson et al., 2012), the whole supply chain (Beretta et al., 2013; Engstrom and Carlsson-Katayama, 2004), household waste (Nahman et al., 2012) or certain product categories (Buzby and Hyman, 2012).

Estimates of the quantity of food waste at global level vary: some sources indicate 1.2 / 2 billion tons, accounting for 30-50% of world food production (IME, 2013), others indicate 1.6 billion tons / year, with a commercial value of 750 million US dollars (FAO, 2017; UE, 2014). In addition, US statistics show that organic waste is the second largest percentage of waste discharged into landfills (UNEP).

A European Union assessment in 2012 estimated there were 88 million tons of waste, which is equal to about 20% of everything that was produced. The main phases involved in this phenomenon were domestic consumption, processing, food service, primary production and distribution (Stenmarck et al., 2016). Based on per capita income, food waste in middle-high income countries seems to be mostly generated in the last stages of the food chain, namely distribution and consumption, determined by consumer behavior or restrictive quality standards in the supply chain, which is also dictated by aesthetics. Food waste occurs in low-income countries in the early stages of the food chain, mainly in the post-harvest phase, due to financial, structural, storage and transport barriers. Therefore, the current waste of resources can be observed at all stages of the food system, from production to consumption to waste management, both at domestic and industrial levels.

In this context, food waste affects global society, the environment and the economy. In fact, global population is key to understanding the dimensions of this issue (Lundqvist, 2009). Some studies estimate that world food production should increase by at least 50% to guarantee food security for the world population, estimated at around 9.3 billion, in 2050 (Clark and Manning, 2018; Bond et al., 2013). However, progress in this area can only be achieved if the food waste genesis is better managed along the whole food supply chain and the limited available resources are used in a better way (Battilani, 2014).

Current models of production and consumption appear to be in trouble, due to the intensive use of natural resources and continuous waste deriving from the production phases (Borrello et al., 2017) and a phase of change seems to be necessary. For example, innovation in the agro-food sector is considered a strategic tool for solving problems in various fields (Rama, 1996; Traill and Meulenberg, 2002; Capitanio et al., 2009; Guerrero et al., 2009; Jakki et al., 2010; Dadura and Lee, 2011; Arcese et al., 2015; Contò et al., 2015; Boccia and Covino, 2016; Vrontis et al., 2016; Bresciani, 2017; Santoro et al., 2017; Franceschelli et al., 2018).

Circular economy

One particular kind of innovative approach is the well-named circular economy, which is an economic system that is able to regenerate without interruption (Stahel and Reday, 1976; Pearce and Turner, 1989; McDonough and Braungart, 2002), recently defined it as "an industrial economy that is reparative or regenerative by intention and design" (Ellen McArthur Foundation, 2013). So, developing a supply chain that has been inspired by the principles of a circular economy rather than conventional supply chains could provide a solution to this problem. This would lead to a reduction of environmental and economic costs related to the disposal of food waste (Borrello et al., 2016). This concept can also be extended to the food chain and, at least theoretically, it could be a possible response to the phenomenon of food waste and a resource for accessing more sustainable food systems, e.g. strengthening collaborative relationships between agro-food companies (Mondéjar-Jiménez et al., 2016; Kristensen et al., 2016). Recent studies in the agro-food sector have highlighted the need for alternative agro-food networks that are able to impose themselves and represent an answer to the collective demand for transition towards more sustainable practices (Jurgilevich et al., 2016).

The distribution phase: farmers and street food traders

Distribution and retail are phases of the food supply chain that generate food wastage. One particular kind of distribution phase is the outdoor food market that is characterized by different operators i.e. farmers and other retailers also named street food traders.

There are numerous studies about farmers and street food traders and their businesses. Farmers are involved in studies on diverse themes for example food safety and food security (Yu et al., 2017; Bovay, 2017; Zhang et al., 2017; Corsi et al., 2017; Hulbrock et al., 2017) or environmental, social and agronomy issues (Berg and Preston, 2017; Ayedun et al., 2017; Danso et al., 2017; Islam et al., 2017; Nonvide et al., 2017; Lee, 2017; Otieno et al., 2017; Boansi et al., 2017; Candelo et al., 2018; Civera et al., 2019). Street food traders have also been the subject of food safety (Cheng et al., 2017; Abou, 1995; Agege, 1988) or the quality and value of food (Chen et al., 2016; Onono et al., 2018; Carron et al., 2017; Youssouf et al., 2012; Janssens, 2014). At the same time, outdoor markets have been used as a study area in several themes, including food waste. Some studies analysed anti-food waste programmes and their efficiency in reducing food safety/security by using food left over from outdoor food markets (Sisson, 2016; Bonomi and Ricciardi, 2017; Moggi et al., 2018), they assessed farmers' perception of food waste (Beausang et al., 2017) and how they managed the market areas (Peira et al., 2018; Bonadonna et al., 2018).

Those who work in the food industry can contribute to the circular economy by applying their understanding and perception of the phenomenon (Beausang et al., 2017; Guo and Zhang, 2014), to the agro-food sector (Kilcher, 2006; Borrello et al., 2016) and involving the different phases of the chain. (Diaz et al., 2017; Jara-Samaniego et al., 2017; Kadir et al., 2016; Eriksson and Spångberg, 2017; Barba and Díaz-Ruiz, 2015).

Methodology

The DEA model was used in order to answer this study's research questions ie measuring the relative efficiency of individual outdoor market operators and evaluating the major factors that affect it. It measured the relative efficiency of individual operators in the first stage of the study, then the results were analyzed to determine the main differences between farmers and street food traders, highlighting the reasons.

Data Envelopment Analysis (DEA)

DEA is used in many sectors for measuring performance efficiency including: healthcare, education, finance, industry, etc. There are numerous studies that apply DEA to the food sector e.g. foodservice and food industry (Giménez-Garcia et al., 2007; Reynolds and Thompson, 2007; Dimara et al., 2008, Dadura and Tzong-Ru, 2011; Alfiero et al., 2017), or the retail sector (Donthu and Yoo, 1998; Barros and Alves, 2003; Mostafa, 2009; Sharma and Choudhary, 2010; Mirthedayatian et al., 2014; Ko et al., 2017; Kahraman et al. 2018) and those where the DEA approach is used from a circular economy point of view (Halog, 2009; Yang and Pollitt, 2010; Pagotto and Halog, 2015). However, to the best of our knowledge, this is the first study that analyses outdoor market operators' efficiency, concerning food waste as a variable that can affect their performance.

Data Envelopment Analysis (DEA) was developed by Charnes et al. (1978) and is a non-parametric methodology primarily used to determine the relative efficiency of similar units denominated Decision Making Units (DMUs), when there are multiple inputs and outputs. This technique first establishes an 'efficient frontier' formed by a set of performances for DMUs that exhibit best practices and then it assigns the efficiency level to other non-frontier units according to their distances to the efficient frontier. There are several types of models used in DEA, but they can be largely classified into a constant returns-to-scale (CRS) model and a variable returns-to-scale (VRS) model, depending on the size variability. The CRS model is based on the assumption that the input and output ratios do not change with size. It is called the CCR model after the first letters of the authors Charnes, Cooper, and Rhodes (1978) and it is an estimation of overall technical efficiency (OTE). In DEA, OTE measure has been broken down into two mutually exclusive and non-additive components: pure technical efficiency (PTE) and scale efficiency (SE). This break down provides an insight into the source of inefficiencies. The PTE measure is obtained by estimating the efficient frontier under the assumption of variable returns-to-scale. It is a measure of technical efficiency without scale efficiency and only reflects the managerial performance to organize the inputs in the production process (Kumar and Gulati, 2008). So, the PTE measure has been used as an index to capture managerial performance. The ratio of OTE to PTE provides SE measure. The measure of SE provides the ability of the management to choose the optimum size. The VRS model applies when the ratio of input and output varies with size; it is also called the BCC model in the name of Banker, Charnes and Cooper (1984) who first introduced this model.

The VRS model searches for PTE (also called managerial efficiency) and includes the so-called convexity constraints by changing the specification of the problem and providing the measure of Managerial Efficiency θ VRS adding eλ = 1 to the programme (θ is a scalar and λ is a vector of constants). From its inception, the DEA has treated each DMU as a "black box" by only considering those inputs consumed and the final outputs produced by this "black box" (Färe and Grosskopf, 2000). However, the efficiency measure is associated to the use of a minimum number of inputs in order to produce a certain number of outputs or the maximum production of outputs using a certain number of inputs (Fethi and Pasiouras, 2010) from which the orientation issues descend.

As is widely known, there are two types of DEA models; the radial (CCR) and the non-radial.

By neglecting slacks, by radial model, it is important to remember how relevant slacks are when evaluating managerial efficiency and, reporting the efficiency score. Therefore, the DEA frameworks used in this study are based on the Slack-Based Model (SBM) which is a non-radial model developed by Tone (2001). This model deals with input excess and output shortfall of each DMU, called Slacks and projecting each DMU to the furthest point on the efficient frontier by minimising the objective function and finding the maximum slacks. When both inputs and outputs can simultaneously be changed, i.e., the firm is able to reduce inputs and increase outputs simultaneously, a non-oriented SBM model is used (Cooper et al., 1997; Tone, 2001). This model allows managers to work on both inputs and outputs to achieve efficiency.

The non-oriented SBM-DEA model

In order to illustrate the model, let us assume that there are *n* DMUs (DMU_j, j = 1, 2,..., n) with m inputs (x_{ij}, i =1, 2,..., m) and s outputs (y_{rj}, r =1, 2,..., s) for each DMU. The u_i and v_j are the weights corresponding to the *i*th input and *j*th output. Then the SBM-DEA model can be described as follows.

$$p^* = min_{\lambda,s^-,s^+} \frac{1-\left(\frac{1}{m}\right)\sum_{i=1}^{m}\left(\frac{s_{ik}^-}{x_{ik}}\right)}{1+\left(\frac{1}{s}\right)\sum_{r=1}^{s}\left(\frac{s_{rk}^+}{y_{rk}}\right)}$$

subject to:

$$\sum_{j=1}^{n}\lambda_{jk}x_{ij} + s_{ik}^- = x_{ik}, \forall i$$

$$\sum_{j=1}^{n}\lambda_{jk}y_{rj} - s_{rk}^+ = y_{rk}, \forall r$$

$$\lambda_{jk} \geq 0, s_{ik}^- \geq 0, s_{rk}^+ \geq 0, \forall i, r, j, k$$

If the optimal value λ_{jk}^* of λ_{jk} is non-zero, then the *j*th outdoor market operator represents the reference set (peers) for the *k*th outdoor market operator and the corresponding optimal value is known as the peer weight of the *j*th outdoor market operator.

The numerator value evaluates the mean reduction rate of inputs or input inefficiency of the *k*th outdoor market operator. Similarly, the reciprocal of denominator evaluates the mean expansion rate of outputs or output inefficiency of the *k*th outdoor market operator. Thus, the value of p_k can be interpreted as the product of input and output inefficiencies. This model is known as SBM-CRS model (Tone, 2001).

The *k*th outdoor market operator is said to be Pareto efficient if all slacks are 0, i.e., $s_{ik}^{-*} = s_{rk}^{+*} = 0$ for all i and r , which is equivalent to p_k^* = 1. The non-zero slacks and (or) $p_k^* < 1$ identify the sources and amount of any inefficiency that may exist in the *k*th outdoor market operator. The reference set shows how input can be decreased and output can be increased to make the kth outdoor market operator. Subsequently, the PTE is determined by SMB-VRS model and we can calculate SE for every market operator.

However, some considerations are proven for the use of SBM-DEA model:

(1) a DMU is said to be SBM-efficient if and only if $p^* = 1$, i.e., when there is no input excess and no output shortfall in an optimal solution;

(2) a DMU can become efficient and improve its performance by deleting excess inputs and augmenting the output shortfalls; and

(3) the optimal SBM efficiency score p^* for any DMU is not greater than the optimal CCR efficiency score θ*.

The results of SBM-CRS and SBM-VRS models are calculated using DEA Solver.

Data

The group of street vendors identified in the study also includes farmers that operate in the area of the open air market in Greater Torino (Torino Città Metropolitana), ie Torino city and province.

Torino is the city of the Salone del Gusto and Terra Madre, the most popular Slow Food events (Parkins and Craig, 2009) and Eataly, the Italian retailer of quality national food products with an international chain of shops (Massa and Testa, 2012; Bertoldi et al., 2015). Grande Torino's main characteristic is its 432 open air markets, where two thirds of them sell food products. Torino city has 42 of the largest and oldest i.e. Porta Palazzo (Black, 2012; Gilli and Ferrari, 2018).
This study covers the area of 27 main outdoor markets (with at least 50 street vendors) in Greater Torino (North-West Italy), with a sample of 196 operators (DMUs) made up of farmers and street food traders. The 27 fruit and vegetable outdoor markets selected are: Porta Palazzo (farm fruit and vegetable and street food traders market), Baltimora, Benefica, Brunelleschi, Chieti, Cincinnato, Crocetta, Don Grioli, Guala, Nitti, Madama Cristina, Pavese, Racconigi, Santa Giulia, Sebastopoli, Svizzera in the Torino city area were studied. Likewise the Province of Torino's fruit and vegetable markets of Carmagnola, Chieri, Chivasso, Collegno, Giaveno, Moncalieri, Orbassano, Pianezza, Pinerolo, Rivalta, Rivoli were also studied.

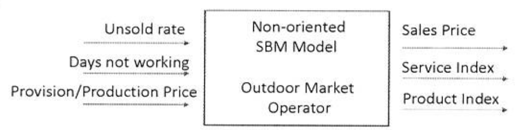
Table.1 Sample description

	Farmers	Street Food Traders	Tot
Porta Palazzo	35	35	70
City	20	46	66
Province	24	36	60
Total	79	117	196

The homogeneity of DMUs should be expected in DEA. Therefore, we selected operators through the following process in order to ensure as much homogeneity as possible. First, in order to secure location homogeneity, we selected operators (farmers and street food traders) in the same market. Only those operators with more than one year in the outdoor market were considered as new operators require a certain period of time to consolidate their business and build up clientele. The sample is made up of 117 street food traders and 79 farmers.

Inputs and outputs
In order to apply DEA successfully, the choice of input and output variables is critical. Input and output variables for DEA should be chosen so that they accurately reflect the outdoor market operators' strategic goals, in terms of sales, customer satisfaction and food waste management systems. In this study, the input and output variables were selected, wherever possible, with consideration of variables used in previous studies for the retail and circular economy. Three inputs and three outputs were selected through this process. The inputs are the provision price (for street food traders) or production cost (for farmers), unsold rate, the number of days the operators don't work (Chen et al., 2005; Perrigot and Barros, 2008; Uyar et al., 2013; Yang et al., 2007). The outputs are: sales price, customer satisfaction index for services and customer satisfaction index for products (Donthu and Yoo, 1998; Yang et al., 2007; Sharma and Choudhary, 2010).

Figure 1. Dea Model



All variables were obtained from two different questionnaires, with the exception of the sales price that was checked directly. One questionnaire was for market operators and the other for final consumers. We defined a range of products with an average price in order to determine the sales and production prices, based on whether a retailer or street food trader was answering the questionnaire. This same range of products was used to understand the sales price and that of the unsold goods. It was made up of six products normally sold at the market in the autumn (white garlic, kale, carrots, fennel, green celery and cauliflower).
In order to check the reliability and quality of the data collected – especially when determining the sales price - we compared the values the single operators had given us with the day's price concerning the range of products, applied by the local fruit and vegetable wholesale market and making necessary adjustments, when there were significant discrepancies.

Questionnaire design
Market operators answered the questionnaire between October and December 2018. They were interviewed in the market areas (Leiper and Clarke-Sather, 2017) on market days between 6:00 a.m and 9:00 a.m. Interviews lasted an average of 20 minutes. Interviewers asked the questions, recorded the answers and made note of the main subjects. The results obtained were then put into groups, compared and the fundamental issues pertinent to the aims of the research were set aside. The first version of the questionnaire was used as a sample of 12 street food traders (6 farmers and 6 street food traders), working in the Porta Palazzo market in order to identify any errors and assess any structural weaknesses (Vecchio and Annunziata, 2013; Clonan et al., 2009). Based on the results obtained, some corrections were made and the final version was then made available for use on the whole project.
Information requested included the interviewees' demographic, social and educational status (eg. gender, age, residency, nationality, job, education) and features of their business (eg. number of days spent at market per week, purchase and/or production price, profit margin). Other information requested concerned food waste in the market areas (eg. perception of waste generated, possible initiatives to reduce its quantity) and how unsold goods were treated (eg. donating it, taking part in community initiatives favouring redistribution).
The second questionnaire was carried out with the final consumer in order to determine their level of satisfaction. On average, 10 questionnaires of final consumers were collected per market operator and for a total of 2,107. Here below, is the information collected in the questionnaire:

- Interviewee's data i.e. age, gender, residency, education, job.
- How often they buy from street food traders and farmers at market i.e. number of days a week;
- Level of satisfaction regarding service experience i.e. waiting time to be served, information from seller through conversation, information written on stall;
- Level of satisfaction regarding the product purchased i.e. assessment of its look, smell, taste (where possible), assessment of the product's origin, assessment of price;

All data concerning the level of satisfaction of the service and product was collected through Likert-type scale questions to assess the consumer's satisfaction for every single agro-food operator. A ten-point Likert-scale was used, ranging from 1 to 10 i.e. 1 = very dissatisfied, 10 = very satisfied, in line with other authors (Coelho and Esteves, 2007).

Table 2. Descriptive statistics of the variables used.

Variables	Minimum	Maximum	Mean	Standard Deviation

Inputs				
Unsold rate	0	0.28	0.15	0.06
Provision/production price	0.80	1.88	1.21	0.29
Days not working	1	6	2.15	1.71
Outputs				
Sales price	1.09	2.85	1.91	0.51
Service index	1.00	10.00	6.50	1.76
Product index	1.00	10.00	6.64	1.78

Findings

4.1. Efficiency Scores

The distribution of the efficiency scores of 196 outdoor market operators is shown in Figure 2. Figure 2 shows the efficiency scores obtained from SBM-CRS and SBM-VRS models. In SBM-CRS model, the efficiency score (OTE) ranges from 0.099 to 1.000, with an average of 0.620 (the dotted line in Figure 2) and a standard deviation of 0.218.

The number of efficient outdoor market operators is 31, indicating that 16% of the sample are efficient. This means that 84% of the outdoor market operators are inefficient, so there is an opportunity to improve efficiency for these operators.

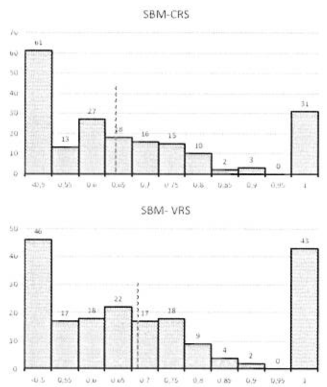
The efficiency scores of 69% outdoor market operators are less than 0.75. Therefore, efficient and ineffective outdoor market operators are strongly distinct.

The efficiency score (PTE) ranges from 0.099 to 1.000 in the SBM-VRS model, with an average of 0.664 (the dotted line in Figure 1) and a standard deviation of 0.222.

The number of efficient outdoor market operators is 43, indicating that 22% of the sample are efficient. This means that 78% of the outdoor market operators are inefficient, and there is an opportunity to improve efficiency for these outdoor market operators.

The efficiency scores of 61% outdoor market operators are less than 0.75. Therefore, it is found that the efficient and ineffective outdoor market operators are strongly distinct.

Figure 2. Histogram of efficiency score in SBM-CRS and SBM-VRS



4.2. Comparison of Efficiency and evaluation of the main factors to affect it

Is the efficiency of the outdoor market operators different depending on the characteristics of the type of operators (farmers or street food traders)? For example, is the street food trader more efficient than the farmer? Or is it the opposite?

The tables below show descriptive statistics of the variables selected for each of the two categories of operator identified: street food traders and farmers.

On analysis, it emerges that on average street food traders' prices are lower than farmers, but reach lower levels of customer satisfaction. Farmers, on the other hand, have a lower % on average of unsold goods, but the production cost of their goods is higher compared to street food traders. What impact do these differences have on the level of efficiency reached?

Table 3. Descriptive statistics of the variables used for type of operators.

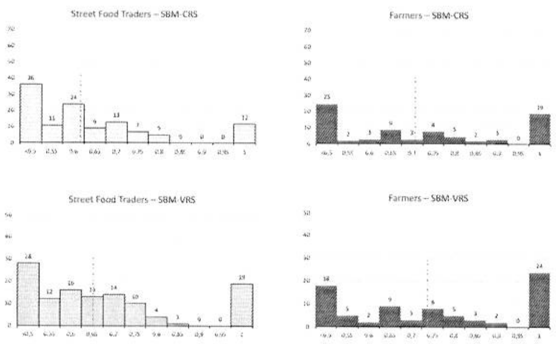
Variables	Minimum	Maximum	Mean	Standard Deviation
Street Food Traders				
Inputs				
Unsold rate	0.03	0.29	0.17	0.06
Provision/production price	0.80	1.23	1.00	0.12
Days not working	1	6	2.15	1.69
Outputs				
Sales price	1.09	2.00	1.53	0.22
Service index	1.00	10.00	6.22	1.65
Product index	1.00	9.60	6.28	1.68
Farmers				
Inputs				
Unsold rate	0	0.24	0.12	0.07
Provision/production price	1.30	1.88	1.54	0.15
Days not working	1	6	2.17	1.76
Outputs				
Sales price	2.11	2.85	2.47	0.21
Service index	2.00	10.00	6.93	1.85
Product index	1.00	9.60	7.17	1.80

The average efficiency score of the street food traders in the SMB-CRS model is 0.583 and 0.676 for farmers. Farmers also reach a higher efficiency score than street food traders in the SBM-VRS model.

Table 4. The DMU's efficiency scores.

Efficiency scores	Minimum	Maximum	Mean	Standard Deviation
SBM-CRS				
Street food traders	0.099	1.00	0.583	0.198
Farmers	0.217	1.00	0.676	0.236
SBM-VRS				
Street food traders	0.099	1.00	0.628	0.211
Farmers	0.217	1.00	0.718	0.232

Figure 3. Histograms of efficiency score for each operator



The approach used to analyze efficiency is a valid tool and the results obtained provide useful indications for implications regarding performance and management. The authors also calculated the potential for improvement for each inefficient unit in order to provide useful managerial tools. This is presented as the percentage of change in each input or output variable necessary for the unit to become 100% efficient. It can have a positive or negative value, indicating whether the inputs or outputs are too large or too small to reach the optimal level. The potential improvement is calculated on the actual and target scores (the value of input or output that should be achievable by the sample and which would ensure a 100% efficiency) determined for each sample. The analysis of slacks for street food traders reveals a surplus of resources due mostly to the unsold rate of over 66% compared to the average. For farmers, however, it is necessary to decrease production cost and time not spent at market by at least one day. The slacks analysis for the outputs underlines as, for the street food traders, the product index should be increased, improving the offer quality.

Figure 4. Slack for inputs and outputs

Discussion and conclusion

This work aims at analysing how outdoor market fruit and vegetable operators manage their unsold products and if this management can provide a competitive advantage. In theory, food waste generated over different phases of the food supply chain makes food operators' costs increase whether in the performance of their core business in terms of production and distribution, managing waste and consequential costs of disposal.

These higher costs reduce the operator's efficiency and result in higher prices for the consumer (Bonomi and Ricciardi, 2017). And of course, company policy that does not keep track of the reduction of waste can worsen an operator's assessment and reputation as the consumer always tends to maintain the phenomenon of wasting food as socially unacceptable.

This collective approach is made even worse by the period of transition we are in at the moment and which is characterised by the prospect of uncertain economic development that involves increasing members of the community (Bonomi and Ricciardi, 2017; Moggi et al., 2017). In fact, thanks to this report, operators working in the distribution phase are increasingly more aware of food waste issues and personally approach their customers. In fact, they show a greater ability to manage and control the phenomenon than the facts show and declare they do not need support and/or take part in programmes to reduce food waste because they don't produce any. It is clear that retailers see the reduction of food waste as a problem of image rather than a problem of substance (Bonomi and Ricciardi, 2017; Moggi et al., 2017).

In the case of outdoor food markets, it has been shown that several retailers, namely Farmers and Street food traders have a different attitude towards managing unsold goods and consequent food waste. In fact, on one hand, farmers associate the definition of food waste to words like "reuse" and "unsold", considering the possibility of using the unsold food differently at the end of the day, normally, by donating it or using it as fertiliser. Street food traders, however, associate the definition of food waste with the meaning of losing food anywhere along the food chain - not tending to donate unsold food or give discounts at the end of the market and not linking the concept to the opportunity of recycling or reusing (Peira et al., 2018).

In light of these considerations, this study highlights how careful management of unsold goods and consequential food waste can be a positive and competitive element for a company. In fact, based on the results achieved, the less food waste there is, the better the performance in terms of efficiency. This has been demonstrated by the different approach of farmers and street food traders in the Greater Torino market areas. In particular, the analysis showed that through their food waste management, farmers seem to reach greater performance compared to the traditional street food traders, contributing to the improvement in how competitive a company is and therefore greater efficiency of waste in the open air market. These observations suggest that the operators who manage different stages of the food chain ie farmers, are more aware of the natural cycles and so also of the circular economy, and this results in better food waste management.

On one hand, these results seem to underline the importance of strengthening the connection between the local area, products and farming culture in order to improve the performance in terms of managing unsold and waste food. On the other hand is the need to get the different operators to work together in order to manage waste more efficiently.

In this last case, it would be useful if initiatives could be set up to change organisational habits i.e. standard collection of unsold goods aimed at improving performance in the market areas.

In fact, collecting left over food which can still be used - especially fruit and vegetables – from the market areas can contribute to creating value. This is the case for individual operators, in terms of reducing costs or improving efficiency, but also for society as a whole in terms of reducing negative impact e.g. waste disposal and increasing positive impact e.g. boosting initiatives in favour of guaranteeing food security. This situation shows that unsold and unsaleable food, even though it has lost its commercial value at market, still has potential that allows it to maintain positive aspects in economic and social terms. An organisational structure that is able to connect all retailers i.e. farmers and street food traders, with all potential consumers seems necessary in order to improve the efficiency of the retail system thanks to advantages for everyone involved. The advantages can be identified in economic benefit, reduction in environmental impact and positive ethical-social effects.

Implications, limitations and future research

Literature about fruit and vegetable outdoor market operators and how they manage food waste has not yet been completely developed and so there are still some issues untouched. For example, to date there has never been an assessment on how competitive different market operators are, which are identified as Farmers and Street food traders in this study. The results obtained show that the awareness of the natural life cycles leads to greater respect for the circular economy concept that represents a useful element to increase competition between outdoor market operators.

The data collected, however, also revealed some limitations determined by the methodology applied, like the study's limited area, as in that this study evaluated a large Italian city and its surrounding area, the number of variables analysed, that tend to only be limited to certain aspects of the distribution and sales process i.e. as inputs "rate unsold" "provision/production price" "non-working days" and as outputs "sales price" "service index" "product index". In the future, the research project will be oriented towards analysing other urban and suburban areas in Italy and the rest of Europe with the aim of comparing the dynamics concerning managing unsold goods and company efficiency in different geographical areas.

References

Abou, E.A. (1995), "Bacteriological quality of ready to eat meals", *The Journal of the Egyptian Public Health Association*, Vol. 70 No. 5-6, pp. 627-641.

Agege, C.O. (1988), "Products and the consumer: An analysis of food and drug legislation in Nigeria", *Food Drug Cosmetic Law Journal*, Vol. 43 No. 1, pp. 201-214.

Alfiero, S., Lo Giudice, A. and Bonadonna, A. (2017), "Street food and innovation: the food truck phenomenon" *British Food Journal*, Vol. 119 No. 11, pp. 2462-2476.

Arcese, G., Flammini, S., Lucchetti, M.C. and Martucci, O. (2015), "Evidence and Experience of Open Sustainability Innovation Practices in the Food Sector", *Sustainability*, Vol. 7, pp. 8067-8090.

Ayedun, B., Okpachu, G., Manyong, V., Atehnkeng, J., Akinola, A., Abu, G. A., Bandyopadhyay, R. and Abdoulaye, T. (2017), "An assessment of willingness to pay by maize and groundnut farmers for aflatoxin biocontrol product in northern Nigeria", *Journal of food protection*, Vol. 80, No. 9, 1451-1460.

Barba, M. and Díaz-Ruiz, R. (2015), "Switching imperfect and ugly products to beautiful opportunities", Escajedo, S. E., & Renobales, S. *Envisioning a Future Without Food Waste and Food Poverty: Societal Challenges*, Wageningen Academic, The Netherlands, pp. 279-284.

Barilla (2012), "Lo spreco alimentare: cause, impatti e prodotti", available at: http://www.barillacfn.com/wp-content/uploads/2012/11/WEB_ITA.pdf (accessed 13 March 2019)

Barros, C., & Alves, C. A. (2003). Hypermarket retail store efficiency in Portugal. *International Journal of Retail & Distribution Management*, *31*(11), 549-560.

Battilani, A. (2014), "Limited access to resources: challenges or opportunities?", In *XIII International Symposium on Processing Tomato 1081*, June 2014, pp. 27-40.

Beausang, C., Hall, C. and Toma, L. (2017), "Food waste and losses in primary production: Qualitative insights from horticulture", *Resources, Conservation and Recycling*, Vol. 126, pp. 177-185.

Beretta, C., Stoessel, F., Baier, U. and Hellweg, S. (2013), "Quantifying food losses and the potential for reduction in Switzerland", *Waste management*, Vol. 33 No. 3, pp. 764-773.

Berg, N., & Preston, K. L. (2017). Willingness to pay for local food?: Consumer preferences and shopping behavior at Otago Farmers Market. *Transportation Research Part A: Policy and Practice*, *103*, 343-361.

Bertoldi, B., Giachino, C. and Stupino M. (2015), "Innovative approaches to brand value and consumer perception: the Eataly case", Journal of Customer Behaviour, Vol. 14 No. 4, pp. 353-367.

Black, R.E.(2012), Porta palazzo: The anthropology of an Italian market, University of Pennsylvania Press,pp. 1-221

Boansi, D., Tambo, J.A. and Müller, M. (2017), "Analysis of farmers' adaptation to weather extremes in West African Sudan Savanna", *Weather and Climate Extremes*, Vol. 16, pp. 1-13.

Boccia, F. and Covino, D.(2016), "Innovation and sustainability in agri-food companies: The role of quality", *Rivista di Studi sulla Sostenibilità*, Vol. 1, pp. 131-141.

Bonadonna, A., Matozzo, A., Giachino, C. and Peira, G. (2018), "Farmer behavior and perception regarding food waste and unsold food", *British Food Journal*.

Bond, M., Meacham, T., Bhunnoo, R., and Benton, T.G. (2013), "Food Waste Within Global Food Systems. A Global Food Security Report", Global Food Security, available at: http://www.foodsecurity.ac.uk/assets/pdfs/food-waste-report.pdf2 (accessed 20 February 2019).

Bonomi, S. and Ricciardi, F. (2017), "Trasformare lo spreco alimentare in risorsa sociale: Una soluzione organizzativa". *Impresa Progetto*, pp. 1-20.

Borrello, M., Caracciolo, F., Lombardi, A., Pascucci, S. and Cembalo, L. (2017), "Consumers' perspective on circular economy strategy for reducing food waste", *Sustainability*, Vol. 9 No. 1, 141.

Borrello, M., Lombardi, A., Pascucci, S. and Cembalo, L. (2016), "The seven challenges for transitioning into a bio-based circular economy in the agri-food sector", *Recent patents on food, nutrition & agriculture*, Vol. 8 No. 1, pp. 39-47.

Bovay, J. (2017), "Demand for collective food-safety standards" *Agricultural Economics*, Vol. 48 No. 6, pp. 793-803.

Bresciani, S. (2017), "Open, networked and dynamic innovation in the food and beverage industry", *British Food Journal*, Vol. 119 No. 11, pp. 2290-2293.

Buzby, J. C. and Hyman J. (2012), "Total and per capita value of food loss in the United States", *Food Policy*, Vol. 37, pp. 561–570.

Candelo, E., Casalegno, C., Civera, C. and Mosca, F. (2018), "Turning Farmers into Business Partners through Value Co-Creation Projects. Insights from the Coffee Supply Chain", *Sustainability*, Vol. 10 No. 4, 1018.

Capitanio, F., Coppola, A. and Pascucci, S. (2009), "Indications for drivers of innovation in the food sector", *British Food Journal*, Vol. 111, pp. 820–838.

Carron, M., Alarcon, P., Karani, M., Muinde, P., Akoko, J., Onono, J., Fèvre, E.M., Häsler, B. and Rushton, J. (2017), "The broiler meat system in Nairobi, Kenya: Using a value chain framework to understand animal and product flows, governance and sanitary risks", *Preventive Veterinary Medicine*, Vol. 147, pp. 90-99.

Charnes, A., Cooper, W. and Rhodes, E. (1978), "Measuring the efficiency of decision-making units", *European journal of operational research*, Vol.2, pp. 429–444.

Charnes, A., & Cooper, W. W. (1984). The non-Archimedean CCR ratio for efficiency analysis: a rejoinder to Boyd and Fare. *European Journal of Operational Research*, *15*(3), 333-334.

Chen, Y., Morita, H., & Zhu, J. (2005). Context-dependent DEA with an application to Tokyo public libraries. *International Journal of Information Technology & Decision Making*, *4*(03), 385-394.

Chen, Z. G., Li, X. and Fan, X. J. (2016), "Method for the discrimination of the variety of potatoes with vis/NIR spectroscopy", *Guang pu xue yu guang pu fen xi= Guang pu*, Vol. 36 No. 8, 2474-2478.

Cheng, Y., Zhang, Y., Ma, J. and Zhan, S. (2017), "Food safety knowledge, attitude and self-reported practice of secondary school students in Beijing, China: A cross-sectional study", *PLoS ONE*, Vol. 12 No. 11.

Cicatiello C., Franco S., Pancino B. and Blasi E. (2016), "The value of food waste: An exploratory study on retailing", *Journal of Retailing and Consumer Services*, Vol. 30, pp. 96–104.

Civera, C., De Colle, S. and Casalegno, C. (2019), "Stakeholder engagement through empowerment:

The case of coffee farmers", *Business Ethics: A European Review*, Vol. 28 No. 2, pp. 156-174.

Clark, J. and Manning, L. (2018), "What are the factors that an opportunity sample of UK students insinuate as being associated with their wastage of food in the home setting?", *Resources, Conservation & Recycling*, Vol. 130, pp. 20–30, https://doi.org/10.1016/j.resconrec.2017.11.005

Clonan, A., Holdsworth, M., Swift, J. and Wilson, P. (2009), "Awareness and attitudes of consumers to sustainable food", in Millar, K., West, P. H. and Nerlich, B. (Eds.) *Ethical Futures: Bioscience and Food Horizons,* Wageningen University: Wageningen, The Netherlands, pp. 205-210.

Coelho, P. S. and Esteves, S. P. (2007), "The choice between a fivepoint and a ten-point scale in the framework of customer satisfaction measurement", *International Journal of Market Research*, Vol. 49, pp. 3, pp. 313-339.

Contò, F., Fiore, M., Vrontis, D. and Silvestri, R. (2015), "Innovative marketing behaviour determinants in wine SMEs: The case of an Italian Wine Region", *International Journal of Globalisation and Small Business*, Vol. 7 No. 2, pp. 107-124.

Cooper, W. W., & Tone, K. (1997). Measures of inefficiency in data envelopment analysis and stochastic frontier estimation. *European Journal of Operational Research*, *99*(1), 72-88

Corsi, S., Marchisio, L.V. and Orsi, L. (2017), "Connecting smallholder farmers to local markets: Drivers of collective action, land tenure and food security in East Chad", *Land Use Policy*, Vol. *68*, pp. 39-47.

Dadura A. M. and Tzong-Ru L. (2011), "Measuring the innovation ability of Taiwan's food industry using DEA", *Innovation: The European Journal of Social Science Research*, Vol. 24 No. 1-2, pp.151-172.

Danso, G.K., Otoo, M., Ekere, W., Ddungu, S. and Madurangi, G. (2017), "Market feasibility of faecal sludge and municipal solid waste-based compost as measured by farmers' willingness-to-pay for product attributes: Evidence from Kampala – Uganda", *Resources*, Vol. 6 No. 3, 31.

Díaz, A.I., Laca, A., Laca, A. and Díaz, M. (2017), "Treatment of supermarket vegetable wastes to be used as alternative substrates in bioprocesses", *Waste Management*, Vol. 67, pp. 59-66.

Dimara, E., Skuras, D., Tsekouras, K. and Tzelepis, D. (2008), "Productive efficiency and firm exit in the food sector", *Food Policy*, Vol. 33, pp. 185 - 196

Donthu, N., & Yoo, B. (1998). Retail productivity assessment using data envelopment analysis. *Journal of retailing*, *74*(1), 89-105.

Ellen MacArthur Foundation (2013), *Towards the Circular Economy*, vol.1., Isle of Wight.

Engstrom, R. and Carlsson-Kanyama A. (2004), "Food losses in food service institutions Examples from Sweden", *Food Policy*, Vol. 29, pp. 203–213.

Eriksson, M. and Spångberg, J. (2017), "Carbon footprint and energy use of food waste management options for fresh fruit and vegetables from supermarkets", *Waste Management*, Vol. 60, pp. 786-799.

Eriksson, M., Strid, I. and Hansson P.A. (2012), "Food losses in six Swedish retail stores: Wastage of fruit and vegetables in relation to quantities delivered", *Resources, Conservation and Recycling*, Vol. 68, pp. 14-20.

FAO (2017), "Food Wastage : Key Facts and Fingers", available at: http://www.fao.org/news/story/en/item/196402/icode/ (accessed 1 February 2019).

Färe, R., & Grosskopf, S. (2000). Theory and application of directional distance functions. *Journal of productivity analysis*, *13*(2), 93-103.

Fethi, M. D., & Pasiouras, F. (2010). Assessing bank efficiency and performance with operational research and artificial intelligence techniques: A survey. *European journal of operational research*, *204*(2), 189-198

Franceschelli, M. V., Santoro, G. and Candelo, E. (2018), "Business model innovation for sustainability: a food start-up case study", *British Food Journal*, Vol. 120 No. 10, pp. 2483-2494.

Gilli, M. and Ferrari, S. (2018), "Tourism in multi-ethnic districts: the case of Porta Palazzo market in Torino", *Leisure Studies*, Vol. 37 No. 2, 146-157.

Giménez-Garcìa, V.M., Marìnez-Parra, J.L. and Buffa F.P. (2007), "Improving resource utilization in multi-unit networked organizations: the case of Spanish restaurant chain", *Tourism Management*, Vol. 28, pp. 262-270.

Guerrero, L., Dolors Guardia, M., Xicola, J., Verbeke, W., Vanhonacker, F., Zakowska-Biemans, S., Sajdakowska, M., Sulmont-Rossé, C., Issanchou, S., Contel, M., Scalvedi, M. L., Signe Granli, B. and Hersleth, M. (2009), "Consumer-driven definition of traditional food products and innovation in traditional foods. A qualitative cross-cultural study", *Appetite*, Vol. 52 No. 2, pp. 345-354.

Guo, P. and Zhang, X. (2014), "Study on circular economy education in rural areas in China", In *International Conference on Logistics Engineering, Management and Computer Science, May 2014*), Atlantis Press.

Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R., and Meybeck A. (2011), "Global Food Losses and Food Waste", FAO Report, Rome, available at: http://www.fao.org/docrep/014/mb060e/mb060e.pdf (accessed 18 March 2019)

Halog, A. (2009). Models for evaluating energy, environmental and sustainability performance of biofuels value chain. *International Journal of Global Energy Issues*, *32*(1-2), 83-101.

Hudson, U. and Messa M. (2014), "Documento di posizione sulle perdite e gli sprechi alimentari", Slow Food, available at: http://www.slowfood.com/sloweurope/wp-content/uploads/ITA-position-paper-foodwaste.pdf (accessed 2 March 2019)

Hulbrock, E., Otten, J. J., Quinn, E., Johnson, D. B. and Lerman, S. (2017), "Exploring the Use of Seattle's Farmers' Market Incentive Program ("Fresh Bucks") by Household Food Security Levels", *Journal of Hunger & Environmental Nutrition*, Vol. 12, No. 3, pp. 362-374.

IME (2013), "Global Food Waste Not, Want Not", available at: www.imeche.org/docs/default-source/reports/Global_Food_Report.pdf?sfvrsn=0. (accessed 18 February 2019).

Islam, Z., Alauddin, M. and Sarker, M.A.R. (2017), "Determinants and implications of crop production loss: An empirical exploration using ordered probit analysis", *Land Use Policy*, Vol. 67, pp. 527-536.

Jakki, M., Sanjit, S. and Stanley, S. (2010), *"Marketing of High-technology Products and Innovations",* Pearson: London.

Janssens, F. (2014), "Street food markets in Amsterdam: Unravelling the original sin of the market trader", in Cardoso, R. D. C. V., Companion, M. and Marras, S. R. (Eds.). *Street food: Culture, economy, health and governance*. Routledge, pp. 98-116.

Jara-Samaniego, J., Pérez-Murcia, M.D., Bustamante, M.A., Paredes, C., Pérez-Espinosa, A., Gavilanes-Terán, I., López, M., Marhuenda-Egea, F.C., Brito, H. and Moral, R. (2017), "Development of organic fertilizers from food market waste and urban gardening by composting in Ecuador", *PLoS ONE*, Vol. 12 No. 7, art. no. e0181621.

Jurgilevich, A., Birge, T., Kentala-Lehtonen, J., Korhonen-Kurki, K., Pietikäinen, J., Saikku, L. and Schösler, H. (2016), "Transition towards circular economy in the food system", *Sustainability*, Vol. 8 No. 1, 69.

Kadir, A.A., Azhari, N.W. and Jamaludin, S.N. (2016), "An overview of organic waste in composting", in *MATEC Web of Conferences*, 2016, art. no. 05025

Kahraman, C., Uluğ, İ., Othan, C. B., Özkan-Özen, Y. D. and Kazançoğlu, Y. (2018), "Efficiency Analysis in Retail Sector: Implementation of Data Envelopment Analysis in a Local Supermarket Chain", In *The International Symposium for Production Research*, August 2018, Springer, Cham, pp. 884-897.

Kilcher, L. (2006), "Organic agriculture in Cuba: Getting by with one's own resources", Geographische Rundschau.

Ko, K., Chang, M., Bae, E. S., & Kim, D. (2017). Efficiency analysis of retail chain stores in Korea. *Sustainability*, *9*(9), 1629.

Kristensen, D. K., Kjeldsen, C. and Thorsøe, M. H. (2016), "Enabling sustainable agro-food futures: exploring fault lines and synergies between the integrated territorial paradigm, rural eco-economy and circular economy", *Journal of Agricultural and Environmental Ethics*, Vol. 29 No. 5, pp. 749-765.

Kumar, S. and Gulati, R. (2008), "An examination of technical, pure technical, and scale efficiencies in Indian public sector banks using data envelopment analysis", *Eurasian Journal of Business and Economics*, Vol. 1 No. 2, pp. 33-69.

Lebersorger S. and Schneider F. (2014), "Food loss rates at the food retail, influencing factors and reasons as a basis for waste prevention measures", *Waste Management*, Vol. 34, pp. 1911–1919.

Lee, J. (2017), "Farmer participation in a climate-smart future: Evidence from the Kenya agricultural carbon market project", *Land Use Policy*, Vol. 68, pp. 72-79.

Leiper, C. and Clarke-Sather, A. (2017), "Co-creating an alternative: the moral economy of participating in farmers' markets", *Local Environment*, Vol. 22 No. 7, pp. 840-858

Lundqvist J. (2009), "Losses and waste in the global crisis", *Reviews in Environmental Science and Bio/Technology*, Vol. 8, pp. 121–123.

Massa, S. and Testa, S. (2012), "The role of ideology in brand strategy: The case of a food retail company in Italy", *International Journal of Retail and Distribution Management*, Vol. 40 No. 2, pp. 109-127

McDonough, W. and Braungart, M. (2002), *Cradle to cradle: Remaking the way we make things*, 1st ed., North Point Press, New York.

Mirhedayatian, S.M., Azadi M. and Saen, R.F. (2014), A novel network data envelopment analysis model for evaluating green supply chain management, *International Journal of Production Economics*, Vol. 147, pp. 544–554.

Moggi, S., Bonomi, S. and Ricciardi, F. (2018), "Against Food Waste: CSR for the Social and Environmental Impact through a Network-Based Organizational Model", *Sustainability*, Vol. 10 No. 10, 3515.

Mondéjar-Jiménez, J. A., Ferrari, G., Secondi, L. and Principato, L. (2016), "From the table to waste: An exploratory study on behaviour towards food waste of Spanish and Italian youths", *Journal of Cleaner Production*, Vol. 138, pp. 8-18.

Mostafa, M.M. (2009), "Benchmarking the US specialty retailers and food consumer stores using data envelopment analysis", *International Journal of Retail & Distribution Management*, Vol. 37 No. 8, pp. 661–679.

Nahman, A., De Lange, W., Oelofse, S. and Godfrey, L. (2012), "The costs of household food waste in South Africa", *Waste Management*, vol. *32* No. 11, pp. 2147-2153.

Nonvide, G.M.A., Sarpong, D.B., Kwadzo, G.T.-M., Anim-Somuah, H. and Amoussouga Gero, F. (2017), "Farmers' perceptions of irrigation and constraints on rice production in Benin: a stakeholder-consultation approach", *International Journal of Water Resources Development*, Vol. 34 No. 6, 1001-1021.

Onono, J.O., Alarcon, P., Karani, M., Muinde, P., Akoko, J.M., Maud, C., Fevre, E.M., Häsler, B. and Rushton, J. (2018), "Identification of production challenges and benefits using value chain mapping of egg food systems in Nairobi, Kenya", *Agricultural Systems*, Vol. 159, pp. 1-8.

Otieno, P.S., Ogutu, C.A., Mburu, J. and Nyikal, R.A. (2017), "Effect of Global-GAP policy on climate change perceptions of smallholder French beans farmers in central and Eastern Regions, Kenya", *Climate*, Vol. 5 No. 2, 27.

Pagotto, M., & Halog, A. (2016). Towards a circular economy in australian agri-food industry: an application of input-output oriented approaches for analyzing resource efficiency and competitiveness potential. *Journal of Industrial Ecology*, *20*(5), 1176-1186.

Parfitt., J., Barthel, M. and Macnaughton S. (2010), "Food waste within food supply chains: quantification and potential for change to 2050", *Philosophical Transation B of the Royal Society*, Vol. 365, pp. 3065-3081.

Parkins, W. and Craig, G. (2009), "Culture and the politics of alternative food networks", *Food, Culture and Society*, Vol. 12 No. 1, pp. 77-103.

Pearce, D.W. and Turner R. K. (1989), *Economics of Natural Resources and the Environment*, Johns Hopkins University Press.

Peira, G., Bollani, L., Giachino, C. and Bonadonna, A. (2018), "The management of unsold food in outdoor market areas: food operators' behaviour and attitudes", *Sustainability*, Vol. 10 No. 4, 1180.

Peri, C. (2006), "The universe of food quality", *Food Quality and Preference*, Vol. 17, pp. 3-8.

Perrigot, R., & Barros, C. P. (2008). Technical efficiency of French retailers. *Journal of Retailing and Consumer Services*, *15*(4), 296-305.

Rama, R. (1996), "Empirical study on sources of innovation in international food and beverage industry", *Agribusiness*, Vol. 12, pp. 123–134.

Reynolds, D. and Thompson, G.M. (2007), "Multiunit restaurant productivity assessment using three-phase data envelopment analysis", *Hospitality Management*, Vol. 26, pp. 20-32.

Santoro, G., Vrontis, D. and Pastore, A. (2017), "External knowledge sourcing and new product development: evidence from the Italian food and beverage industry", *British Food Journal*, Vol. 119 No. 11, pp. 2373-2387.

Sharma, V., & Choudhary, H. (2010). Measuring operational efficiency of retail stores in Chandigarh Tri-city using DEA. *Journal of Services Research*, *10*(2), 99

Sisson, L.G. (2016), "Food Recovery Program at Farmers' Markets Increases Access to Fresh Fruits and Vegetables for Food Insecure Individuals", *Journal of Hunger and Environmental Nutrition*, Vol. 11 No. 3, pp. 337-339.

Smil, V. (2004), "Improving Efficiency and Reducing Waste in Our Food System", *Environmental Sciences*, Vol. 1 No. 1, pp. 17-26.

Stahel, W. and Reday, G., (1976), *The potential for substituting manpower for energy*, Report to the Commission of the European Communities.

Stenmarck, A., Jensen, C., Quested, T. and Moates, G. (2016), Estimates of European Waste Levels, Fusion Project, Commissioned by European Commission; Fusions: Stockholm, Sweden, 2016.

Stuart, T. (2009), *Sprechi. Il cibo che buttiamo, che distruggiamo, che potremmo utilizzare*, Bruno Mondadori, Milano, 47-52

Tone, K. (2001). A slacks-based measure of efficiency in data envelopment analysis. *European journal of operational research*, *130*(3), 498-509.

Traill, W.B. and Meulenberg, M. (2002), "Innovation in the food industry". *Agribusiness*, Vol. 18, pp. 1–21.

UE (2014), "Commission staff working document impact assessment on measures addressing food waste to complete SWD 207 regarding the review of EU waste management targets". Annex 3, available at: http://register.consilium.europa.eu/doc/srv?l=EN&t=PDF&f=ST+11598+2014+ADD+12 (accessed 20 February 2019)

UE (2012), "Risoluzione del Parlamento europeo del 19 gennaio 2012. Evitare lo spreco di alimenti", available at: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P7-TA-2012-0014+0+DOC+XML+V0//IT (accessed 2 February 2019)

UNEP, "Food Waste: The Facts", available at: http://www.worldfooddayusa.org/food_waste_the_facts (accessed 2 February 2019)

Uyar, A., Bayyurt, N., Dilber, M., & Karaca, V. (2013). Evaluating operational efficiency of a bookshop chain in Turkey and identifying efficiency drivers. *International Journal of Retail & Distribution Management*, *41*(5), 331-347.

Vecchio, R. and Annunziata, A. (2013), Consumers' attitudes towards sustainable food: A cluster analysis of Italian university students", *New Medit*, Vol. 12 No. 2, pp. 47-56

Verghese, K., Lewis, H., Lockrey, S. and Williams H. (2013), "The role of packaging in minimising food waste in the supply chain of the future. Final Report", RMIT University, available at: http://www.chep.com/foodwaste/ (accessed 10 March 2019)

Vrontis, D., Bresciani, S. and Giacosa, E. (2016), "Tradition and innovation in Italian wine family businesses", *British Food Journal*, Vol. 118 No. 8, pp. 1883-1897.

Weber, C.A. (1996), "A data envelopment analysis approach to measuring vendor performance", *Supply Chain Management: An International Journal*, Vol. 1 No. 1, pp. 28-39.

WRAP (2009), "Household Food and Drink Waste in the UK. Report prepared by WRAP", available at: http://www.wrap.org.uk/sites/files/wrap/Household%20food%20and%20drink%20waste%20in%20the%20UK%20-%20report.pdf (accessed 2 February 2019)

Yang, C., Wang, J. T. C., & Lu, W. M. (2007). Performance measurement in military provisions: The case of retail stores of Taiwan's General Welfare Service Ministry. *Asia-Pacific Journal of Operational Research*, *24*(03), 313-332.

Yang, H., & Pollitt, M. (2010). The necessity of distinguishing weak and strong disposability among undesirable outputs in DEA: environmental performance of Chinese coal-fired power plants. *Energy Policy*, *38*(8), 4440-4444.

Youssouf, I., Youssouf, M.L., Soumarkamla, D. and Ayao, M. (2012), "Traditional poultry supply and marketing in the city of N'Djamena in Chad", *International Journal of Poultry Science*, Vol. 11 No. 5, pp. 341-348.

Yu, H., Gibson, K. E., Wright, K. G., Neal, J. A. and Sirsat, S. A. (2017), "Food safety and food quality perceptions of farmers' market consumers in the United States", *Food control*, Vol. 79, pp. 266-271.

Zhang, M., Jin, Y., Qiao, H. and Zheng, F. (2017), "Product quality asymmetry and food safety: Investigating the one farm household, two production systems of fruit and vegetable farmers in China", *China Economic Review*, Vol. 45, pp. 232-243.