

## **ECONOMIC ANALYSIS AND MANAGEMENT OF BREAD WASTE FROM PRODUCERS: RESULTS OF A SURVEY CONDUCTED IN SICILY (ITALY)**

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### **Abstract**

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The reduction of waste is a key objective for the EU. This issue has gained a greater media interest only recently, due to its importance in terms of sustainability. Within the agri-food system, waste affects the whole chain. The main aim of this research is to identify the quantity of waste of bread and bread derivatives in the analyzed sales points and to understand whether or not the variables relative to the analyzed socio-economic context affect this phenomenon. The research project aims at analyzing the behaviour of the sales point's owner regarding the food raw materials' supply procedure and frequency. The aim is also to analyze the size of the food supply and the relative sale in order to calculate the inventories; to identify the groups of foodstuffs which have a greater waste; to analyze the management of redundancies and to identify the most frequent waste disposal methods. The instrument used in this survey is a questionnaire structured with multiple-choice questions. The choice of the sample has been made by only taking into account the companies producing bread and oven-produced products. In order to obtain indications as exhaustive, truthful and consistent with reality as possible, 113 companies located in the territory of Southern Italy (Sicily) have been identified.

*Key words:* agri-food supply chain; food waste; bread; food supply

### **Introduction: Analysis of the Wastes throughout the Agri-Food Supply Chain**

Food waste is present throughout the agri-food supply chain: on farms, in the transformation and distribution processes, in restaurants, in canteens and even at home. The reasons determining waste are different throughout the supply chain. According to a study carried out in 2016 by FAO (FAO, 2017), it turns out that 58.1% of food waste is generated by the economic activities which are present throughout the food supply chain, while 41.9% of wastes are ascribable to consumers. In the production activity a significant 66.5% of products appear to be in surplus, and in the distribution the surplus amounts to 22.3%, in the catering it is equal to 6%, and finally in the manufacturing it amounts to 5.2%. The European Commission has identified the following main causes of food loss and waste:

#### ***Food overproduction***

The above mentioned FAO data, indeed, show us that every EU citizen daily has 3.450 kcal, 105 g of proteins on average and as many as 143 grams of fats at his/her disposal. These levels are around one and half times those recommended for energy, 1.8 times those of proteins and 4 times those of fats. Food overproduction is determined by the increase of the world population and by the consumers' growing needs. This system was born in a particular period, when the most important energy source, oil, had a low cost, and it was, therefore, possible to enhance productive activities. Today, however, the situation is different, since the cost of oil has increased exponentially and it is no longer possible to manage to keep the previous production rates. Waste in fields is the first step in which foods are thrown away. Farming is influenced by different factors, such as: weather conditions, crop pests, unfavourable years. The uncertainty of production levels pushes the farmer to produce in a

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quantity which is superior to that required by the market. Unsold foods are wastes for human nutrition, wastes of labour, of water and energies (Gocmen et al., 2009).

#### ***High aesthetic standards of the market***

Large-scale retail and GDOs have strongly influenced the demands of the consumers requiring product with perfect aesthetic features (Darani et al., 2017; Lanfranchi et al., 2015b).

#### ***Losses in the food transformation processing phase***

The transformation phase is the one immediately following the collecting phase. It is possible to identify two different types of transformation: the first one deals with the early phases of harvest handling and transformation (refrigeration of fruits and of foods in general), the second phase, instead, transforms the product from raw material into semi-finished or finished product (from milk to cheese, from wheat to pasta). The transformation phase, therefore, is characterized by many expected losses (Salvo et al., 2016; Serdaris et al., 2014).

#### ***Mistakes in the planning of production or of the demand***

Food industry is obliged to withdraw from big supermarkets some products which are defined seasonal (Easter eggs, panettones, etc.) which have market only in a specific period of the year. These products, despite being perfectly edible, most of the times are thrown away because the operations necessary to reintroduce the product into another distribution channel are too complex and expensive. It is extremely important to manage to define the consumer's demand with the best possible accuracy, in order to avoid the accumulation of unsold products in stock (Gellynck et al., 2009).

#### ***Waste in the distribution activity***

The waste of food products only in Italy is equal to 777.000 tons per year. Distribution is the phase of the food supply chain which acts as a bridge between the processing and the consumption phases. Most of wastes derive from this latter type of distribution and affect easily perishable products such as fruit, vegetable, dairy products and meat, which have shorter storage time compared to dried or packaged goods. GDOs which define the great quantity of generated waste show different attitudes.

#### ***Expiration dates***

By law, on each food product some expiration dates approximately indicating when the product is no longer edible must be present. The consumer is too reliant on the date written in the product label. It is important, therefore, to educate the consumer about a responsible purchase and consumption: in order to do so, it is necessary to have a double expi-

ration labelling indicating both the deadline of the product's sale (commercial deadline) and the deadline of the product's consumption (deadline for consumption).

#### ***Waste in the catering sector***

The catering sector is the source of a great quantity of wastes, the main reason being that it is difficult to succeed in programming the turnout in the premise and therefore the customer's request. It becomes evident that the dishes which have not been entirely consumed cannot be served again at the tables, but rather must be thrown away. Among the other reasons prompting the formation of wastes in this sector, we may find the big portions prepared and served, the quality standard required by some big catering chains and even the necessity to keep stocks constant in order to offer wide choices of menu at all times. Wastes in the dish represent the most significant part of losses in the catering sector (Agnoli et al., 2016).

#### ***Wastes in the Cereal Industry***

In order to analyze the characterization of the wastes of bakery products and of bread derivatives, it is necessary to consider that the mechanical reduction of the raw material generates a great quantity of waste biomass, generally identifiable with the term "bran" (Brancoli et al., 2017; Eriksson et al., 2017; Sumanac et al., 2013). According to its provenance, it has a different nature and quality. In the case of the grain of wheat, for example, only a part of it constitutes flour (around 80%), while the remaining 20% represents a by-product (bran). As well as this type of by-product, cereal processing industries have to dispose of other quantities of biomass, such as unsaleable products and the residuals of the local and machineries' (doughs, flour, etc.) washing procedures (Kim et al., 2012; Lanza et al., 2011). This industrial sector is characterized by a high production of waste biomass, with some features particularly suitable for the valorization in biogas plants (Selvaggi et al., 2017; Alimkulov et al., 2014; Chinnici et al., 2014). In Table 1 a characterization of the organic wastes resulting from this sector is proposed (Ratinger et al., 2016; Simeone et al., 2015; Gulmezoglu et al., 2010 and Havlíková et al., 2015).

## **Research Objective**

The main objective of this research is to identify the quantity of waste of bread and bread derivatives in the analysed sales points and to understand whether or not the variables relative to the analysed socio-economic context affect this phenomenon (Andersson and Ohlsson, 1999). Moreover, this survey sets itself the following objectives: to analyse the behaviour of the sales point's owner regarding the food raw materials' supply procedure and frequency; to analyse the size of the

**Table 1**  
**Characteristics of the cereal industry's organic wastes**

| Type of waste biomass    | Type of waste      | End use     | Factors of production kg waste/t finished product |
|--------------------------|--------------------|-------------|---|
| Bran                     | By-products        | Animal feed | 60-70   |
| Waste of production      | By-products /Waste | Animal feed | 20  |
| Machine washing residues | By-products /Waste | Animal feed | 5 - 10  |

Source: Our elaboration

food supply and the relative sale in order to calculate the inventories; to identify the groups of foodstuffs which have a greater waste; to analyze the management of redundancies and to identify the most frequent waste disposal methods. Therefore, this study is carried out with the aim of assessing the quantity of bread waste in some sales points in the cities of Palermo, Catania and Messina. Through the methodology adopted, it was possible to form a heterogeneous sample representative of the different regional realities: inhabitants, territory morphology and economic vocation.

## Methodology Used

The instrument used in this survey is a questionnaire structured with multiple-choice questions. The detection technique used was the administration of an on-line questionnaire, specially prepared according to the research objective, that was uploaded on the Google Forms platform of docs.google (Lanfranchi et al., 2014b). As regards the questionnaire's structuring, the first step was to analyze the literature concerning similar surveys. Subsequently, some bakers were interviewed in order to adapt the questionnaire and the formulation of the questions to the objectives the survey had set itself. The questions asked in the questionnaire were formulated in order to determine the main strengths and weaknesses of the sector being examined (Lanfranchi et al., 2015a). The choice of the sample was made by only taking into account the companies producing bread and oven-produced products. In order to obtain indications as exhaustive, truthful and consistent with reality as possible, 280 companies have been identified, and for the purposes of the present investigation, only 113 Sicilian companies have submitted a complete questionnaire reply. Data collections were carried out in the cities of Palermo, Catania and Messina, in the months between November 2016 and March 2017. Even though they do not represent a purely statistical sample due to the unavailability of the information basis for the random sampling of the respondents' names, the obtained results can be regarded as significant considering the sample size and the data quality (Boatto et al., 2016). The choice of the analysis is not down to chance, but it is carried out in order to highlight the sector's main strengths, in relation to the production of bread and bakery products. The aim of the research is also to identify the

main critical points, represented precisely by wastes, produced by the sector itself, and which producers have to dispose of or to ensure an optimal use in order to transform them from critical factors into additional resources for producers and entrepreneurs themselves (Giannetto et al., 2016; Scuderi and D'Amico, 2015; Lanfranchi et al., 2014; Ascuito et al., 2003).

### Analysis of the Sample Being Researched

Through the questionnaire it was possible to lay down the framework of the availability of agri-industrial wastes in the bakery and confectionery products' sector at the regional level and of the related disposal routes.

The analysis related to the business size, which refers to the average annual production of bread and of its derivatives, clearly shows that 64% of the sample surveyed is represented by small-sized businesses with an average annual production which is inferior to 500 quintals. The remaining part falls within the category of medium-sized businesses, with an annual production ranging from 500 and 2000 quintals (32%). The production consists mainly of bread, bakery pastry (buns, crackers, breadsticks, etc.) and confectionery products (cakes, tarts, biscuits, etc.). The sample consists of 61% rotisseries and bakeries and 27% pastry shops and bars (Table 2).

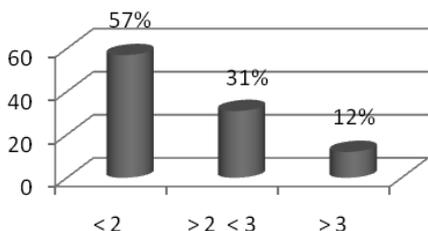
**Table 2**  
**Main socio-economic characteristics of consumers surveyed**

| Directions  | Characters   | n          | %          |
|---|--------------|------------|------------|
| Gender  | Male         | 89         | 79         |
|   | Female       | 24         | 21         |
|   | <b>Total</b> | 113        | 100        |
| Shop  | Restaurant   | 13         | 12         |
|   | Café/ bakery | 31         | 27         |
|   | Bakery/Deli  | 69         | 61         |
|   | <b>Total</b> | <b>113</b> | <b>100</b> |
| Dimensions of shop<br>(annual average production) | 100/500 q    | 72         | 64         |
|   | <500 >2000 q | 36         | 32         |
|   | > 2000       | 5          | 4          |
|   | <b>Total</b> | 113        | 100        |
| City  | Palermo      | 32         | 28         |
|   | Catania      | 33         | 29         |
|   | Messina      | 48         | 42         |
|   | <b>Total</b> | 113        | 100        |

Source: Our elaboration

### Description of the Research

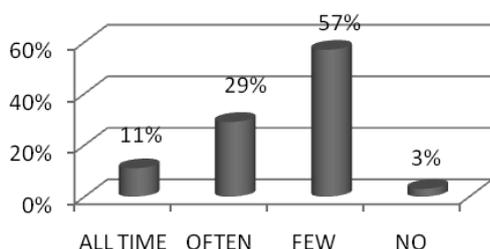
Most of the interviewed companies stated that they averagely produce a total amount of wastes which is not superior to 2 kilos each day (Figure 1), also arguing that a quantity superior to the one expressed would be synonymous with waste and therefore with a mismanagement of resources.



**Fig. 1. Daily quantity of bread wastes (in kilos)**

Source: Our elaboration

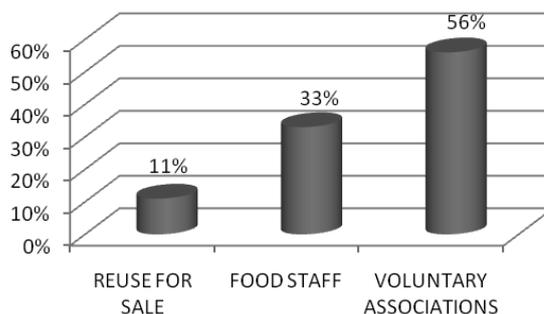
In order to identify the main reasons for waste in the sales points, some information regarding the warehouse management methods have been collected (Figure 2).



**Fig. 2. Warehouse stock**

Source: Our elaboration

57% of the respondents prefer not to have abundant warehouse stocks and this choice is influenced for 75% by the customers' needs. The choice of orders is mainly influenced by the expiration date, and indeed, 81% of entrepreneurs prefer to purchase short-term products. There are basically two reasons: to have products which are always fresh and for the immediate trade timing. Subsequently, the respondents were asked if they throw away redundant or unconsumed food. 65% of food traders prefer to trash the redundant prepared food and only 30% of them reuse the food product for other destinations. 56% of those businesses which reuse the product stated that it is delivered to voluntary organizations to be distributed to the less privileged social groups, while 33% of it is destined to the sales points dealers' own consumption (Figure 3).



**Fig. 3. Destination of redundant food products**

Source: Our elaboration

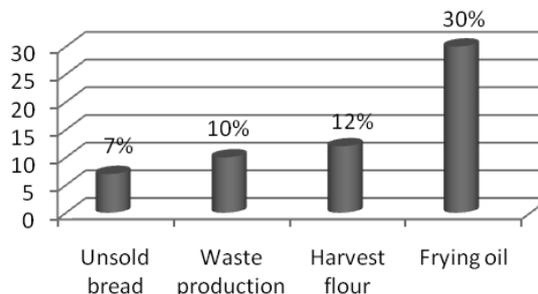
Table 3 shows the analysis of the quantity sold for each product type. The table shows that among the products causing a greater waste, in other words, those products which are sold at a percentage lower than 50%, "derivates" rank first, pasta ranks second and confectionery products rank third.

**Table 3**  
**Quantity sold for each product type (values in %)**

|                | >50% | >50%<100% | 100% |
|----------------|------|-----------|------|
| Bread          | 7    | 36        | 57   |
| Breadstick     | 8    | 58        | 34   |
| Biscuit        | 11   | 46        | 43   |
| Dessert        | 14   | 73        | 13   |
| Pasta          | 19   | 68        | 13   |
| Other products | 25   | 64        | 11   |

Source: Our elaboration

41% of unconsumed bread is trashed, while 59% is reused (such as breadcrumbs for 42%, while for the remaining 47% it is reused to make bruschetta). Finally, Figure 4 shows the percentage waste throughout the supply chain for bread production.



**Fig. 4. Quantity of waste throughout the "bread supply chain"**

Source: Our elaboration

In general, the most relevant wastes are represented by production residuals (flours, remains of doughs, shape cuttings, etc.), and, above all, by frying oil (30%) and not us-

able flour (10%). These products currently find as disposal channels the feedingstuffs industry, except for oil which is disposed as waste, or, in some cases, sold as fuel.

## Discussions and Research Results

The results and considerations which have arisen derive from the interpretation of the data collected and processed throughout the research activity carried out by the authors. In this regard, with the aim of identifying corrective actions oriented to the reduction of waste, and on the basis of similar experiences undertaken at international level, an anti-waste campaign aimed at entrepreneurs was hypothesized at the level of the single sales points. The research group has proposed to the 113 sales points analyzed the adoption of an experimental anti-waste campaign, as an intervention strategy aimed at reducing waste, in order to assess the possibility of extending this strategy within the whole distribution channel and to GDOs. The analysis carried out shows that most of the wastes generated by the companies dealing with the production of bread and confectionery products are widely used in the feedingstuffs industry. Breadcrumbs, which is a product used for many preparations in the kitchen and in the food industry and which could represent a valid by-product to be used in the food industry, paradoxically cannot be considered as such (Lebersorger and Schneider, 2014; Milovic and Radojevic, 2015). Indeed, to obtain this latter product, production needs to be planned and it is also necessary to establish in advance the quantity of bread suitable to allow the same quantity of breadcrumbs to be realized. In summary, the product which is realized, after leaving the laboratory where the production is carried out, according to the current hygienic, sanitary and food safety regulations, cannot be re-introduced into the laboratory to make a further transformation. In any case, only by implementing a careful planning of its productions, through a careful analysis of its customers' requests and by planning its production capacity in relation to the different periods of the year, it will be possible for a company, with regard to seasonal work, to minimise agri-industrial wastes (Lanfranchi et al., 2016b).

### *The environmental impact of bread waste*

The research group, after identifying the entity of the waste in the sales points being the subject of the survey, has calculated the ecological footprint related to this waste in order to provide a concrete perception of the relationship between waste and environmental impact. The calculation of the ecological footprint was made by measuring the waste in the sector and by relating it to the consumption of the natural resources necessary to produce it. Starting with an average

assessment of waste in the interviewed companies equal to 2 kilos a day, multiplied by the number of companies, 113, we obtain 226 kg of waste corresponding to 6 780 kg of bread per month. This quantity of waste used as average in calculating the ecological footprint gives a value equal to 1 320 678 squared meters of land, with a coefficient of ecological footprint expressed in hectares corresponding to 132.1, equal to 1.2 hectares of ecological footprint for each sales point. They include the part of the land planted with wheat, the part of "energetic" soil necessary to produce fertilizers, pesticides, equipment, processing and logistics. Altogether, the waste detected throughout the research, only for bread, in the 113 sales points, generates a negative externality of the environment that can be summarized as follows: 721 Kg CO<sub>2</sub>eq, 1 014m<sup>3</sup> liters of water. Therefore, the quantity of carbon dioxide emitted by bread waste in a year is averagely equal to the emissions emitted by a runabout travelling 5 996 km in a year (Lanfranchi et al., 2016a; Vandermeersch et al., 2014).

## Conclusions

Fighting food waste is a social, ecological and economic priority, for politics, institutions, local authorities, companies and civil society. The reduction of waste is a key objective for the EU, and indeed among the recommendations of the European Parliament we can find the possibility of allowing retailers to considerably lower the price of fresh food products, up to under production cost when they are on their expiry, with the aim of reducing the quantity of unsold and rejected products and of offering the consumers with a lower available income the possibility of purchasing high quality products at more affordable prices. Every waste generates other wastes, and every savings share generates other savings. The solution of hunger in the world has been dealt with for many years at international level, by investigating and analyzing its causes and setting specific goals to tackle it, but the problem of waste has been ignored for a long time (Lanfranchi et al., 2014c). This issue has gained a greater media interest only recently, due to its importance in terms of sustainability. Within the agri-food system, waste affects the whole chain: production, processing, distribution and catering, in different modes and for specific causes. In the present study, we intended to focus our interest on food waste in the sector of flour and, in particular of bread. We tried to understand the main reasons for wasting of bakeries and of commercial businesses who sell bread and bread derivatives. The survey has shown that the quantity of waste in this sector is still high. Indeed, given that the "cost of bread" is on average equal to 1.84 euros per kilo, and given that the 113 companies being surveyed waste a total of 6 780 kilos of

bread a month, there is a total loss of about 14 500 euros in economic terms.

#### Author's Contributions

The work is the result of intensive research in the University of Agriculture and Rural Development, Department of Management of Plovdiv and Department of Economics of the University of Messina. The article is the result of a full collaboration of the authors. However Maurizio Lanfranchi, in addition to coordination and setting of the study, designed the research plan, interpretations of data he wrote "Methodology used", "Discussions and research results", and "Conclusions"; Carlo Giannetto, wrote paragraphs "Research objective" and "Analysis of the sample being researched"; Dimitrova wrote paragraph "Wastes in the cereal industry"; while Lanfranchi and Giannetto wrote the paragraph "Introduction: analysis of the wastes throughout the agri-food supply chain"; Giannetto and Dimitrova wrote the paragraph "Description of the research".

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