February 2015

The research leading to these results has received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration under grant agreement n° 311778
Italian case study report (Task 3.5)

Global and local wheat-to-bread supply chains
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Andrea Marescotti, Gianluca Brunori

To be quoted as:
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Acknowledgements

We thank all experts for their valuable advice and helpfulness. In particular: Stefano Benedettelli (University of Florence), Claudio Pozzi (Rete dei Semi Rurali), Stefano Pignedoli (CRPA), Angela Zinnai and Francesca Venturi (University of Pisa), Rosella Rocchi (Unicoop Firenze). We also thank Livia Ortolani from AIAB for the helpful information shared from the Solibam project.

Summary

This report provide insights into the Italian bread sector, by analysing three case studies: a global, a regional, and a local wheat to bread chain, as part of Work Package (WP) 3 (Task 3.5) of the EU Project GLAMUR (http://glamur.eu/).

Aims

The general purpose of the GLAMUR project is to compare pairs of European national food chains with local and global features, in order to highlight the key issues of food chain performances, the specific interactions between the studied food chains and the policy settings, and to point out the methodological strength and weakness of overall applied pairwise comparative analysis. Research teams from Italy and the UK both analysed the bread sector. The two teams selected “twin” case studies and identified the following set of key issues of global and local bread chains in both countries: (i) How do approaches to biodiversity impact on how global-local wheat to bread chains are innovating and adapting? (ii) How is technological innovation affecting performance in global-local wheat to bread supply chains? (iii) To what extent are stakeholders in global-local chains making use of traditional production processes and preservation of local knowledge? (iv) How are issues related to nutrition impacting on product development and consumer choice in global-local chains? (v) To what extent does communication and availability of information benefit stakeholders in global-local chains?

Methodology

The methodology relies on a qualitative approach. The case studies are selected to represent a global, a regional, and a local wheat to bread chain. Primary data gathering was performed via in-depth semi-structured interviews with both relevant actors of the three wheat-to-bread chains and experts. The former were selected in order to cover all the stages of the supply chain; the latter were chosen according to each chain’s specificity and identified key issues. Secondary data were gathered reviewing the scientific literature, grey literature and the web. Case study performance was assessed basing on a set of sustainability attributes (see Kirwan et
al., 2014) that highlight issues related to the degree of globalness (or localness) of each chain. Sustainability attributes draw on WP2 analysis and are measured through a set of suitable indicators (see table below).

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Attribute</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td>Biodiversity</td>
<td>• Locally adapted varieties and breeds</td>
</tr>
<tr>
<td>&amp; Ethics</td>
<td></td>
<td>• On-farm eco system management at national (IT) level</td>
</tr>
<tr>
<td>Economy &amp; Environment</td>
<td>Technological Innovation</td>
<td>• Innovation to reduce GHG emissions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Innovation to reduce waste &amp; disposal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Metrics in place to support sustainable packaging for bread</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use/re-use of traditional production processes and preservation of local</td>
</tr>
<tr>
<td></td>
<td></td>
<td>knowledge</td>
</tr>
<tr>
<td>Health</td>
<td>Nutrition</td>
<td>• Salt content</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fat content</td>
</tr>
<tr>
<td>Economy &amp; Social</td>
<td>Information and communication</td>
<td>• Communication between stakeholders along chain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Availability of information to consumers</td>
</tr>
<tr>
<td>Environment</td>
<td>Pollution</td>
<td>• Global warming potential</td>
</tr>
<tr>
<td>Environment</td>
<td>Resource use</td>
<td>• Energy use</td>
</tr>
<tr>
<td>Economy &amp; Social</td>
<td>Value creation and distribution</td>
<td>• Differentiation on the market</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Share of farmer’s price on final bread price</td>
</tr>
</tbody>
</table>

**Case studies**

1. Global chain: Mulino Bianco Pan Bauletto, industrial white and sliced bread, produced by the Barilla company and distributed to Italian retailers.
2. Regional chain: Sourdough Tuscan Bread, produced within the Integrated Supply Chain Project “Bread from Tuscan Wheat” funded by the Regional Administration of Tuscany under the rural development program 2007-2013.

3. Local chain: Floriddia’s bread; the wheat to bread chain is integrated on Floriddia’s farm.

Results

A qualitative summary of the performance of the three chains across the attributes considered is reported in the following table. Question marks indicate either information that is not available or a lack or evidence, or consensus, on the performance of the chain at stake.

<table>
<thead>
<tr>
<th></th>
<th>“Floriddia” Local</th>
<th>“Sourdough Tuscan Bread” Regional</th>
<th>“Barilla” Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity</td>
<td>+++</td>
<td>++</td>
<td>+?</td>
</tr>
<tr>
<td>Technological innovation</td>
<td>++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Nutrition</td>
<td>?+++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Information and communication</td>
<td>++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Resource use and pollution</td>
<td>+?</td>
<td>?</td>
<td>++</td>
</tr>
<tr>
<td>Value creation and distribution</td>
<td>+++</td>
<td>++</td>
<td>++</td>
</tr>
</tbody>
</table>
Discussion

- The objective of the case study is to evaluate the performance of three wheat to bread chains of different lengths in relation to a pre-defined set of sustainability attributes. The interviewed stakeholders agree on the fact that “local” and “global” are ideals and several interconnections take place, with local chains incorporating some global features and global chains and vice versa. “Intention” is what makes the difference among the two. According to the global chain wheat procurement: “Production choices at the industrial scale are just a matter of feasibility”. This entails both scale and time, as the global producer must necessarily deliver large quantities and with a continuity in time.

- Despite the different requirements of local and global chains, some convergence emerges particularly regarding the need to innovate. Global chains need to innovate continuously, and local “behaviours” provide sources of inspiration (i.e. small scale “laboratories”). The regional case well illustrates the effort to reconcile traditional knowledge and know-how with industrial scale needs (including export), while pushing for innovation (e.g. standardization of the sourdough leavening). Analogously, innovation in farming and processing is not precluded to the local producer, thanks to the financial support from Tuscany Region’s Rural Development funds. This producer is also well connected to a network of experts ranging from academics to NGOs active in rural seed exchange networks. “Flexibility” is a key feature of the local case study, where traditional know how is improved through experts’ advice.

- Different policy levels show a relevance in relation to different case studies, supply chain stages and sustainability attributes. At the level of wheat production, all case studies interact with the CAP policy. Rural development and the territorial dimension of food show close relationships. Other European level policies impact on food chains, especially when they work at the global level. The global baker is particularly concerned with safety requirements (e.g. maximum pesticides residues allowed in wheat) and the content of labelling (particularly health claims). Moreover, environmental action programmes (e.g. carbon emissions reduction targets) and sustainable development strategies, are all translated into key performance indicators for the global supply chain. Barilla Corporate Social Responsibility effort is widely demonstrated by the LCA studies for most products, the periodical indicator assessment, the active involvement in the sustainability debate.

- The present case study represents an attempt to illustrate and discuss the local and global comparison based on real life applications referred to a specific sector. We reckon that, as such, the analysis is partial in many ways (as discussed in par. 6.1) and cannot be generalized. The need to identify specific supply chains represents a
limitation in terms of representativeness, especially in Italy where fresh bread production is so pulverized and diversified. However a validation of these first insights will derive from the next work package with the cross country comparison, with the UK case studies, which offer a picture that's similar and different in many ways.
1. Introduction

1.1. Research objectives and teams involved

This report documents global and local aspects of wheat to bread supply chain in Italy, as part of Work Package (WP) 3 (Task 3.5) of the Project GLAMUR and it is developed by the Italian Foundation for Research in Organic and Biodinamic Agriculture (FIRAB).

The present report explores and compares three supply chains in the bread sector in Italy. The three supply chains chosen based on a set of parameters to distinguish “local” from “global” are analysed to understand how supply chains perform with respect to a set of critical attributes that define sustainability in the bread sector. Sustainability attributes draw on WP2 analysis (see GLAMUR WP2 report (Kirwan et al., 2014)).

We use a qualitative approach for measuring the performance in relation to a set of attributes and indicators. These preliminary results will serve as a basis for a cross comparison between Italian and British bread chains’ performance. Thus, the Italian and the British teams jointly selected additional case specific RQs, based on quick scans and a common research plan.

1.2. Description of the sectorial national context

There are six main segments in the wheat to bread supply chain: i) seed sector; ii) production and commercialization of grains; iii) milling; iv) baking; v) distribution; vi) consumption.

Figure 1 – The wheat to bread supply chain

i. The seed sector is linked to innovation in terms of control and preventive fight of plant diseases. It plays a crucial role in achieving and maintaining levels of production and allows to pursue standard features of the final product. In addition, the seed sector can help protect biodiversity, enhance quality of raw material for food processing and promote territoriality. Throughout Italy, there are 210 cereals’ seed companies, which cover around 170,000 hectares and produce around 128,000 tonnes certified seed per year. This amount of seed allows to sow cereals on roughly 800,000 hectares (on average, cereal sowing encompass the use of 160 kg of seed per hectare (Italian Ministry of Agriculture, 2008). The certified seed is key for supply chain traceability.

ii. Wheat production involves farmers and agricultural associations, cooperatives and producer associations. In Italy, approximately 124,000 cereal farms produce soft wheat (38% cereal farms) over slightly more than 500,000 hectares (ISTAT, 2010). In the period 2008-2013,
the average Italian supply of wheat (durum and soft) accounted for 7.3 million tonnes per year, with 1.2 billion euro value (3% of the value of the total agricultural production in Italy). Soft wheat only accounted for roughly 500 million euro (around 1.3% of the value of the total Italian agricultural production). Unstable prices characterize the international trade of grains due to several structural and contingent factors. Private traders operating in grain commercialization are either equipped with their own storage facilities or act as mere intermediaries between the farmers and the agricultural industry. Commerce companies engaged in trading operate at ports and shipyards and are represented by a limited number of large companies, often belonging to multinational groups (Cargill, Louis Dreyfus, Conagra, etc.), which operate predominantly on non-EU markets. The level of domestic production of soft and durum wheat is insufficient to meet the demand of the Italian processing industry, thus leading to high levels of imports by milling companies of soft wheat. The trade balance is in structural deficit: Italy exports very limited quantities of wheat flours especially on the European markets. Italy's dependence on imports derives also from the limited degree of self-sufficiency which shows that domestic production can cover between 36% and 50% of domestic needs. High import rates are also a consequence of other market related factors (quality of grain in terms of protein content, prices, poor fluidity of the market) and organizational factors (pulverization of supply which does not guarantee adequate volumes, inadequate lists of commodity exchanges) that constitute the main problems of the national supply (ISMEA, 2012). **Commercialization.** Storage facilities represent a weak link in the supply chain in Italy. With some exceptions, in Italy a high share of storage plants is characterized by obsolescence, a limited processing capacity per hour, a single pit of receipt and load line which limits the possibility of storing homogeneous batches of product. Consequently, also due to the strong pulverization of the production stage, the national production of cereals is difficult to organize into homogeneous lots, consistent in terms of qualitative characteristics and able to satisfy the needs of the processing industry. The latter has to turn to foreign product, as indicated by the above-mentioned high trend of imports of wheat grain and steady growth in recent years.

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1 Structural factors are given by, for instance, the slowing rate of yields growth occurred in the least twenty years together with a decrease in prices and an increase of production costs. This resulted in a lower profitability of cereal production and, therefore, a substantial reduction of these crops. In parallel, there has been a growing demand from emerging countries and consumption patterns towards increased meat consumption. Contingent economic factors are attributable primarily to: i) the decrease in supply caused by adverse weather conditions which result in a significant reduction of stocks even within a single year; ii) the increase in the price of oil, which acts largely on the increased costs of production but also on costs of transport; iii) fluctuation of the dollar, which directly affects the level of trade (U.S. dollar devaluation); iv) speculative actions which relate to commodities as terms of trade (i.e. futures); v) limited exports actions (duty / quota) by the exporting countries (Romano and Stefani, 2013).
iii. **The milling industry** is a strategic sector in the Italian national chain of soft and durum wheat and holds, overall, a position of absolute importance at European and international levels (Table 1). According to Italmopa (2011), - the Italian Milling Industry Association which holds the representation at the national and international levels for the milling industry - in Italy there are 375 mills (259 dedicated to soft wheat flour production) that employ more than 10 million tons of wheat and overall absorb 4,600 employees (2500 employees for soft wheat flour). The total turnover of 3.5 billion Euros of milling represents 2.8% of total turnover in the Italian food industry.

Table 1 – Number of plants and grinding capacity per country

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of plants</th>
<th>Total grinding capacity (Mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td>392</td>
<td>10.3</td>
</tr>
<tr>
<td>Germany</td>
<td>308</td>
<td>7.5</td>
</tr>
<tr>
<td>France</td>
<td>457</td>
<td>6.4</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>59</td>
<td>6.6</td>
</tr>
<tr>
<td>Spain</td>
<td>163</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Source: Italmopa, 2011

In recent years, the Italian milling industry has undergone a significant reduction both in terms of number of mills and processing capacity, for both soft and durum wheat processed, as it happened in the rest of Europe. This major restructuring has resulted in a significant reduction the number of existing mills in parallel to a decline of the annual potential production of soft wheat flour, estimated at 15% over the past 20 years, while the production of durum wheat flour showed a slight progression. These opposing trends reflect the evolution of the demand by the downstream industrial stages of the supply chain: a reduction of the national consumption of bread, alongside with an increase in exports of pasta.

Europe lacks a harmonized classification of wheat flour. In Italy, the Ministry of Agriculture, Food and Forestry (Ministero delle Politiche Agricole Alimentari e Forestali) provides the legal framework (DM 17-12-20132). Table 2 displays the categories of soft wheat flours.

Table 2. Italian soft wheat flours

<table>
<thead>
<tr>
<th>Soft wheat* flour</th>
<th>Humidity, (maximum allowed, %)</th>
<th>Hashes, (minimum allowed, %dm**)</th>
<th>Hashes, (maximum allowed, %dm**)</th>
<th>Proteins*** (minimum allowed, %dm**)</th>
</tr>
</thead>
</table>

iv. **The second processing stage** of flour consists of two main branches: the pasta industry, and the baking/confectionery industry (industrial and artisanal). The first absorbs almost all of the durum wheat while the other absorbs mainly soft wheat flour. The industry sells a portion of its pasta and confectionery productions on foreign markets, either directly or through a network of wholesalers and brokers. The bakery sector, in contrast, is mainly oriented towards domestic demand. Baking industries are 185 and more than 24,500 of craft bakers are engaged in 1.1 million tonnes bakery products, with a turnover estimated at more than € 7,000 million on an annual basis (INEA, 2012). Overall, craft baking accounts for 90% and only the remaining 10% is industrial. Bread manufacturing involves a dense network of small artisan firms, involved in both baking and direct sale to the final consumer as well as to supermarkets. The industrial baking shows a high presence within the large distributors.

v. **Consumption.**

Italy produces and consumes around 3.2 million tonnes of bread per year, worth 8 billion euro. Of this, 90% is produced in artisan bakeries, and the 10 per cent remainder is industrial, although in terms of value industrial bread retains a higher portion of turnover (over one billion euro). There are more than 300 varieties of local breads in Italy and each region has a particular recipe and tradition. Despite the different features, bread is always present on Italian tables. “Cafone” in Campania, “Puccia” in Puglia, “Michetta” in Lombardia, “Ciriola” nel Lazio, “Crescia” nelle Marche, “Carta musica” in Sardegna, “Focaccia” in Liguria, “Piadina” in Emilia Romagna, “Vastedda” in Sicilia and many others. Every Italian Region has its own handcraft breads with unique characteristics, which are primarily due to wheat cultivar, flour class and raising method, baking, shape and size of the loaves, along with salt quantity. Despite regional and local varieties, there are general features, such as crispy crust and relatively short shelf life. Traditionally, Italians buy bread directly from bakeries, which pack the loaves in paper bags. A small number of these has been recognized at the European level through Protected Designation of Origins (PDO) and Protected Geographical Indications (PGI) quality marks. This demonstrates the strong relationship of some breads with the territory of reference, although

<table>
<thead>
<tr>
<th>Type</th>
<th>Moisture</th>
<th>Protein</th>
<th>Lipid</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 00</td>
<td>14,50%</td>
<td>0,55%</td>
<td>9,00%</td>
<td></td>
</tr>
<tr>
<td>Type 0</td>
<td>14,50%</td>
<td>0,65%</td>
<td>11,00%</td>
<td></td>
</tr>
<tr>
<td>Type 1</td>
<td>14,50%</td>
<td>0,80%</td>
<td>12,00%</td>
<td></td>
</tr>
<tr>
<td>Type 2</td>
<td>14,50%</td>
<td>0,95%</td>
<td>12,00%</td>
<td></td>
</tr>
<tr>
<td>Whole meal</td>
<td>14,50%</td>
<td>1,30%</td>
<td>1,70%</td>
<td>12,00%</td>
</tr>
</tbody>
</table>

* Triticum aestivum; ** dm: dry matter; *** Proteins: nitrogen Kjeldahl * 5.7

Source: Decree 17-12-2013 (see footnote 2)
the majority of artisanal bread does not meet the requirements of quality labels, due to the variable characteristics and the globalized provenance of grains. As opposed to this variety of types, industrial bread is normally a soft loaf, with a shelf life up to 40 days. It is sliced, packed with plastic and mainly sold by supermarkets. While the handcraft bread production is scattered on the Italian territory, the industrial baking sector is highly concentrated. The top three companies occupy a total share of 37.4% of the market, while private labels account for 13.5%.

The bread market in Italy is undergoing a deep process of change. Despite the general decline in consumption, the baking industry has resisted the crisis with a positive trend, although very diversified among the different segments. Consumption of “table bread”, which refers to traditional freshly baked bread, is decreasing. The sector of bread substitutes, which includes dry breads and breadsticks enriched with different cereals, sandwich bread, tortillas, unleavened bread and the segment of gluten-free has recently shown the highest increase rates. There is a strong push for innovation and the most interesting dynamics concern the ability to offer the right balance between taste, authenticity, healthiness, and at the same time adaptability to new lifestyles (including packaging).

According to Assopanificatori (2012) each family spends approximately 28 euro per month on bread. In the last years, consumer prices have been highly variable: from € 1.70 per kg in Naples (Southern Italy) to € 3.94 per kg in Milan (Northern Italy) (Altroconsumo, 2012) also depending on bread type, quality and marketing channel (supermarkets are normally less expensive). This variability of prices, in particular following price spikes in 2008 and 2010 (see Stefani and Romano (2013) for a description of price variations along the supply chain) has affected affordability for consumers. It also has determined a widening of the gap between very low priced bread (1 euro per kg) and very niche high quality breads which can reach up to 5 euro per kg.

2. Context of the Case study

2.1. Criteria of selection of the case studies

The distinction between local and global supply chains is articulated around four main issues: i) physical/geographical distance among the steps of the supply chains; ii) governance and organization issues, in particular the distribution of power among local and global actors; iii) the resources, knowledge and technologies employed in the production process; iv) the role of territory in shaping the identity of the product. In the real world, local and global chains often overlap, because the same firm can operate both in local and global chains, or because some characteristics of the production/marketing process have local and global features at the same time. Based on these four dimensions we have identified and analysed three bread supply
chains in Italy - a local, a regional and a global bread chain - in order to explore the relevant sustainability attributes according to their length.

The first case is the Industrial bread produced by the Barilla company. Barilla group is a multinational and stands as one of the top Italian food groups, leading company for pasta production, bakery products and processed sauce market of continental Europe, and the flatbread market in Scandinavia. The Group employs a workforce of over 15,000 people and has an annual turnover of 4 billion euro (2012) in 49 production plants (14 in Italy and 35 abroad), including 9 mills that provide the majority of raw materials required for the Group’s production of pasta and a part of the supply of flour for oven-baked goods. Products are exported to over 150 countries: the plants provide an annual production of nearly 3 million tons of foodstuff that are consumed worldwide under various labels. Out of its various brands, Mulino Bianco is a leader in the sector of industrial pre-packaged bread in Italy. Pan Bauletto is the brand of the most important soft bread produced by Barilla, among several other types of bread. Such industrially produced bread is made of soft wheat flour (made from grains produced both in Italy and coming from abroad), water, salt yeast and vegetable oil. This soft bread is marketed exclusively in Italy.

Figure 4 represents the main relevant steps occurring through the supply chain, and places them on a local to global scale for a visual interpretation. It shows that the main stages of the Pan Bauletto supply chain are all happening at the national level, due to the features of the final product. The upstream stages occur at a continental level, for what concerns imports of part of the soft wheat, and at a global level for what concerns the primary inputs used for cultivation.

*Figure 2 - WFSC for global bread supply chain*
The second supply chain analyzed is an intermediate case between global and local supply chain. We define it as “regional”. The recent establishment of the Protected Designation of Origin for Tuscan Bread (waiting for official approval) states that Tuscan Bread PDO must be produced exclusively with soft grains grown within Tuscany Region borders according to the Product Specification of the “Pane Toscano DOP” (Tuscan Bread PDO). Also the processing stages of milling and baking must take place within the region, while commercialization is mostly regional and national and eventually global (export is one of producers’ aims). This PDO production is also financed within an “integrated supply chain project” (Progetto Integrato di Filiera) by the Tuscan Regional Administration (through the Tuscan RDP 2006-2012) aimed at enhancing regional wheat production, secured by a traceability system for the production of Tuscan Bread sourdough obtained in accordance with the product specification proposed for the PDO.

Figure 5 shows the main steps of the chain, indicating the degree of localness of each stage.

Source: author’s elaboration based on WFSC framework
The third case is a local bread supply chain. The entire supply chain from farm to gate takes place within the same farm, situated in the province of Pisa. Floriddia’s family farm covers over 300 hectares and employs 12 full time workers. The farm turned to organic agriculture in 1987, then started to experiment with the cultivation of ancient varieties of wheat and gradually decided to invest in on farm milling and baking facilities.

The following table represents that all stages of the supply chain are at the local level. The upper stages, regarding production inputs are at most national (for what concerns the seeds exchange), and the commercialization is for most part regional and local, although it reaches the regional level with the online sales.

Source: author’s elaboration based on WFSC framework

<table>
<thead>
<tr>
<th>Scale</th>
<th>Production inputs</th>
<th>Agricultural Production</th>
<th>Grain handling</th>
<th>Milling</th>
<th>Baking</th>
<th>Distribution</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Land</td>
<td>Soft wheat production within Tuscany borders</td>
<td>Farmers consortium in Siena</td>
<td>Flour of selected varieties Sourdough</td>
<td>Bakeries</td>
<td>PDO Tuscan Bread 20 tons* per year</td>
<td></td>
</tr>
<tr>
<td>Regional</td>
<td>water</td>
<td></td>
<td></td>
<td>Milling in Lucca Water Flour of selected varieties Paper packaging</td>
<td>Retailers Supermarkets</td>
<td>P1 Euro per kg</td>
<td></td>
</tr>
<tr>
<td>Regional</td>
<td>workers</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Regional</td>
<td>seeds</td>
<td></td>
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</tr>
<tr>
<td>Regional</td>
<td>fertilizers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National</td>
<td>seeds</td>
<td>machinery</td>
<td>machinery</td>
<td>Retailers</td>
<td>PDO Tuscan Bread 20 tons per year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>National</td>
<td>machinery</td>
<td>energy</td>
<td>energy</td>
<td></td>
<td>3-3,5 Euro per kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>National</td>
<td>fertilizers</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Continental</td>
<td>fuel</td>
<td>fuel</td>
<td>fuel</td>
<td></td>
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<tr>
<td>Continental</td>
<td></td>
<td>energy</td>
<td>energy</td>
<td></td>
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</tr>
<tr>
<td>Global</td>
<td>fuel</td>
<td>fuel</td>
<td>fuel</td>
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<tr>
<td>Global</td>
<td></td>
<td>energy</td>
<td>energy</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

* data referred to "Pane Toscano a lievitzione naturale", waiting for approval of the official PDO

*Figure 4 – Table WFSC figure for local bread supply chain*
Table 2 summarizes the local/global dimensions of the three supply chains analyzed according to the four criteria of discrimination between local and global.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Production Inputs</th>
<th>Agricultural Production</th>
<th>Grain handling</th>
<th>Milling</th>
<th>Baking</th>
<th>Distribution</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>land and seeds</td>
<td>Organic farm production of several varieties of ancient wheat, soft and hard</td>
<td>On farm storage</td>
<td>Flour type 1 and 2 (stone milling)</td>
<td>Artisanal baking</td>
<td>Direct Sale</td>
<td>Semi-wholegrain bread</td>
</tr>
<tr>
<td>water</td>
<td></td>
<td></td>
<td></td>
<td>energy (solar panels on farm)</td>
<td>other ingredients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>workers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(oil, oil, salt, water, sourdough and bakers’ yeast)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local</td>
<td>seeds</td>
<td></td>
<td></td>
<td>machinery</td>
<td>machinery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional</td>
<td></td>
<td></td>
<td></td>
<td>energy</td>
<td>energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continental</td>
<td>fuel</td>
<td></td>
<td></td>
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<tr>
<td>National</td>
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<tr>
<td>Global</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: author’s elaboration based on WFSC framework

Table 2 – Local/global dimensions of the bread chains selected

<table>
<thead>
<tr>
<th>LOCAL VS. GLOBAL</th>
<th>WHEAT-TO-BREAD CHAIN</th>
<th>CASES SELECTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical / geographical</td>
<td>Place of cultivation of wheat</td>
<td>Barilla: for bread the market is national. It</td>
</tr>
<tr>
<td>distance</td>
<td>with respect to milling, baking, distribution and consumption</td>
<td>is a global multinational firm.</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------------------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Tuscan bread PDO: regional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer: local</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Governance: degree of overview of the supply chain by “local actors” and “global actors”</th>
<th>Social distance between millers and bakers with respect to farmers and consumers</th>
<th>Barilla does not control the supply chain: on the provisioning side, wheat market is very globalized. Big retailers affect the soft bread market.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuscan Bread PDO is based on a contract agreement between regional stakeholders (farmers, storage firms, miller, and bakers). No distributor is directly involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer has control over the chain. It is a niche market.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Resources, knowledge and technologies</th>
<th>Technology of milling and baking process. Mix of ingredients used.</th>
<th>Barilla produces an industrial soft bread, pre-packed, long shelf life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuscan Bread is defined by the PDO specification, produced on an industrial scale but with artisanal and traditional features</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The farmer produces on farm an artisanal bread with ancient wheat varieties with a modern stone milling plant</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Role of territory in shaping product identity</th>
<th>Quality attributes of bread in relation to territorial typologies</th>
<th>Barilla: no explicit relation to territory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuscan Bread PDO has a strong territorial identity based on PDO specification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer’s bread is linked to territory but not explicitly</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.2. Global-local issues in the value chain

The bread sector provides an interesting case in terms of local/global contrasts, which are linked to all steps of the supply chain, from raw material production, processing, to consumption. The assessment of the bread supply chain’s sustainability performance is a key theme due to the relevance of bread in almost any diet across different countries, for land use implications for wheat production and weight in the international trade. Based on international academic literature, national news, and on preliminary interviews performed during the quick scan of the case studies, we identified a set of main issues, further explained in the next paragraphs.

2.2.1. Bread quality

Sensory attributes, (i.e. appearance, odour, flavour and oral texture, and the perceived freshness) contribute to bread quality and are major determinants of acceptability and choice by consumers (Heenan et al., 2009; Jensen et al., 2011). Ingredients and processing, as well as social, demographic, and product experiences contribute to consumer perceptions of bread (see, e.g., Hersleth et al., 2005; Heenan et al., 2008). Consumers’ beliefs and attitudes towards intrinsic (e.g. appearance and shape) and extrinsic features of a product (e.g. labelling and nutritional facts) drive food choices (Biloukha and Utermohlen, 2000; Roux et al., 2000). For the consumer, the key attributes of bread are flavour and texture (Gellynck et al., 2009). Besides flavour, the freshness, colour, texture and biting properties dramatically influence the overall perception of bread. Research should explore how the perception of quality of bread changes along the local global continuum, in relation to intrinsic and extrinsic quality attributes (Chambers et al., 2007; Grebitus et al., 2013).

2.2.2. Relocalization of wheat

Wheat is a “global” commodity generally standardized and commercialized across the world, prices set by a board of exchange. It represents an ingredient and a double processing is required to turn it into bread, pasta or confectionery. Moreover, a high specialization has occurred within this crop, with fewer wheat varieties being cultivated. Grains have remained in the background of food re-localization movement because of less emphasis on freshness, lack of small-scale processing equipment, and their frequent use as unrecognizable ingredients in food rather than being served in a recognizable form as the focus of a meal (Hills et al., 2013). The use of locally produced wheat as opposed to imports from large scale distant producers poses challenges and opportunities in reconnecting staple crop producers, commercial bakers and consumers (Hills et al., 2013) also in terms of self-sufficiency and environmental impact.

2.2.3. Recognition of provenance and identity preservation

Wheat is hardly traceable and usually information about where it is from and who produces it is lost as the product moves along the supply chain downstream from the farmer. The
The industrialized commodity system determines a loss of information about where, by whom, and under what conditions that wheat is grown. Wheat of different varieties and from different farms is generally blended together during milling to achieve desired qualities in the resulting flour. Although there has been a general movement towards some level of identity preservation in the grain sector (Elbehri, 2007), the scale of this identity preservation occurs within the current industrial wheat supply chain (preserving information about the region in which the wheat was grown) rather than preserving “the story” of the wheat (i.e. preserving information about the individual farm) (Hills et al., 2013). There are many different levels of identity preservation that could be possible in wheat, but this has to come to terms with blending practices of millers to achieve consistent quality (Barling et al., 2008), as well as the size of the supplies needed by each firm.

2.2.4. Environmental impacts of bread chains

Cradle to grave assessments of the environmental impact of bread chains rely on life cycle analyses (LCAs). LCA studies can support environmentally concerned consumers, as well as conscious policy makers and producers in purchasing environment friendly products and selecting sustainable production processes. The environmental impact of bread production is linked to the geographical area of production, to the processing technology, and to the production scale (Andersson and Ohlsson, 1999; Rosing and Nielsen, 2004; Mondal and Datta, 2008). A shortcoming of LCA is the lack of harmonization; for example, studies can differ for the chain stages covered by the analysis. Despite methodological differences, researchers agree that the environmental performance of bread chains is mainly affected by (i) wheat farming system, (ii) efficiency of wheat cooling and storage facility, (iii) milling technology and scale of the milling plant, (iv) baking technology, (v) packaging facility and material, and (vi) pattern of consumption. Wheat farming system and pattern of consumption have the highest potential impact on the environment. (Espinosa-Orias et al., 2011).

2.2.5. Socio-economic implications of locally based production and consumption

Bread is a staple food that can be either highly standardized or diversified, also within the same country, according to context and habits. Emphasis on bread quality and varieties across the country and initiatives aiming at valuing (e.g. bread made with ancient wheat varieties and organic bread) and appreciating them (ad hoc events, fairs, markets etc.) are now widespread all over the country.

Affordability and food security issues interact with nutritional quality and healthy diet demands (Capacci et al., 2012). Economic and social implications in terms of price affordability of bread for consumers are less investigated by academic literature (Sundkvist et al., 2001). Bread affordability is particular evident in national news following price spikes in 2008, together with the long-term trend of decrease in bread consumption among Italian consumers. In parallel,
there is a booming of short food supply chain projects and wheat to bread chain experiences that reconnect wheat production, milling baking and selling.

Bread waste is also a prominent issue, both in the national news and academic literature. On this regard, education projects in schools are emerging as a widespread and valuable strategy (bread is re-considered as a healthy snack, associated with jam or honey or olive oil as a possible substitute to industrial snacks).

2.3. System boundaries, characteristics and mapping

2.3.1. Global wheat-to-bread chain

Barilla is leader of the global supply chain. It is a privately owned multinational group company. Despite its dimensions, Barilla is still owned and controlled by the Barilla family with three brothers in key positions. Barilla purchases from consortia and cooperatives, for strategic commodities based on cultivation contracts (e.g. for durum wheat). For raw materials like sugar, vegetable oils and partially wheat, Barilla signs contracts with wholesaler intermediaries. Large scale distribution is the main marketing channel, flanked by retailers and small shops. The overall geographical scope of the Barilla company is described in Figure 2. Dark blue identifies areas with sales offices and the light blue identifies places with production plants and sales offices. In 2011, Barilla owned 36 production plants and nine mills in nine countries

3The location of the production sites is as follows: 9 in Italy (Marcianise-Caserta, Foggia, Pedrignano-Parma, Ascoli Piceno, Castiglione delle Stiviere-Mantova, Cremona, San Nicola-Melfi-Potenza, Novara, Rubbiano-Parma); 1 in Greece (Thiva); 1 in Turkey (Bolu); 2 in the US (Ames, Avon); 1 in Mexico (San Luis de Potosi); 6 in France (Gauchy, Grand Pré-Chateauroux, Malterie-Chateauroux, St. Vulbas-Plain de l’Ain-Lione, Talmont, Valenciennes-Onnaing); 1 in Sweden (Filipstad); 13 in Germany (Celle + 12 Lieken); 2 in Russia (Solne, Ufa).

The mills are located in: 5 in Italy (Pedrignano, Altamura, Castelplanio, Ferrara, Galliate), 1 in Greece (Volos), 1 in Turkey (Bolu), 1 in the US (Ames), and 1 in Sweden (Filipstad). In 2011, a new plant was built in Rubbiano, for sauce production, while two German plants (Lieken) were closed down.

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The description of Barilla's soft bread supply chain relies upon the Environmental Product Declaration (EPD) of “Mulino Bianco Pan Bauletto Bianco”. Upstream processes include: 1) cultivation and processing of raw material; 2) production of agricultural inputs; 3) transport of raw material to the production plant.

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4 Barilla is directly involved into durum wheat breeding and owns Intellectual Property Rights (IPR) on some varieties.

5 The LCA covers the production of agricultural inputs (e.g. fertilizers), which Barilla is not involved in.
Input provision. Overall, Barilla’s mills process 30% of needed flour, while 70% is purchased. Regarding the supply of wheat, Barilla makes production contracts with consortia or cooperatives of producers on the basis of specific quality requirements, or imported mainly from European countries (Eastern Europe). Price setting depends on the commodity exchange price, alternatively, the price is bargained at the beginning of the season on the basis of the amount purchased, with an additional premium price relying on the adoption of production guidelines and often the use of specific wheat varieties. Soft wheat must meet very strict requirements because the industrial baking process cannot be adjusted "manually"; as artisan bakers can do. Raw materials intended for automatic industrial baking ought to be standardized, e.g. in terms of flour strength, as processing steps are set up in advance (e.g. dough rising times). Barilla’s main flour suppliers are seven: three out of seven are relevant for Pan Bauletto's supply chain. The provision is regulated by biannual or quarterly contracts, covering quality issues, too. Flour is highly perishable, costs for logistics and transports to Italy are very high, because the flour must be kept as fresh as possible; as a consequence most flour suppliers are national.

Production process. Core processes include: 1) mixing of the ingredients, i.e. the raw materials (e.g. flour, water, salt, and yeast) to form a dough; 2) bulk fermentation, division of dough into individual loaf-sized pieces, moulding, proofing; 3) baking of pieces in tunnel gas oven; 4) cooling and packaging; 5) production of packaging material; 6) delivery of products to distribution platforms.
Distribution. Across Italy, Pan Bauletto is distributed through mass retailers (75%) as well as individual traders and retailers. The price list is national, there are discounts and promotions depending on the local market (and on the importance of the customer). The company is concerned about the fair distribution of margins; such care is intended both to satisfy upstream suppliers and to assign them responsibility.

Consumption. Downstream processes include end consumption and waste disposal of primary packaging. Normally, Italian consumers do not eat soft bread at meals. Italians eat soft bread occasionally, in case they run out of freshly baked bread or to make sandwiches and eat out. Waste of Pan Bauletto is very low, in terms of returned goods; this is mainly due to the long shelf life.

2.3.2. Regional wheat-to-bread chain

Tuscany cereal sector. Before illustrating the regional case study, it is important to introduce the context in which it develops. Tuscany cereal sector is going through a great change, influenced on one hand by increased price volatility on international markets, and, on the other hand, the evolution of the common agricultural policy, which made farmers more aware of market signals because of the decreasing financial support in particular since 2005, when decoupling became effective6. The storage is one major issue for the processing stage of the supply chain as it is regionally fragmented and does not favour concentration or product differentiation, with an impact in terms of higher operating costs and transportation. The

6 At the time of the last census (ISTAT, 2010) 23% of farmers in Tuscany (16,571 the overall number of farmers in the Region) were dedicated to the production of cereals (a half compared to the previous decade). The reduction in utilized area is about one-third. The average agricultural area for cereals is about 10.5 hectares: 13.32 ha for durum wheat (grown by 7,721 companies), and 5 ha for soft wheat (grown by 3,825 companies). The contraction on utilized areas for cereals hits all the main categories of product: -35% for soft wheat, -33% for durum wheat, more than -50% less for corn, -29% for barley. In terms of area planted, Siena and Grosseto have more than half of cereal crops, followed by Pisa (17%) and Arezzo (14%). Arezzo is, however, the province where the greater the importance of the cultivation of soft wheat (28% of the regional total in 2010), while Siena is the most important province for durum wheat, which is also the most important cereal crop in Tuscany, with 59% of the cultivated areas. Soft wheat accounts for 11%. The trend of production, despite the general down trend, is fluctuating depending also on seasons and markets. In terms of elevation, 78% of cereal farms is located on hilly areas with an extension of more than 193 thousand hectares, 11% on mountain areas with more than 16 thousand hectares, the remaining 11% is located in the lowlands with 14 thousand hectares. 599 companies use organic wheat production methods, nearly half of which are concentrated in the provinces of Siena and Grosseto. The effects of the new CAP after the Fischler Reform were also amplified by a number of structural weaknesses, such as the small size of farm holdings, low crop yields and the high average age of farmers, all representing disincentives to invest in the farm, promoting the dropout rate from wheat production and even, in some cases, from farming. The reduced size of the companies, besides contributing to the pulverization of the offer, does not allow to recover the costs of processing, whereas the low yields per hectare, varying not only from area to area, but also, for the same area from one year to the other as a result of seasonal weather patterns, adversely affect the profitability of the crop. Furthermore, the storage system is fragmented on the territory, preventing an efficient concentration of the product and generating an increase of the costs of management and transport, while the infrastructure system is not always suitable to the needs of the industry, especially in some areas.
regional processing of wheat is not closely tied to procurement in Tuscany, although in some cases there are established links between some mills and their local suppliers. The reasons for the use of supplies from outside the region or abroad are linked to price convenience, but also to quality features of the product and the service (uniform batches by large-sized companies, especially for durum wheat), which are not always available by regional structures. The downsizing of the regional wheat production has also had a significant impact on supply chain operators related to the agricultural phase, namely seed companies, sub-contractors, suppliers of inputs and collection and storage centers, although the contraction of regional production has a limited impact on the industry segment – milling, pasta and bread production – because of the limited dependency on local production of wheat. These stakeholders were forced to revise their business decisions, implementing strategies aimed at strengthening the differentiated storage of wheat, the spread of integrated supply chain contracts and diversification of business into new segments.

The regional case study. The case study is the wheat to bread chain defined within the Integrated Supply Chain Project, ISCP (Progetto Integrato di Filiera), “Sourdough Tuscan Bread”, funded by the local government of Tuscany under the 2007-2013 Rural Development Program (RDP). In 2004, the Consortium “Sourdough Tuscan Bread” (Consorzio Pane Toscano a Lievitazione Naturale, CPT) was created by a group of bakers, grain farmers and a milling company, all from Tuscany. The CTP registered the label “CPT Pane Toscano a Lievitazione Naturale” and established a product specification. The main objective of the CTP was to apply for the PDO “Pane Toscano DOP” (Sourdough Tuscan Bread PDO). In 2001, the CTP applied for the PDO; the process of endorsement has exceeded ten years and is still facing oppositions at EU level.

The ISCP has formalized the relationships among all actors of the supply chain. Tuscan wheat to bread chain must develop within the boundaries of Tuscany. Besides the promotion of soft wheat farming, the ISCP aims at restoring the cultivation of ancient and traditional CVs of soft wheat. This objective is coherent with PDO requirements and guidelines. The agreement under the ISCP covers acceptable yields, a premium price and a minimum guaranteed price for farmers, and full traceability from farm to fork. Actors of the ISCP are 72 farms, a mill and 25 bakeries. According to the ISCP, the geographical distance between different actors of the supply chain should not exceed 70 km.
Wheat production and storage. Most farmland is within the local administration of Siena (South-East Tuscany). All farmers refer to the facilities offered by the Agricultural Consortium of Siena for input supply, including certified seeds, and wheat storage. The ISCP allows 10 km as the maximum distance between a farm's headquarter and the shared storage center.

Milling. The ISCP encompasses a mill only, Mulino Giambastiani. The mill company also leads the project. Sourdough Tuscan Bread is part of the miller’s overall business, which is far wider. The family milling company, operational since the 1930s, is located in a rural area of the Italian Region of Tuscany, within the administrative boundaries of Lucca. The mill has undergone various structural upgrading, starting with a complete rebuilding in the 1950s due to a fire during World War II. Over time, milling technologies have improved towards high tech grinding. Currently, a dedicated software drives the milling process. Currently, the miller has thirteen full time employees. The mill operates 24 hours per day, Monday to Saturday, and produces several types of flour, e.g. wholemeal, strong, plain. Most soft wheat (90%) comes directly from North-Italian cooperatives; wheat breeds with certain technological features are imported from Canada. Recently, imports from France, Austria, and Romania have raised, due to price inconstancy. For at least two decades, the milling company has stopped purchasing Tuscan wheat, except for an overall 10-15%, because of the sharp decrease in Tuscan wheat farming. Mulino Giambastiani’s business strategy includes direct delivery of flour to 1250 customers (bakeries), by means of eight owned trucks. Deliveries take place for 80% in Tuscany and 20% in other Italian Regions, i.e. Emilia Romagna, Lombardy, Liguria, and Veneto. The milling company
left South-Italy bakeries, due to untrustworthiness with regard to payments. Mulino Giambastiani is among the promoters of “Tuscan Bread PDO”. Aiming at the PDO label, the processing is computer driven and allows full traceability.

**Baking.** The ISCP includes 25 bakeries located all over Tuscany, mostly artisan and small-medium scale. Within the ISCP, the whole production process of Sourdough Tuscan Bread has been standardized, from wheat breeds to packaging. At the University of Florence, the team of prof. Benedettelli, expert in grain genetics, selected the suitable ancient and/or traditional wheat breeds. The Isolation and molecular and functional characterization of lactic acid bacteria and yeasts from sourdough Tuscan bread had been lead by the team of Prof. Manuela Giovannetti, expert in microbiology, at the University of Pisa. The selection and the definition of the baking practices (such as leavening conditions, rising times and temperatures) been lead by the team of prof. Andrich, expert in food technology, at the University of Pisa. Expert bakers, headed by Piero Capecchi, worked up the baking process. The CTP developed the labelling, including the design and some health and nutritional claims, and proposed paper as packaging material.

**Consumption.** Currently, most consumers are within the boundaries of Tuscany; however, the CPT aims at expanding the selling area, including export. According to the ISCP, the retailing price ranges between 3.00 and 3.50 €/kg. A dedicated web site ([http://www.panetoscano.net/](http://www.panetoscano.net/)) helps the spread of information about progresses in the PDO process as well as health and nutritional information. Dedicated promotions in supermarkets help consumers to know the product.

2.3.3. **Local wheat-to-bread chain**

Floriddia’s brothers are the owners of a farm which today covers more than 300 ha in Valdera (Pisa province). It is an organic farm since 1987. Initially, the transition to organic was difficult because the use of conventional varieties determined much lower yields. The farm is located in a hilly area characterized by clay soils. With experience, a balance in the management of soil fertility through rotations with legumes was achieved. Today it produces mainly cereals (wheat and barley, oats and millet), legumes (chick peas, grass peas and lentils), fodder such as alpha alpha, clover and faba beans. A turning point in the history of the farm is the decision by Rosario to cultivate ancient varieties of wheat, which are more suitable to organic agriculture practices. He got in contact with the Network of Rural Seeds (Rete dei Semi Rurali) that organizes exchanges of traditional seeds in Italy. Thanks to the results achieved, since 2009 Floriddia grows exclusively old varieties of cereals and has been awarded as a “guardian farmer”. With the technical assistance of CTPB (Tuscan Coordination for Organic Farmers), an association dedicated to the promotion and diffusion of organic agriculture in Tuscany, the farmer experienced that the old varieties in rotation with legumes can achieve excellent results in terms of yields and decided to devote more and more land to this
experiment. The farmers into contact with an expert geneticist and activated an experimental project with children hospital (in Florence) to verify relationships between grain varieties and celiac disease. Floriddia also experiments with multifunctional agriculture: through RDP funds, he financed the restoration of old houses to devote them to agritourism - 4 bedrooms, swimming pool and restaurant since 2007. Other activities include educational tours, recreational and cultural activities.

Initially Floriddia sold its cereal production to a cooperative in the Marche region, who followed an alternative pricing policy. Usually, the price of organic products is 30-60% greater than the conventional product, depending on the harvest. This cooperative decided not to follow the fluctuations of market prices (even if they are very favorable for the farmer), believing that a constant price of wheat of 38 € per 100 kilos was a better strategy in the long term. In the following years, despite the initial resistance to experiment with downward phases of the supply chain, Floriddia invested in the construction of a stone mill for the on farm production of flour and then built an oven for the production of bread, pasta and biscuits. Since Floriddia started to produce flour on farm direct sales were expanded: directly on the farm, to the local bakeries (400 kg per week) and to the GAS (solidarity purchasing groups) who regularly prepare their orders through the online catalog and the e-commerce service that is available on the website. The price is one euro per kilo, while the conventional flour is 30 cents. On-line sales have also been activated: this way Floriddia covers the whole Italian territory, the goods are packed carefully and shipped via courier within 3-4 days from receipt of order. Floriddia serves a varied clientele from individual private companies that operate mainly in the catering industry, such as restaurants, pizzerias, gastropubs, shops and all those who are interested in buying organic products.

*Figure 9 - Map for local Floriddia’s bread supply chain*
2.4. Production and processing of the product: issues about quality

2.4.1. Global bread

Pan Bauletto is baked and packed in Italy; the plants are two, one is in Cremona (north of Italy) and the other in Melfi (South of Italy). The bread comes sliced in 400 g loaves. The crumb is spongy and elastic and the crust is soft. The whole production process happens within an aseptic atmosphere, thus allowing Pan Bauletto 45 days shelf life.

Figure 10 – Pan Bauletto bread

Source: http://www.mulinobianco.it/pane-del-mulino/panbauletto/bianco

At present, Barilla chooses not to use organic raw material, because organic farming is not yet able to deliver enough quantity and standardized produce, suitable for industrial processing. Soft wheat suppliers do not have to meet any requirement with respect to their
farming system, provided that strict quality requirements are met. Barilla monitors and controls the safety of the raw materials. Quality Specification, as well as chemical-physical and organoleptic features are an integral part of the Purchase Agreement with the suppliers. For major raw materials (e.g. common wheat), Barilla entails farming protocols for wheat suppliers. Periodically, Barilla carries out a number of controls on suppliers, aimed at certifying the respect of the standards, in terms of suitability of the facilities, analysis of the raw material, unloading, handling and traceability of different lots of wheat, etc. Barilla adopts the Food Safety System Certification, FSSC, 22000 as a group. FSSC 22000 is a complete food safety management system scheme, explicitly developed for the food industry. It defines the requirements for integrated processes that work together to control and minimize food safety hazards throughout the food chain, according to the ISO 22002-1: 2009 (22003:2007) quality standard. Operativeness of certification is open access, via FSSC Certificates Data Base (https://viasyst.net/fssc). Lloyd’s Register Quality Assurance (LRQA) is the accredited certification body. The label of “Mulino Bianco Pan Bauletto” encompasses the list of ingredients, including allergen alerts, nutritional facts, such as nutrients’ content (energy, proteins, carbohydrates, fats, fibre, and salt) and percentage daily energy requirements, and nutritional claims, i.e. no sweetening additives, no hydrogenated fats, and no food colourings.

2.4.2. Regional bread
The main points of the Sourdough Tuscan Bread product specification are as follows:

- Wheat has to be cultivated in Tuscany; The Consortium “Sourdough Tuscan Bread” provides farmers with the list of allowed soft wheat varieties, without setting farming standards;

![Figure 11 – Tuscan bread](http://www.panetoscano.net/).
• Selected wheat CVs only are allowed in certain proportions: 
• All-purpose flour has to include wheat germ; 
• Sourdough leavening is compulsory; 
• No salt in the recipe; 
• The final weight has to range between 0.45 and 1.10 kg; 
• The CTP packaging is compulsory.

An official control over the supply chain would be implemented with the endorsement of the PDO label. The control will be performed by one of the bodies recognized by both the local government of Tuscany and the Italian Ministry of Agriculture. Single actors of the supply chain provide for their own quality schemes. The label of “Pane Toscano a Lievitazione Naturale” covers information about the production process, including references to ingredients and traditional baking, and about territoriality, as well as nutritional claims, i.e. low gluten, sourdough leavening, and preservation of organoleptic features guaranteed.

2.4.3. Local bread
Floriddia bakes using stone grounded flour from ancient grains reproduced and grown on farm only. The milling process encompasses the (i) rough grinding of wheat kernels, producing germ-poor flour and germ-rich bran, and the (ii) roll grinding of germ-rich bran, producing wheat germ and bran. The germ is reintegrated in the flour and then sifted to obtain a Type 1 coarseness (Table 2).

The leavening is a two steps process and relies on sourdough; though, 2% bakers’ yeast is needed due to the low raising power of the flour. The oven is wood-fired. Floriddia’s bread shelf life is 7 days, if stored closed in a paper bag or a cloth.

Floriddia is a certified an organic farm. The accredited certification body, “Suolo e Salute” (Soil and Health) certifies both farming system and food processing. Seed-saving is among farming activities; it is implemented in collaboration with a small network of Italian organic and biodynamic farms, with the Universities of Florence and Pisa, and with the Italian Rural Seed Network, a non-profit association involved in the protection of plants’ genetic resources. Water for food processing is Grander® Revitalised Water, which is deemed to improve both the dough, in terms of development and rising power, and the bread, in term of digestibility and shelf-life. Floriddia does not have an automatic packaging system for bread. For bread directly

Centauro, Bilancia, Serio, Verna, and Pandas as red wheats, and Mieti, Mec, Marzotto, and Bolero as white wheats; Cvs originating directly from those breeds are allowed, as well as CVs with certain technological features.

http://www.granderwater.co.uk
sold in the on-farm shop, as well as for bread sold to local groceries, the packaging consists of a paper bag. The label encompasses the following features: territoriality, recalls to traditional bakery, the list of ingredients, consumption suggestions, and health claims, i.e. easy-to-digest foodstuff, can help lowering cholesterol and glycaemia, and no chemical from field to fork.

*Figure 12 – Floriddia bread*

Source: [http://www.ilmulinoapietra.it/](http://www.ilmulinoapietra.it/)

### 2.5. Critical issues

Following a preliminary analysis of the case studies selected for comparison, the most relevant aspects related to local and global bread supply chains are:

- **Varieties of grains used in the production process.** Both regional and local supply chains base their distinctive character on the traditional/ancient varieties of soft wheat. The recovery of these varieties is also connected to a recovery of land destined to wheat production in Tuscany region. In both regional and local cases, the ability to grow these traditional varieties, especially if associated to the organic production method, is developed in collaboration with research bodies (universities) and specialists that supported the actors of the supply chains.

- **Nutritional value of final product.** The nutritional value of the bread produced at different scales emerges as a critical issue in the case studies selected. On one side the global chain makes an effort to improve the healthiness of the final product by reducing salt content, avoiding to use preservatives or introducing wholegrain varieties of products. On the other side, the regional and local chains make claims on the better quality and healthiness of bread (based on the strict specifications for PDO production): no salt, use of sourdough (which favours a better digestion compared to other types of yeast), ancient and traditional varieties of soft wheat, low gluten content, preservation of wheat germ in the flour, artisanal processing procedures.
• **Provenance of grains and role of traceability.** It is the one of the main arguments on which the local food chain differentiates itself and seeks a higher value-added for a more local bread. While the industrially produced bread necessitates of specific standard characteristics for flour, made of grains whose provenance is not fully known (either national or continental, but also global), the regional/local supply chains make use of grains cultivated in specific areas of the region.

• **Role of marketing and quality of information.** Global industrial chains have the resources to carry out powerful communication campaigns and marketing strategies. PDO Tuscan Bread is a marketing tool in itself, which can be more or less successful. The local supply chain implies that the farmer develops marketing and communication abilities in order to be successful on the market.

• **Technological innovation, also in relationship to environmental impact and waste.**

• **Farmers’ remuneration.** The value that is distributed long the supply chain is linked to the value that is generated on the market, through the final price. Both the local and the regional chains benefit of some forms of financing by the CAP, within rural development measures in particular. This is because they are closely connected with the agricultural phase of the supply chains, while the global chain cannot benefit from public financing (at least directly, as the farmers that supply Barilla will receive CAP payments for wheat).
3. Research Design

3.1. Research questions

The general research questions (RQs) common to all case studies are:

1. What are the key food chain performance issues in relation to the global-local comparison?
2. What is the methodological strength and weakness of overall applied pairwise comparative analysis?
3. What are the specific interactions of the food chains under study and the policy settings?

In accordance with the UK team, five research questions have been identified in order to make comparisons in Work Package 4. These questions are the result of a recurring process of joint reflection among the two teams, and they represent a subset of questions out of the ones initially indicated in the research plan. They will be investigated through a set of common indicators across the two teams.

1. How do approaches to biodiversity impact on how global-local wheat to bread chains are innovating and adapting?
2. How is technological innovation affecting performance in global-local wheat to bread supply chains?
3. To what extent are stakeholders in global-local chains making use of traditional production processes and preservation of local knowledge?
4. How are issues related to nutrition impacting on product development and consumer choice in global-local chains?
5. To what extent does communication and availability of information benefit stakeholders in global-local chains?

We investigate also other relevant attributes within the Italian context through available indicators. In particular, we decided to examine two further research questions:

6. How do local and global bread supply chains perform in terms of pollution and resource use?
7. How is value added creation and distribution affected by length of the supply chain?
### 3.2. The attributes: overview

Table 3 shows the collection of the attributes used in the Italian bread case study, a brief statement on most relevant issues emerging from the literature and it indicates whether the set of indicators is comparable with the UK team. See Annex 2 for an extended literature review on the overall set of attributes identified in WP2.

**Table 3 – Attributes of performance selected by the IT team (alphabetical order)**

<table>
<thead>
<tr>
<th>DIMENSION</th>
<th>ATTRIBUTE</th>
<th>CRITICAL ISSUE IN THE LITERATURE</th>
<th>DISCRIMINATORY AMONG LOCAL AND GLOBAL (based on quickscan)</th>
<th>UK team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment and ethic</td>
<td>Biodiversity</td>
<td>Decrease in bread wheat genetic diversity (Bonnin et al. 2014)</td>
<td>HIGH</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ancient varieties of wheat and sourdough fermentation (Dawson et al. 2012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment of biodiversity (Bonneuil et al. 2012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evolution of bread wheat varieties in organic farming (Coda et al. 2014)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social and Ethic</td>
<td>Information and Communication</td>
<td>Consumer perception of bread quality (Gellynck, 2009) organic and conventional bread (Annett, 2008)</td>
<td>HIGH</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Effects of information on consumer preference (Kihlberg, 2005)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Information of functional ingredients on bread choice (Hellyer, 2012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health</td>
<td>Nutrition</td>
<td>Ingredients, baking methods, nutritional quality and health impacts (Dewettinck, 2008)</td>
<td>HIGH</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relevance of salt reduction in bread (Belz et al, 2012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Importance of variety of grains, fiber and wholegrain (Jones, 2011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Potential of sourdough fermentation to improve nutritional properties of bread (Poutanenn, 2009; Katina et al. 2005)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fortification (Yusufali, 2012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>Pollution and Resource use</td>
<td>Environmental impacts of bread production at different scales (industrial, artisanal, home baking) and different baking methods (Espinoza-Orias, 2011; Andersson and Ohlson, 2009) Environmental impacts of different parameters: country of origin of wheat, production method, type of flour, type of packaging, transport (Williams, H. and Wikström, 2011; Meisterling et al 2009)</td>
<td>HIGH</td>
<td></td>
</tr>
<tr>
<td>Environment and economic</td>
<td>Technological Innovation</td>
<td>Genetic improvement of wheat cultivars and yield (Sener et al., 2009) Innovations in machinery for milling and bread processing (Martínez-Monzó, 2013) Environmental impacts of bread losses and waste (Friedman and Bartoli, 2010)</td>
<td>HIGH</td>
<td></td>
</tr>
<tr>
<td>Economic and Social</td>
<td>Value Creation and Distribution</td>
<td>Bread price and affordability for consumers (Smith et al. 2013) Price transmission in the wheat to bread chain (Rumánková, 2014, Cacchiarelli and Sorrentino, 2013) Profitability for farmers/ Quality of relationships on competitiveness (Gracia, 2010)</td>
<td>HIGH</td>
<td></td>
</tr>
</tbody>
</table>
**Biodiversity.** Bread domestic biodiversity relates to the genetic variability of plants and the conservation of genetic resources. Grains are the most widely cultivated agricultural products (half the world suitable land area is devoted to their cultivation) due to high adaptability to different environments, easy storability and transportability, beyond high yields and richness in carbohydrates. Soft wheat (*Triticum aestivum*) with an overall annual production of about 714 million tons (FAOSTAT, 2013) is one of the most important crops in the world. Over time, and particularly in the last century, bread has undergone profound changes due to the genetic improvement of wheat and the developments of milling and baking technologies. The process of domestication and genetic selection of wheat, has originated the current crop species. Breeding programs carried out during the last century have led to the replacement of traditional breeds with new cultivars with reduced height (semi-dwarf), high yields, high protein content (i.e. gluten, crucial for the baking process), to be grown in very different environments, although modified with agronomic interventions (i.e. technological and chemical inputs). This process has improved the yields and the agronomic characteristics (Benedettelli, 2013; Calderini et al., 1995), but has caused a genetic erosion of soft wheat (Bonnin et al., 2014; Bonneuil et al., 2012). Traditional and ancient varieties are being re-discovered for their characteristics of high adaptability to pedo-climatic conditions, of relative tolerance to fungal diseases, no need for added nutrients (the longer roots allow them for a higher absorption from soil), ability to compete with weeds for their tall size. These features have proved to be effective in organic and biodynamic farming systems, or low input agriculture (Dawson et al., 2012). Because of the lack of varieties for organic agriculture, associations of organic farmers in several European countries have begun cultivating landraces and historic varieties, effectively practicing *in situ* conservation of agricultural biodiversity (Chable et al., 2014; Malandrin and Dvortsin, 2013). In addition, the higher the genetic diversity of the bread wheat cultivated on a single field, the more the benefits to farmland biodiversity (Chateil et al. 2013). Ancient varieties are also relevant in relation to the re-discovery and production of traditional types of breads, linked to the historic place production according to social and cultural traditions (Gallo et al., 2009). In recent years, the genetic improvement in bread wheat is linked to qualitative and nutritional value of raw material for the development of improved varieties in terms of content in bioactive substances that have positive nutritional impacts to human health⁹.

**Technological innovation** as an attribute represents the applications of advancements in scientific knowledge in farming, food manufacturing and transportation, which can significantly affect food chain performance. The link with the territory (local varieties, traditional farming systems, local community lifestyles) is not neglected: on the contrary it is emphasised as one of

⁹ [www.healthgrain.org](http://www.healthgrain.org)
the key strengths of Italian food system, and enrolled in the promotion of local, regional and national brands. The concept of “retro-innovation” (Stuiver, 2006; Marsden, 2009) well adapts to describe the trend of innovation in the bakery sector. The “active rediscovery of marginalised and often forgotten knowledge and result in effective linkages between old and new knowledge” (Stuiver, 2006). Combining the best of traditional elements together with the best of modern developments seems to be the main challenge both for local and global bread chains. Technological innovation as an attribute can be viewed from three different perspectives in terms of global/local dynamics: firstly, answering food security and quality (enhancing health standards and thus safety); secondly, maintaining ecological resilience; and thirdly, ensuring competitiveness of businesses/markets (for example, reducing waste and increasing efficiency by reducing costs).

**Nutrition.** During all steps of bread making, complex chemical, biochemical and physical transformations occur, which affect and are affected by the various flour constituents. In addition, many substances are used to influence the structural and physico-chemical characteristics of the flour constituents in order to optimize their functionality in bread making (Dewettinck et al., 2008). Three dimensions affect the nutritional value of bread:

1) Nutritive value of cereals (mainly soft wheat plus other added cereals). Nutrient composition of bread cereals is 50-80% carbohydrate, proteins (8-12%), lipids (1.5-7.0%) and micronutrients, such as B vitamins, biotin, folic acid.

2) Processing of wheat, flour and bread, and conservation. These phases may decrease or increase the levels of the bioactive compounds in grains and modify the bioavailability of these compounds (Slavin et al., 2001). In addition, storage can also alter the bioavailability of nutrients in cereals (especially vitamins). During milling, a separation among the different components of grains occurs. Nutrients are distributed unevenly among grain components: the endosperm is rich in starch, bran is rich in dietary fibre and proteins, the germ is a rich source of oil tocopherols, sugars, protein and B vitamins. Therefore, the nutritional value of the flour depends on the extraction rate from the grain, beyond temperature of the milling process. To increase the palatability and bread making quality, a part of the components is removed. White flour corresponds to an extraction rate of 75% or less, as all the bran and germ are removed (van der Kamp et al, 2014). This means that nutritional value of white bread (bread made of white flour) is lower than bread made with whole meal flour bread. The bread making process consists of three stages: mixing, fermentation and baking. During the three stages, depending on the conditions of the process (pH, temperature, time of heating), there is a loss of vitamins. Nutritional value can change consistently whether yeast or sourdough are used. The difference between yeast and sourdough is microbial composition, (yeast is composed only of saccharomycetes and sourdough is composed also of lactobacillus). Sourdough fermentation can influence the nutritional quality by decreasing or increasing levels of compounds, and
enhancing or retarding the bioavailability of nutrients (Poutanen et al., 2009; Katina et al. 2005).

Salt reduction for cardio-vascular diseases and blood pressure (Young, 2001, Quilez and Salas-Salvado, 2012) is a trend in bread making industry. Breads containing whole grain, multi-grain or other functional ingredients are becoming more important (see also Van der Kamp et al., 2014; Sumanac et al., 2013). We assist the emergence of life stage nutrition (i.e. products formulated to reflect the nutritional requirements of particular consumer subsets, e.g. children or women). In addition, the production of dietetic breads of which gluten-free and sodium-reduced bread are the most important (Dewettinck et al, 2008; Young, 2001). Another recent trend is sourdough leavening, which is of expanding interest for improvement of flavor, structure and stability of baked goods. Cereal fermentation may modify accessibility of the grain fibre and gluten, which may render bread better suitable for celiac persons (Poutanen et al., 2009; Moroni et al. 2010).

**Information and communication** in the supply chains are analysed on two different grounds. At the level of the supply chain actors, information flows can show a varying degree of intensity and integration depending on the degree of competition on the market and the territorial connection among stakeholders. Traceability is also included within this attribute. Its focus is on ensuring the safety of the supply chain and protecting people and the environment from harm. Traceability is, therefore, directly associated with regulation and certification within the supply chain, and is concerned to avoid food scandals and environmental catastrophes. Full traceability of the wheat to bread supply chain requires dedicated storage structures for wheat, in order to ensure wheat separation and identity preservation.

In parallel, the amount and quality of information to consumers on the product is a determinant of informed purchasing decision. Food information for consumers includes food advertising, descriptions and images of food on packaging, list of ingredients, nutritional labelling, health and nutritional claims, disposal of packaging and information given on the internet or over the telephone. Nutritional and health claims\(^\text{10}\) play a key role in the information

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\(^{10}\) EU Directive 90/496 identifies two types of label information: ‘nutrition labeling’ (energy value, protein, carbohydrate, fat and fibre content) and ‘nutrition claims’ extolling particular nutrition properties. Regulations on nutrition information are different between countries. In the EU, both nutrition labeling and nutrition claims are still voluntary, but, according to Directive 90/496, if a nutrition claim appears on a label or in advertising, nutrition labeling becomes compulsory, albeit with a certain degree of freedom about the labeling. However, Regulation 1924/2006 introduced a mandatory scheme for using nutrition and health claims for food products, requiring specific standardized claims in line with the nutrition properties. The annex of Regulation 1924/2006 provides both a list of permitted nutrition claims and the relative conditions to comply with in order to use these cues.
asymmetry between producers and consumers (Stranieri et al., 2010). Consumers’ reaction to health claims depend on the type of product and on characteristic of consumers (Wills et al., 2012).

**Resource use and pollution** concern respectively, the use and management of the flows of available resources and inputs into the natural environment, which cause adverse changes to ecosystems. This attribute has been widely explored by LCA available literature on the bread sector, as previously explained (see par. 2.2.4) The indicators available for “resource use” and “pollution” are drawn from secondary LCA studies available through the Environmental Product Declaration (Pan Bauletto in 2012 and 2011) and through the SOLIBAM project reports. For the regional case, data on environmental impacts is not available. Robust comparability among LCAs, developed according to different standards, can be quite hard and limiting, however it was possible to obtain two consistent indicators.

**Value added creation and distribution.** This attribute is concerned with looking at both how value is created, but how it is distributed within the supply chain. The value created is a result of the value of the product on the market, also with respect to its comparable competitor products. At the same time, as evidenced in the WP2 Italian report, value distribution is concerned with an adequate return for producers in order to help protect local economies (there are linkages here with the attribute 'contribution to economic development').

### 3.3. The Indicators

#### Biodiversity

- **Locally adapted varieties and breeds.** This indicator aims at capturing the level of domestic biodiversity, by assessing the type of varieties used to produce flour. We distinguished between the following categories: 1) standard commercial varieties only; 2) deliberate use of varieties adapted to local conditions to assist biodiversity; 3) deliberate use of heritage/traditional varieties as part of planned biodiversity measures.

- **On-farm eco system management.** This indicator aims at capturing the compliance with recognized environmental schemes as opposed to minimum EU standards, assuming that environmental schemes (i.e. organic, integrated agriculture) are practices that enhance agro-biodiversity.

#### Technological innovation.

- **Innovation to reduce GHG emissions.** GHG mitigation practices implemented within the past six years in (i) wheat production and storage facilities, (ii) milling facility (iii) baking oven, and (iv) distribution systems.
- **Innovation to reduce waste and disposal.** Waste reduction and disposal innovations within the past six years (i) wheat production and storage facilities, (ii) milling facility (iii) baking oven, and (iv) retail and distribution systems.

- **Metrics in place to support sustainable packaging for bread.** This indicators aims at assessing bread packaging: non-recyclable (0); part of packaging is recyclable (1); all recyclable packaging (2); recyclable packaging from responsibly sourced materials (3); recyclable packaging from responsibly sourced materials and recycling instructions (4).

- **Use/ re-use of traditional production processes and preservation of local knowledge.** Practical use of traditional production processes and preservation of local knowledge.

**Nutrition.**

- **Salt content.** g per 100g bread. Suggested scoring: More than 1.5g (0); 1.5 - more than 1.00g (1); 0.5 - 1.00g (2); less than 0.5g (3).

- **Fat content.** g per 100g. Suggested scoring: Above 3g (0); 1-3g (1); 0-1g (2).

**Information and communication.**

- **Communication between stakeholders along chain.** This indicator aims at assessing whether communication between stakeholders (i) is confined to first tier (1) or (ii) the communication goes beyond the first tier (2) according to actors’ perceptions.

- **Availability of information to consumers.** This indicator looks at whether information delivered to the consumer (i) meets legal requirements (1); (ii) exceeds legal requirements via enterprise-related materials (e.g. web-site, product labelling) (2); (iii) there is evidence of provision of information that exceeds legal minimum via whole supply chain mechanisms (e.g. traceability systems) (3).

**Resource use and pollution.**

- **Energy use:** it includes coal, oil, natural gas, uranium, coal and lignite, beyond electricity and energy incorporated in packaging (for the global case). It is calculated for each stage of the supply chain and expressed in MJ/kg bread.

- **Global Warming Potential:** this impact category is among the most commonly used in LCA. It traces all greenhouse gasses that are directly and indirectly released into the atmosphere as a result of the analysed product life cycle, service or activity. The time horizon for the impact refers to over 100 years timeframe. It is measured in g CO₂ equivalent.
Value creation and distribution.

- **Ability to charge a price premium.** Differentiation can be expressed by the premium price obtained by the product in relation to the average price level of comparable products in the market area of reference (available from secondary sources, i.e. national ministry of economics and finance).

- **Share of farmer’s price on final bread price.** The share of price for the farmer (per kg of wheat) with respect to the final price of the product (per kg bread) indicates how much of the final value created returns to the farmer. The ratio between wheat price and bread price must be corrected by the actual amount of flour needed in the different recipes.
3.4. Synoptic table and link to research questions

<table>
<thead>
<tr>
<th>Dimension,</th>
<th>Attribute</th>
<th>Brief attribute description</th>
<th>Used indicators</th>
<th>Research Question</th>
<th>Data collection</th>
</tr>
</thead>
</table>
| Environment, ethic  | Biodiversity | Ability of food supply chains to preserve the stock of natural resources (domestic biodiversity and local varieties, wild biodiversity) | ● Locally adapted varieties and breeds  
  ● On-farm eco system management at national (IT) level | 1st shared RQ      | ● Interviews                     |
| Economic, environment | Technological Innovation | Applications of advancements in scientific knowledge in farming, food manufacturing and transportation, which affect food chain performance. | ● Innovation to reduce GHG emissions  
  ● Innovation to reduce waste & disposal  
  ● Metrics in place to support sustainable packaging for bread  
  ● Use/re-use of traditional production processes and preservation of local knowledge | 2nd and 3rd RQ     | ● Interviews  
  ● secondary data |
| Health              | Nutrition    | Nutritional qualities associated with food in terms of its composition and ability to contribute towards physical health and well-being | ● Salt content  
  ● Fat content | 4th RQ           | ● Interviews, expert advice       |
| Economic, social    | Information and communication | Amount of information transmitted to consumers, Traceability and transparency | ● Communication between stakeholders along chain  
  ● Availability of information to consumers | 5th RQ           | ● Interviews  
  ● secondary data |
| Environment         | Pollution    | Any input into the natural environment which causes adverse changes to ecosystems        | ● Global warming potential                                                     | 6th RQ           | ● Secondary LCA data |
| Environment         | Resource use | The use and management of the flows of available resources through global and local food chains (resource consumption of land, energy, other materials used to make food). | ● Energy use                                                                  | 6th RQ           | ● Secondary LCA data |
| Economic, social    | Value creation and distribution | Fair and/or stable producers' incomes | ● Differentiation on the market  
  ● Share of farmer's price on final bread price | 7th RQ           | ● Secondary data  
  ● interviews |
4. Methods

4.1. Presentation of attributes and indicators

The 24 attributes identified and broadly defined in WP2 Comparative and National reports, were contextualized within the wheat-to-bread supply chain and reviewed systematically based on available academic literature. Scopus, Web of Science and Google Scholar databases were integrated for this purpose. This allowed to evidencing the most critical issues for each attribute. Then, based on information gathered during the quick scan, (interviews, documental analysis and direct observation) we assigned a preliminary judgement on the degree of variability of the performance on each attribute of local, regional and global chains (by means of a qualitative judgment: low, medium, high). See Annex 2 for the extended review and preliminary assessment on all 24 attributes.

Following, the list of indicators was established using several sources, and by refining the indicators to make them applicable to the context of the bread sector in Italy. The selection of the indicators was a compromise between informative value and practical sense according to data that was available in the existing time span. The indicators were selected and adapted based on the following sources:

- Relevant academic literature concerning the wheat-to-bread chain.
- The SAFA list of indicators (FAO, 2013)
- Other related projects (SOLIBAM, 2014)

Furthermore, we sought expert advice to support the selection of most suitable indicators and reference values. The interviews were in depth and experts in different domains were involved to cover the variety of attributes (see Table 7 for the list of experts and field of expertise).
### 4.2. Calculation details and benchmarks used

<table>
<thead>
<tr>
<th>Name</th>
<th>Main attribute</th>
<th>Definition</th>
<th>Unit</th>
<th>Source</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locally adapted varieties and breeds</td>
<td>Biodiversity</td>
<td>Standard commercial varieties only (1); current practice includes deliberate use of varieties adapted to local conditions to assist biodiversity (2); current practice includes deliberate use of heritage/traditional varieties as part of planned biodiversity measures (3)</td>
<td>ordinal: 1,2,3</td>
<td>SAFA</td>
<td>Participatory/performance</td>
</tr>
<tr>
<td>On-farm eco system management at national (IT) level</td>
<td>Biodiversity</td>
<td>i.) Farmers growing to minimum EU standards; ii) membership of recognized environmental management schemes</td>
<td>yes (1)/no (0). Total score available 2</td>
<td>SAFA (adapted)</td>
<td>Participatory/performance</td>
</tr>
<tr>
<td>Innovation to reduce GHG emissions</td>
<td>Technological</td>
<td>GHG mitigation practices implemented within past 6 years in: i.) wheat production and storage; ii.) milling; iii.) baking processes; iv.) distribution systems.</td>
<td>yes (1)/no (0). Total score available 4</td>
<td>SAFA (adapted)</td>
<td>Participatory/performance. LCA studies</td>
</tr>
<tr>
<td>Innovation to reduce waste &amp; disposal</td>
<td>Technological</td>
<td>Waste reduction &amp; disposal innovations within past 6 years in: i.) wheat production and storage; ii.) milling; iii.) baking processes; iv.) retail/distribution systems.</td>
<td>yes (1)/no (0). Total score available 4</td>
<td>SAFA (adapted)</td>
<td>Participatory/performance</td>
</tr>
<tr>
<td>Metrics in place to support sustainable packaging for bread</td>
<td>Technological</td>
<td>Bread packaging: non-recyclable (0); part of packaging is recyclable (1); all recyclable packaging (2); recyclable packaging from responsibly sourced materials (3); recyclable packaging from responsibly sourced materials and recycling instructions (4)</td>
<td>ordinal: 0,1,2,3,4</td>
<td>SAFA (adapted)</td>
<td>Participatory/performance</td>
</tr>
<tr>
<td>Use/ re-use of traditional production processes and preservation of local knowledge</td>
<td>Technological</td>
<td>Practical use of traditional production processes and preservation of local knowledge</td>
<td>yes(1)/no (0)</td>
<td>SAFA (adapted)</td>
<td>Participatory/performance</td>
</tr>
<tr>
<td>Category</td>
<td>Subcategory</td>
<td>Description</td>
<td>Unit</td>
<td>Benchmark</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>----------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Salt content</td>
<td>Nutrition</td>
<td>Percentage weight per 100g (compared to daily nutritional guidelines). Suggested scoring: More than 1.5g (0); 1.5 - more than 1.00g (1); 0.5 - 1.00g (2); less than 0.5g (3).</td>
<td>g salt/100g</td>
<td>GLAMUR Benchmark: based on Brinsden et al 2014 - UK’s voluntary salt reduction prog suggests that salt in bread should be ltd to less than ≥1.0g/100g</td>
<td></td>
</tr>
<tr>
<td>Fat content</td>
<td>Nutrition</td>
<td>Percentage weight per 100g (compared to daily nutritional guidelines) Suggested scoring: Above 3g (0); 1-3g (1); 0-1g (2).</td>
<td>g fat/100g bread</td>
<td>GLAMUR Benchmark: based on UK national Guidelines where High fat is more than 17.5g fat per 100g. Low fat is 3g or less per 100g. so have used 3g as the benchmark for scoring.</td>
<td></td>
</tr>
<tr>
<td>Communication between stakeholders along chain</td>
<td>Information and communication</td>
<td>i.) communication between stakeholders confined to first tier (1); ii.) communication beyond first tier (2)</td>
<td>ordinal: 1,2</td>
<td>SAFA (adapted) Participatory/performance</td>
<td></td>
</tr>
<tr>
<td>Availability of information to consumers</td>
<td>Information and communication</td>
<td>i.) meets legal requirements (1); ii.) exceeds legal requirements via enterprise-related materials (e.g. web-site, product labelling) (2); iii.) evidence of provision of information that exceeds legal minimum via whole supply chain mechanisms (e.g. traceability systems) (3)</td>
<td>ordinal:1,2,3</td>
<td>SAFA (adapted) Participatory/performance</td>
<td></td>
</tr>
<tr>
<td>Differentiation on the market</td>
<td>Value creation and distribution</td>
<td>(price of bread-price of average comparable bread)/average price of comparable bread (regional or national)</td>
<td>percentage</td>
<td>GLAMUR Benchmark: Secondary data from National Observatory on prices (Ministry of Economics and Finance, Italy) (October 2014)</td>
<td></td>
</tr>
<tr>
<td>Share of farmer’s price on final bread price</td>
<td>Value creation and distribution</td>
<td>price of wheat (euro per kg) /price of bread per kg(*conversion rate wheat to bread) corrected by the amount of wheat needed to make 1 kg of bread) Average conversion factor global: 1,28 regional: 1,16 local: 1</td>
<td>percentage</td>
<td>GLAMUR Secondary data, interviews</td>
<td></td>
</tr>
<tr>
<td>Energy use</td>
<td>Resource use</td>
<td>Non-renewable energy resource use</td>
<td>MJ / kg bread</td>
<td>EPD, SOLIBAM LCA, No benchmarking</td>
<td></td>
</tr>
<tr>
<td>Global Warming Potential</td>
<td>Pollution</td>
<td>Global Warming Potential</td>
<td>g CO2 equiv. / kg bread</td>
<td>EPD, SOLIBAM LCA, no benchmarking</td>
<td></td>
</tr>
</tbody>
</table>
4.3. Methods of data collection

We evaluated a “local”, a “regional” and a “global” bread chain, by means of interviews with relevant actors of the three chains. The three selected bread chains are as follows:

(i) local chain: sourdough bread produced by the *Floriddia* farm;
(ii) regional chain: *Pane Toscano a Lievitazione Naturale* (Sourdough Tuscan Bread);
(iii) global chain: Barilla’s *Mulino Bianco Pan Bautelto Bianco* (Mulino Bianco’s soft white bread).

Paragraphs 2.1 and 2.3 provide details about case study’s selection process and criteria.

Primary data gathering was performed qualitatively, via in-depth semi-structured interviews with both relevant actors of the three wheat to bread chains as well as with experts. In-depth interviews are extended discussions with research subjects. The extent to which the conversation follows a pre-determined sequence of open-ended questions allow distinguish (i) structured, (ii) semi-structured, and (iii) unstructured interviews. Structured and semi-structured interviews ensure sufficient comparability across the information collected, while unstructured projects give priority to recording respondents’ own views by implementing relatively loose filters. Recording (e.g. on a digital device) and transcribing the interviews helps to preserve their full information content, while facilitating computer assisted cataloguing, as well as data analysis. Taking detailed notes is needed when respondents do not allow recordings (Starr, 2014).

Tables 6 and 7, respectively, display actors and experts interviewed per each case study, their relevance within the supply chain and/or their field of expertise, as well as the type of answered interview. Secondary data was collected from case studies' websites and related materials. Annex 5 displays the list of accessed web sites and linked documents per case study.

**Table 6 – Supply chain stakeholders interviewed**

<table>
<thead>
<tr>
<th>Actor's Position</th>
<th>Case Study</th>
<th>Institution or Enterprise</th>
<th>Type of Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner and manager</td>
<td>LOCAL</td>
<td>Floriddia’s</td>
<td>Semi-structured</td>
</tr>
<tr>
<td>Agronomist</td>
<td>REGIONAL</td>
<td>Farmers’ cooperative of Siena - Agricultural production</td>
<td>Semi-structured</td>
</tr>
<tr>
<td>Associate</td>
<td>REGIONAL</td>
<td>Domenici’s bakery</td>
<td>Semi-structured</td>
</tr>
<tr>
<td>Legal representative</td>
<td>REGIONAL</td>
<td>Giambastiani’s milling company</td>
<td>Semi-structured</td>
</tr>
<tr>
<td>Director</td>
<td>REGIONAL</td>
<td>Consortium for the Promotion and Protection of Tuscan Bread</td>
<td>Semi-structured</td>
</tr>
<tr>
<td>Quality and Food Safety Director</td>
<td>GLOBAL</td>
<td>Barilla – Bakery</td>
<td>Semi-structured</td>
</tr>
<tr>
<td>Internal Company Reference and Health, Safety, Environment &amp; Energy Director</td>
<td>GLOBAL</td>
<td>Barilla – Center for Food &amp; Nutrition</td>
<td>Semi-structured</td>
</tr>
</tbody>
</table>
### Table 7 - Experts interviewed, their field of expertise and their employing institution or enterprise

<table>
<thead>
<tr>
<th>EXPERT’S POSITION</th>
<th>FIELD OF EXPERTISE</th>
<th>INSTITUTION OR ENTERPRISE</th>
<th>TYPE OF INTERVIEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associate Professor of Plant Genetics</td>
<td>Wheat genetics</td>
<td>University of Florence – Department of Food Production Science and Environment</td>
<td>Unstructured</td>
</tr>
<tr>
<td>Quality and Safety Director</td>
<td>Food quality, food safety, and marketing</td>
<td>Barilla – Bakery</td>
<td>Semi-structured</td>
</tr>
<tr>
<td>Consultant and former baker</td>
<td>Artisan bread baking</td>
<td>Self employed</td>
<td>Unstructured</td>
</tr>
<tr>
<td>Quality Manager</td>
<td>Food quality, food safety, and retailing</td>
<td>Unicoop Firenze (supermarket chain), Fresh produce</td>
<td>Unstructured</td>
</tr>
<tr>
<td>Internal Company Reference and Health, Safety, Environment &amp; Energy Director</td>
<td>Food safety, energetic and environmental efficiency</td>
<td>Barilla – Center for Food &amp; Nutrition</td>
<td>Semi-structured</td>
</tr>
<tr>
<td>Quality Manager</td>
<td>Industrial bread baking</td>
<td>Tuscan industrial bakery, supplier of mass distribution retailers</td>
<td>Unstructured</td>
</tr>
<tr>
<td>Associate Professor of Food Science and Technology</td>
<td>Yeasts' biotechnology and baking technology.</td>
<td>University of Pisa – Department of Agriculture Food and Environment</td>
<td>Unstructured</td>
</tr>
</tbody>
</table>
5. Results

5.1. Performance analysis

Table 8 summarizes the values of the indicators for each bread chain\(^{11}\).

<table>
<thead>
<tr>
<th>Name</th>
<th>Main attribute</th>
<th>Unit</th>
<th>Global</th>
<th>Regional</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locally adapted varieties and breeds</td>
<td>Biodiversity</td>
<td>ordinal: 1,2,3</td>
<td>33%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>On-farm eco system management at national (IT) level</td>
<td>Biodiversity</td>
<td>yes (1)/no (0). Total score available 2</td>
<td>50%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>Innovation to reduce GHG emissions</td>
<td>Technological innovation</td>
<td>yes (1)/no (0). Total score available 4</td>
<td>100%</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td>Innovation to reduce waste &amp; disposal</td>
<td>Technological innovation</td>
<td>yes (1)/no (0). Total score available 4</td>
<td>75%</td>
<td>75%</td>
<td>75%</td>
</tr>
<tr>
<td>Metrics in place to support sustainable packaging for bread</td>
<td>Technological innovation</td>
<td>ordinal: 0,1,2,3,4</td>
<td>75%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Use/ re-use of traditional production processes and preservation of local knowledge</td>
<td>Technological innovation</td>
<td>yes (1)/no (0)</td>
<td>0%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Salt content</td>
<td>Nutrition</td>
<td>g salt/100g</td>
<td>25%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Added Fat content</td>
<td>Nutrition</td>
<td>g fat/100g</td>
<td>0%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Communication between stakeholders along chain</td>
<td>Information and communication</td>
<td>ordinal: 1,2</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Availability of information to consumers</td>
<td>Information and communication</td>
<td>ordinal: 1,2,3</td>
<td>66%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Differentiation on the market</td>
<td>Value creation and distribution</td>
<td>percentage</td>
<td>25%</td>
<td>44%</td>
<td>80%</td>
</tr>
<tr>
<td>Share of farmer’s price on final bread price</td>
<td>Value creation and distribution</td>
<td>percentage</td>
<td>5.1%</td>
<td>4%</td>
<td>8.6%</td>
</tr>
<tr>
<td>Energy use</td>
<td>Resource use</td>
<td>MJ / kg bread</td>
<td>18.2</td>
<td>NA</td>
<td>22.5</td>
</tr>
<tr>
<td>Global Warming Potential</td>
<td>Pollution</td>
<td>g CO2 equiv. / kg bread</td>
<td>1012</td>
<td>NA</td>
<td>1800</td>
</tr>
</tbody>
</table>

Figure 13 and 14 represent, respectively, the performance on each indicator and the performance on each attribute of the global, regional and local chains. Indicators within each attribute are aggregated assuming equal weight (i.e. two indicators, 50% each). While some of the indicators of performance are positively correlated, e.g. “locally adapted varieties and breed”, others are negatively correlated to best performance, e.g. “resource use” and “GWP”.

\(^{11}\) A table of all descriptors is present in Annex 6 to the report.
Figure 13 – Performance Indicators for Global, regional and local bread chains

Figure 14 – Performance profiles per attribute for the global, regional and local chains.*

*Different colors depict attribute based groups of indicators, i.e., blue-biodiversity, red-technological innovation, purple-nutrition, orange-information and communication, azure-value creation and distribution, green-resource use and pollution.
Overall, the local chain shows the best performance across most attributes based on the selected indicators. Especially in terms of biodiversity, nutrition and information / communication. The local chains’ performance is worst in terms of resource use / pollution and technological innovation. The global chain has an opposite performance profile, because it performs best in resource use and pollution and in innovation, while it is relatively less performing for nutrition, biodiversity and information. Value creation and distribution is also best performing in the local case. The regional case seems “intermediate” also in terms of performance, because it shares some strengths and weaknesses with both local and global cases. A complete assessment of the environmental performance was not possible, due to the lack of data.

In the paragraph below, the overall performance analysis is supplemented with an in depth discussion - attribute by attribute.
5.1.1. Biodiversity

According to available literature, growing traditional/heritage varieties and compliance with agro-environmental measures are practices that favour both domestic and wild biodiversity. The three cases differentiate themselves in terms of biodiversity: in the global case there is not explicit intention to safeguard biodiversity, while in the regional and local case there is some degree of willingness to contribute to biodiversity. The regional case links the production of wheat to a set of heritage and locally adapted varieties grown in Tuscany, but does not require explicitly that farmers comply with eco system management schemes of any sort. The agronomic protocol, as indicated by the agronomist in charge of the project is aimed at minimising the heterogeneity of the wheat supply, with respect of major technological quality requirements (e.g. protein content).

In the local chain, biodiversity is a management strategy. Rosario Floriddia, the owner and manager, explicitly refer to biodiversity protection when describing the farming system, seeds’ selection, and bread wheat processing. For example, “Our bread flour is made of a number of wheat breeds, i.e. Frassineto, Inallettabile, Tilmidia, Taganrog, Gentil Rosso, Abbondanza, Senatore Capelli, Etrusco. However, on farm we cultivate more soft, durum, emmer, and einkorn wheat breeds. In August-September 2015, we will saw thousands varieties of wheat within the same field. Actually, my farm participates to a project, driven by an expert of plant genetics and former professor, Salvatore Ceccarelli. He set up blends of soft wheats, durum wheats, and barleys, roughly made of a thousand breeds each. He is testing those grain mixes all over the world, and my farm is providing him with testing fields”. Biodiversity is also a reference point for the marketing. In addition, the farm is certified as organic, which is recognised to be more environment-friendly than conventional farming. All Floriddia’s activities towards biodiversity protection are feasible on a small scale. Floriddia talks about his farmland as the lab where he “tests” ancient wheats. Floriddia acts jointly with Universities and research centres in Tuscany, providing them with his bread for experimental research aimed at discovering the existing ties between biodiversity and nutritional value and between biodiversity and human health.

5.1.2. Technological Innovation

Technological innovation is key in all three case studies. The extent to which the stakeholders of each bread chain can invest in state of the art facilities and in improvements in their chain’s management is tied to the scale.

Environmental performance.

The global chain assesses its sustainability performance over time and with lots of detail, as indicated by the Corporate social responsibility report 2014 (http://www.barillagroup.com/corporate/en/home/our-sustainable-model/sustainable-business-reports.html). LCA performed in two subsequent years relative to Pan Bauletto, show
a reduction of CO2 emission and energy use in all phases of the supply chain (more detail is provided on the Pollution and Resource Use attributes).

The farmer supply chain is an example in which a strong effort was put in the environmental efficiency of milling and baking structures (e.g. solar panels, class A building). However, these investments happen just once in a while and are linked to policy support.

The same applies to the regional case. For example, the milling company within our regional case study, says: “We need to be in step with the times, so we have updated our plants. We have implemented a facility for water purification and one for bringing dusts from milling down; dust is re-used as a by-product. We have improved our machinery by reducing noise pollution and implemented a facility for the automatic packaging, which helps hygiene.”

Sustainable packaging.

In terms of packaging, the global case relies on a plastic bag which is recyclable and there is explicit indication on the packaging. The regional bread uses a paper bag, with a plastic insertion – to allow to visualize the product – thus making recycling more complicated for the consumer, who must separate plastic from paper (and there is no indication on recycling anyway). The local bread uses a paper bag, which is easily recyclable.

Waste.

Barilla minimizes waste throughout Pan Bauletto’s supply chain by making the shelf life very long (over 30 days, through aseptic packaging and ethanol on bread). Also confirmed by experts in the retailing sector, waste is not significant. Sourdough Tuscan Bread does not stale quickly, compared to common freshly baked bread (max 2/3 days). The sourdough leavening allows bread to last for around five days, and is used for traditional recipes that are based on stale bread. Moreover, based on contract agreements, retailers do not order surplus bread because they are in charge of waste disposal. Experts of the retailing sector state that there is lower waste of Sourdough Tuscan Bread, but we did not find reliable data on retail and consumption. A similar argument applies to local bread: it is not baked every day, it is sold out and it lasts up to 7 days. Moreover the high price discourages waste by the consumer

**Traditional knowledge as a base for innovation.**

Regional bread bases its distinguishing factor on the market on the traditional processing and local input. The request of the PDO represents an innovation in itself, although the establishment is encountering several difficulties. The global bread does not yet lever on traditional knowledge to qualify its industrial bread. The local bread has improved traditional grinding and milling by supplementing it with a facility which allows to save wheat germ. In addition, he promotes the link between traditional varieties of wheat and nutritional features of the bread.
5.1.3. Nutrition

We considered only two indicators which were deemed appropriate by the UK and IT teams: salt level and added fats. Other nutritional parameters were not available among the different products.

For both indicators the performance of the global bread is the lowest.

Salt.

Although global bread has the highest salt level, there was a sensible reduction of salt percentage in the recipe over time. Barilla had to reduce salt level progressively, as consumers are accustomed to salty bread. Regional bread doesn’t include salt by definition. Local bread has very low salt content, thus salt is only used to counterpart the sweetness of the wheat germ.

Fat.

Regional and local chains bake according to the traditional recipe which does not include any fats. The global bread uses vegetable oil to keep the moisture and elasticity of the bread. In particular Pan Bauletto Bianco uses only natural ingredients and extra-virgin olive oil. No hydrogenated fats and no palm oil is used for this particular product. This represents a relevant global issue, as palm oil is becoming the most widely used fat for food processing, among other productions. Barilla employs it for other products, and takes care that this is supplied sustainably (100% of Barilla’s palm oil suppliers are Roundtable on Sustainable Palm Oil (RSPO) members; ››11% of purchased palm oil is RSPO certified). Despite the general agreement on the environmental impact of palm oil production, the nutritional impacts have been questioned but the issue is still controversial.

5.1.4. Information and communication

Communication flows within the supply chain

In all three case studies direct communication goes beyond the first tier of the chain. Obviously, the longer the chain the more complex the communication flows are. For the global chain, stakeholders stressed the fact that on the side of provisions, contacts with upstream producers are mediated by a really strong market competition.

Information to the consumer

Barilla advertises Pan Bauletto via standard media channels. The dedicated web page provides pictures of bread, eating suggestions, the list of ingredients, nutritional facts and nutritional claims; there is also a forum, for people to share recipes where Pan Bauletto is an ingredient. The web site provides information on Mulino Bianco resource efficiency and environmental impacts. The packaging provides a picture of the product; special features, e.g. percentage daily energy requirements and amount of fibre, are highlighted. The label encompasses the list of ingredients, including allergen alerts, nutritional facts, (i.e. energy,
proteins, carbohydrates, fats, fibre, and salt) and, and nutritional claims (i.e. no sweetening additives, no hydrogenated fats, and no food colourings). The label also provides information about packaging disposal, social responsibility (i.e. “we use clean energy”, “we support renewable energy”), as well as web and contacts.

The Consortium “Sourdough Tuscan Bread” has a web site, where everybody can access all available information about the bread. Information covers collaboration with Universities, research findings, and recipes with stale bread as an ingredient. Additional advertising is poor. The Consortium suggests bakers a special packaging, encompassing information about the production process, including references to ingredients and traditional baking, and about territoriality, as well as nutritional claims, i.e. low gluten, sourdough leavening, and preservation of organoleptic features guaranteed. Information about packaging disposals as well as contacts are missing.

Floriddia’s farm advertises the bread on its web site. The site includes all information about farming system, wheat varieties and breeding, milling, baking, and nutritional features. Additional available information covers collaboration with research institutes, including research findings, collaboration with the seed saving association, as well as eating suggestions, mainly recipes with stale bread as an ingredient. Bread is sold loose in small groceries. The European food information and labelling legislation do not encompass any special requirements for food sold loose. Italian grocers traditionally sell bread in paper bags. At the on-farm and on-line shops Floriddia’s bread is sold in a dedicated paper bag. The labelling encompasses the following features: territoriality, recalls to traditional bakery, the list of ingredients, consumption suggestions, and health claims, i.e. easy-to-digest foodstuff, can help lowering cholesterol and glycaemia, and no chemical from field to fork. No information on packaging disposal, nor contacts are available.

5.1.5. Resource use and Pollution
The assessment of resource use and pollution relies on secondary LCA studies available for the local and the global supply chains. The former has been developed within the Solibam project in 2014 (www.solibam.eu) while the latter is publicly available on the web, from the EPD (Environmental Product Declaration) website for the year 2012. The following figures provide a synthesis of the impact of each step of the global and local chains to Global Warming Potential (GWP). To be noticed: the steps considered slightly differ among the chains because different LCA methodologies were employed: in particular, in the local case, milling and baking are represented separately, while in the global case they are considered under “processing”.

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Moreover, the global case represents packaging as a separate step, while for the local chain this is not relevant. The local case has a higher overall impact in terms of GWP per kg of bread. These results correspond to expectations, also confirmed by literature, that large scale industrial milling and baking are more efficient in these regards. For the local case, the higher carbon dioxide production is explained by fire oven baking with the use of wood (and wood combustion causes release of nitrous oxides). For the regional case, no LCA studies are available.

*Figure 15 – Global warming potential for each step of the local chain*

![Local supply chain - Global Warming Potential](image1)

Source: authors’ elaboration on LCA data for Pan Bauletto (EPD, 2012)

*Figure 16 – Global warming potential for each step of the global chain*

![Global supply chain - Global Warming Potential](image2)
Source: authors’ elaboration on LCA data for Floriddia’s farm available from Solibam project.

Concerning the amount of energy used, the local chain shows again an overall higher energy consumption. However due to the differences in methods among the LCA studies, the representation of the hotspots along the chain steps is not available.

5.1.6. Value creation and distribution

Price premium to comparable

The local bread has the best performance in terms of differentiation. This is due to the fact that the farmer defines the final price based on production costs, which are higher than standard production. The global bread has a lower premium price with respect to the other two chains. However, the premium price is positive because it differentiates itself compared to other industrial soft breads (e.g. natural ingredients, brand value, better organoleptic features).

Price to farmer over final price.

The local bread has a fully integrated supply chain, there are no intermediaries and this allows the farmer to retain the highest percentage of the final price. The regional case fixes a price range for wheat for farmers (including a premium price) and the range for retailing price of bread. In the global chain, wheat is bought on the global commodity market, thus producers price is based on the market price. It is to be added that soft bread is sold through large distribution channels which tend to sell at reduced price base on strong promotions (the price used for calculations is based on official price list).

5.2. Relevant descriptors and contextual information

The descriptors’ matrix draws on the analysis of the interviews as well as on the screening of the gathered secondary data (Annex 6). The process of indicator construction resulted in a collection of data, some of which were not used for assessing the performance of the three bread chains. In this paragraph we recall the ones that particularly enrich the context of the case studies in relation to some of the attributes.

Sourdough leavening

Sourdough fermentation can improve the flavour (Brummer and Lorenz, 2003) and, most importantly, the nutritional properties of wheat bread. During sourdough leavening, the cereal grain undergoes a series of biochemical processes that ultimately result in the production of bioactive compounds, without removing any nutritionally important components (Salmenkallio-Marttila et al., 2001). Additionally, during sourdough leavening, the gluten molecule is pre-digested, thus reducing the gluten sensitivity risk for consumers.

Milling speed
Due to friction, the higher the milling speed the higher the milling temperature. Expert interviews highlighted that high milling temperatures help the oxidation of the germ’s fatty acids, thus affecting the nutritional quality of the flour.

**Use of preservatives**
The use of chemical food additives to extend the shelf life can affect consumer preferences for bread.

**Wholegrain versus white flour**
Wholegrain flour is a source of dietary fibre. When the milling process allows including the wheat germ, the flour is also a source of unsaturated fatty acids. Both dietary fibre and unsaturated fatty acids have positive impacts on human health (see, for example, Hu and Willet, 2002).

**Inclusion of the wheat germ within the baking flour**
The germ is a nutrient rich component of wheat kernels. However, due to the content of unsaturated fatty acids, flour including wheat germ has a shorter shelf life that flour produced after germ removal. Moreover, expert interviews highlighted some of the food safety risks associated with wheat germ. For example, usually flour containing wheat germ exceeds the Italian thresholds for pesticide content.

**Flour strength**
The “strength” is a measure of the leavening power of a flour. The gluten content of the wheat is a proxy of the strength: the higher the gluten content, the higher the strength. However, high gluten flour can expose consumer to gluten sensitivity. Heritage wheat varieties and wheat populations result in flour with lower strength.

**Flour supply**
Italy has a limited ability to produce wheat suitable for baking purposes. Major constraints are pedo-climatic characteristics of Italian agricultural areas. Traditionally, Italian soft wheat varieties have had a low strength. Recently, frequent rains during the wheat farming season have affected both the yield and the mycotoxin content of the Italian soft wheat. Stakeholder interviews point out that large scale bakers cannot rely not only on the wheat supply of a single region of Italy (e.g. Tuscany), but also on the Italian supply.

**Number of soft wheat varieties within the baking flour**
The higher the number of the varieties of wheat, the higher the biological diversity of the resultant flour. However the variability among different varieties of wheat doesn’t necessarily correspond to higher genetic diversity. Nonetheless the number of varieties included in the farm bread is much higher than the number of varieties included in the regional or the global bread.

**Year when each wheat variety first entered the seed market**
Early expert interviews pointed out that the gluten content of wheat increased over time, due to a shift in the aim of breeding techniques from productivity to high leavening power. Thus, the year when a wheat variety entered the seed market in Italy could be a proxy of the ability of the resultant flour to promote gluten sensitivity at the consumer level. However, additional stakeholder and expert interviews highlighted that, currently, the breeding techniques are uniform, regardless of the “age” of a seed variety. This is due to the genetic uniformity that is required for a wheat strain to be marketed as a variety.

**Traceability**

Complete traceability of the wheat to bread supply chain requires dedicated storage structures for wheat, in order to ensure wheat separation and identity preservation. For the regional case, ensuring complete traceability is one of the objectives of the Integrated Supply Chain project and investments to this aim are financed by Tuscany Region within the rural development plan. Floriddia has EU organic certifications for both farming system and food production. The body in charge of certification, i.e. providing the electronic certificate, and control is “Suolo e Salute” (Soil and Health). The electronic certificate indicates the identity of the operator, the type or range of products covered by the certificate, its period of validity. When farming and processing of the agricultural feedstock happens within the same firm, down tracking is allowed. The EU organic logo is labelled on pre-packed products, e.g. wheat flour. Bread’s packaging misses the logo; however, given the local distribution of bread and the fact that everybody can go to the farm, trust replaces the organic labelling (see, for example, Tovar et al., 2010). Pan Bauletto does not encompass a full tracking down to wheat farms.

### 5.3. Data quality check

In order to check the quality of data used to calculate the indicators, we used the pedigree matrix approach (Ciroth, 2012; Lewandowska, 2004). The data for all indicators and for each bread chain was rated according to the pedigree matrix. The pedigree matrix method allows each data used based on five quality criteria: reliability of the source, completeness of the data, temporal correlation, geographical correlation, and technological correlation. Table 9 shows the evaluation for each indicator considered.

**Table 9: Pedigree matrix used to evaluate the data quality** (source: Ciroth, 2012; Lewandowska, 2004; adapted).

<table>
<thead>
<tr>
<th>INDICATORS</th>
<th>Quality score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Global</td>
</tr>
<tr>
<td>Locally adapted varieties and breeds</td>
<td>B</td>
</tr>
<tr>
<td>On-farm eco system management at national (IT) level</td>
<td>B</td>
</tr>
</tbody>
</table>

13 [http://www.suoloesalute.it/](http://www.suoloesalute.it/)
<table>
<thead>
<tr>
<th>environmental aspect</th>
<th>priority</th>
<th>focus area</th>
<th>relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation to reduce GHG emissions</td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Innovation to reduce waste &amp; disposal</td>
<td></td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>Metrics in place to support sustainable packaging for bread</td>
<td></td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Use/ re-use of traditional production processes and preservation of local knowledge</td>
<td></td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Salt content</td>
<td></td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Fat content</td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Communication between stakeholders along chain</td>
<td></td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>Availability of information to consumers</td>
<td></td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Differentiation on the market</td>
<td></td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Share of farmer's price on final bread price</td>
<td></td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Energy use</td>
<td></td>
<td>A</td>
<td>-</td>
</tr>
<tr>
<td>Global Warming Potential</td>
<td></td>
<td>A</td>
<td>-</td>
</tr>
</tbody>
</table>
6. **Discussion**

In the following paragraph we highlight the strengths and the shortcomings of the research methodology used. Than we discuss the answer to the research questions, with respect to the attributes biodiversity, technological innovation, nutrition and information and communication.

### 6.1. Methodology: effectiveness and limits to validity

The methodology adopted for case study analysis entails the integration between qualitative (mainly in-depth interviews) and quantitative (indicators selection and measurement) approaches. This has enriched the performance assessment and the understanding of the cases.

However, the case study research underwent a series of difficulties, that are listed below:

- We studied three bread chains, each providing a final product with specific features and a different way of consumption. This has complicated the comparability of performances.
- The participatory approach had a secondary role in our work. We mainly relied on qualitative data collection by means of interviews and meetings with chains’ stakeholders and experts. We pinned down the indicators through a process made of recurring steps. Moving from collected data, we defined the indicators by means of an informed judgment.
- We were not able to collect data from all the stakeholders of each bread chain. In particular consumers were not directly addressed. Our prospective work will involve consumer perceptions as well as insights on the attribute “waste”.
- While food chains’ performance is dynamic, the assessment with indicators is static.
- We could not base the assessment on first best indicators. For example, in order to assess value added it would have been best to have detailed data on average costs referred to the bread type chosen, for each step of the chain and for each chain. Another example concerns the assessment of technological innovation. We should know the amount and the share of the monetary investments intended for the production line of the product under study. This task is hardly achievable when it comes to assess complex production systems, e.g. Barilla’s food technologist in charge of soft wheat purchasing says: “At Barilla’s, it’s hard to talk about investments in technological innovation with respect to a single product. A thousand people are working on innovation in wheat based foods... With regard to Pan Bauletto, for example, we select the most suitable wheat breeds, we test different milling systems, we plan logistics, and so on...”.

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6.2. Addressing the shared research questions

6.2.1. Biodiversity
How do approaches to biodiversity impact on how global-local wheat to bread chains are innovating and adapting?

Each of our case studies have a different approach to biodiversity. Depending on the supply chain needs, biodiversity gains more or less relevance at the production level.

The global chain does not explicitly refer to biodiversity to innovate and adapt. Wheat is purchased according to its technological features; buyers require homogeneous lots and large/constant supplies. Barilla’ team studies closely the wheat sector technologies and trends, trying to integrate new approaches to food production and consumption within their marketing strategy. The production scale is the main constraint for considering biodiversity of purchased wheat. Global chain does not even purchase organic wheat or flour, because quantities available on the market are not reliable.

On the opposite, the local chain production choses to valorise biodiversity from wheat production to bread processing and distribution. This is made feasible due to restricted quantities produced and sold and in fact there is no need to produce a perfectly homogeneous product, since small variations are appreciated by the customers. He farms a limited area that can be monitored. Moreover, he benefits from the collaboration with experts (universities, rural seed network, etc..) that allow him to experiment with new and old breed systems (e.g. participatory breeding).

In the regional chain, biodiversity was one of the key elements that were meant to be emphasized. However, technological constraints limited the number and type of varieties of wheat that could be included in the disciplinary. This supply chain must compromise between scale and technology requirements and biodiversity valorisation.

6.2.2. Technological Innovation
How is technological innovation affecting performance in global-local wheat to bread supply chains? and To what extent are stakeholders in global-local chains making use of traditional production processes and preservation of local knowledge?

It was very hard to conceptualize and define technological innovation across such different context and scales. Global scale’s ability to invest in reduction of environmental impacts is higher, but this does not prevent a local farmer to invest as well to improve structures and processing facilities. The main difference lies in the frequency in which these investments are made and the availability of financial support.
Governance of the supply chain is relevant in this regard. It is hard to coordinate innovations through the chain when actors are scattered around the territory (as it is in the case of regional bread) and environmental performance is not made explicit as an objective (e.g. no corporate social responsibility within the Integrated Supply chain project).

In our cases there are several examples of innovation within tradition. Examples include: research in sourdough technology (e.g. standardization of sourdough) and microbial composition of bread. Research in sourdough storage systems (i.e. lyophilisation) to improve transferability and shelf life. Improvement in traditional grinding technologies (e.g. supplementing stone milling with roll milling in order to extract the maximum possible germ). Additional innovations is related to the breeding system adopted (e.g. at the local level participatory breeding is evolved from traditional mass selection of wheat). These innovations are gaining increasing market visibility.

6.2.3. Nutrition

How are issues related to nutrition impacting on product development and consumer choice in global-local chains?

Nutritional value of bread is a controversial issue and there is a lack of consensus on what are the parameters that affect nutritional performance. This is why the indicators are so restricted (only two). Controversial issues concern:

- Grains, in particular relevance of heritage varieties on nutritional parameters.
- Milling technology, in terms of preserving original features of the kernel into the flour
- Baking technology, linked to sourdough leavening
- Ingredients, in relation to salt level, fats, addition of gluten and preservatives.

Considering the comparison local – global, we highlight that:

- Global chains improve the nutritional quality of bread by adapting the recipe (i.e. ingredients, especially reduction of salt levels, and shift from palm oil to olive oil and natural preservatives).
- Local chains lever on raw material and traditional know how to improve nutritional and health features of bread.

6.2.4. Information and communication

To what extent does communication and availability of information benefit stakeholders in global-local chains?

On the level of communication with consumers, we state that, as the scale increases the amount of economic resources available for marketing strategies increases as well. This allows
a much more pervasive communication through various channels. However, at the local level a much less costly communication strategy occurs as well, as it is based on the word of mouth and entails the role of trust between consumers and producer. This aspect is not well represented by our indicators.

6.2.5. Resource use and pollution

How do local and global bread supply chains perform in terms of pollution and resource use?

As previously demonstrated by specialized literature, and confirmed by our indicators, global chains have a relative advantage with respect to small scale producers in terms of energy use and environmental impact. This is mainly due to economies of scale and the possibility to upgrade the equipment through suitable investments. In this sense, on the side of production, the comparison of the environmental performance is quite straightforward. Consumption as a “hotspot” is less explored. This has a strong impact in terms of way of consumption and waste. For example, leftover bread can be stored in home freezing facilities or eaten after toasting, thus boosting the energy use. A recent article on an Italian journal states that, according to the Commission, who is aiming at extending the Energy Efficiency Directive, several products, will be banned or regulated between 2015 and 2017 because they use more energy than needed, among which there is the toaster with two slots. The objective is to reduce the waste of energy. If the “double slot” toaster is reduced to a single slot, power consumption is reduced by 35%, bringing a potential money saving also for the consumer. This issue is not directly linked to local / global supply chains, although the global industrial bread is more suitable for toasting than the other freshly baked breads.

6.2.6. Value added creation and distribution

How is value added creation and distribution affected by length of the supply chain?

The generation of value added along the chain has only been partially addressed due to the limitations intrinsic of our two indicators, which nonetheless allow to state that the local bread gains a higher price, relative to a generic comparable, thus differentiating itself on the market as a niche product. At the same time, the farmer retains a higher share of the consumer price, higher than the one obtained by the farmers of the other chains. Although this finding is coherent with expectations, it cannot be generalized.
7. Conclusions: addressing the general research questions

The objective of the case study was to evaluate the performance of three wheat to bread chains of different lengths in relation to a pre-defined set of sustainability attributes. The identification of the key performance issues in relation to the global-local comparison was addressed through the case study development. According to the stakeholders interviewed, there is a general agreement on the fact that local and global are ideals, but reality is a mixture of both: local chains that tend to global and global chains that tend to be local. “Intention” is what makes the difference among the two. In the words of the person in charge of wheat procurement in the global chain “In fact, it is a matter of feasibility”. This entails both scale and time, as the global producer must necessarily deliver large quantities and with a continuity in time.

Despite the different requirements of local and global chains, some convergence emerges particularly regarding the need to innovate. Global chains need to innovate continuously, and local “behaviours” provide sources of inspiration (i.e. small scale “laboratories”). At the same time, the global chain can dispose of higher resources to be able to make investments, as described by an important industrial baker in Tuscany “Thanks to the strong economies of scale, industrial production can afford to withstand the costs related to the search of a level quality impossible to achieve for artisan bread. I refer to the meticulous control of the production process, continuous improvement of products (including the management of customer complaints), traceability, hygiene conditions and standard of safety for consumers, and "last but not least" the reduction of the environmental impact.” (Largoconsumo, 2012). Our regional case well illustrates the effort to reconcile traditional knowledge and artisanal know-how with industrial scale needs (including export), while pushing for innovation (e.g. standardization of the sourdough leavening). Analogously, innovation and advanced technologies are not precluded to the local producer, when the farmer (as in our local case) is surrounded by a rich network of experts (including researchers) and can rely on public funding to support its investments. This opportunity corroborates another key asset on which the local producer can rely on: flexibility. The farmer can exploit the traditional know how and maintain the artisanal feature of its production, which allows him to gain a high price premium as a valuable niche product.

For what concerns the interactions of the food chains under study and the policy settings, different policy levels are intertwined in relation to different case studies and sustainability attributes. At the level of wheat production, all case studies interact with the CAP policy. Most farmers in all chains benefit of the single farm payment – including imported wheat, a commodity which most probably benefits from non-European policy support - and additional rural development measures. Rural development and the territorial dimension of food show close interactions. Our regional case develops within an Integrated Supply chain project, which aims at promoting food chain integration, thus there is explicit support accorded to different
actors of the chain beyond farmers. Moreover, the ongoing recognition of the Tuscan Bread PDO explicitly aims at the protection of the geographical indication at the EU level. The local farmer is certified organic, therefore it also moves within the boundaries of the European quality policy.

Many European regulations and directives impact upon at least one or more stage of the food chain (Deliverable 6.1 Policy Analysis) in particular with regard to the global chain. Examples include safety requirements (e.g. maximum pesticides residues allowed), health claims, and labelling. Moreover environmental action programmes (e.g. carbon emissions reduction targets) and sustainable development strategies, following the United Nations summits (the Marrakech Process, see p. 54) are all key performance indicators for the global supply chain. Barilla Corporate Social Responsibility effort is widely demonstrated by the LCA studies for most products, the periodical indicator assessment, the active involvement in the sustainability debate.

The present case study represents an attempt to illustrate and discuss the local and global comparison based on real life applications referred to a specific sector. Concluding with a reflection on what is the methodological strength and weakness of the overall applied pairwise comparative analysis, we reckon that, as such, the analysis is partial in many ways (as discussed in par. 6.1) and cannot be generalized. The need to identify specific supply chains represents a limitation in terms of representativeness, especially in Italy where fresh bread production is so pulverized and diversified. However, a validation of these first insights can derive from the cross country comparison, with the UK case studies, which offer a picture that’s similar and different in many ways.

8. References


Local food chain Assessment: a Multidimensional performance-based approach) 7th FP, Grant agreement no: 311778.


9. Annex

Annex 1 – Critical areas in the Italian wheat–to–bread supply chain

The Italian Plan for the wheat sector (2009), which has the general objective to set actions and interventions to increase the competitiveness of the wheat sector in Italy. The identification of strategic guidelines derives from the identification of structural critical areas within the cereal sector, let alone the conjuncture, summarized in the following table. For soft wheat to bread chain, in summary the main issues of the supply chain are (National Wheat sector Plan, 2009):

- High dependence on imports. Italy is a net importer on the world market and imports are necessary and complementary to local production for quantitative and qualitative reasons.
- Poor remuneration of wheat has so far led the farmer to low investments in quality.
- Storage service is not always equipped to recognize and then enhance the quality the distribution of the processing facilities and production areas identify a real district of wheat only in the Po Valley (North of Italy).
- Lack of coordination. If there is evidence of integration processes established between certain segments of the chain (secondary processors and mills, maize-growing
companies and feed mills, bakeries and suppliers of raw materials), a general
disconnection between the agricultural stage and milling system and further
downstream segments is emphasized. This is a consequence of poor infrastructures and
suitable storage systems. Moreover, the fluctuating trend in prices provides the
conditions to operate "profitably" based on a short term logic to the detriment of
coordinated collaboration.

Critical issues of the wheat to bread supply chain in Italy

<table>
<thead>
<tr>
<th>Critical areas of the wheat sector in Italy</th>
<th>Production of wheat</th>
<th>Milling</th>
<th>Baking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decline in profitability. The price rise in 2007 suggested a possible recovery that was not consolidated in 2008</td>
<td>High processing capacity with respect to actual processing levels</td>
<td>Specialized and segmented demand</td>
<td></td>
</tr>
<tr>
<td>Increase in production costs (fertilizers, agro-drugs, transport energy, electricity, feed, seed, ...)</td>
<td>Slow introduction of technological innovations</td>
<td>High fluctuation of raw material on the domestic market</td>
<td></td>
</tr>
<tr>
<td>Inconsistent domestic production, with parallel increase in imports</td>
<td>Weak infrastructure endowment</td>
<td>Bottlenecks in the provision of quality products, certified and traceable</td>
<td></td>
</tr>
<tr>
<td>Structural limitations of businesses</td>
<td>Lack of tools to cover the risks of price volatility</td>
<td>Difficulties in having uniform lots, in safety, quality and quantity</td>
<td></td>
</tr>
<tr>
<td>Territorial dispersion that complicate logistics. Infrastructures seem inadequate to ensure adequate quality;</td>
<td>Difficulties in developing appropriate marketing policies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insufficient supply, not always responding to a demand that is become very segmented and specialized</td>
<td>Specialized demand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discontinuous supply from year to year</td>
<td>High dependence on the pasta and bread-making industry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of tools / procedures to hedge the risk of price volatility.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate transfer practices between production of wheat and storage (reward methods, programmatic commitments, ...)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consolidation of plant diseases that have introduced plant protection parameters to be observed in trade agreements and framework contracts;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction of agricultural land used for this purpose</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Other policy areas of interventions, beyond the cereal sector, concern other stages of the bread chain. In particular for the baking sector a process of liberalization occurred. Before July 2006, with the Decree-Law n. 223, the bakery sector was subject to the provisions of the Law 31 July 1956, no. 1002 stating, "New rules on bread." The discipline of law del1956 required for the new plant bakeries the permission by the Chambers of Commerce, Industry and Agriculture. The permission required to ascertain the usefulness of a new bakery in relation to the density of existing bakeries and the volume of production in the locality where the authorization was required. The license was subject to the assessment of the efficiency of the systems and their relevance to the technical requirements and sanitary provided by the same law in 1002 and the applicable laws and regulations. The law of 1956 above briefly examined had long been criticized as deemed patently anachronistic. It, in fact, posed a barrier to entry for new bakers and a limit to growth for those already operating on the territory.

This decree law approved on the 4th August 2006, n.248 which replaced the previous law and was strongly backed by the Minister of Economic Development Bersani, is dedicated to deregulation or, rather, the "citizen-consumer rights and competition" and touches areas beyond bakeries (i.e. professional services, commercial distribution, drugs, taxi drivers, cars, bank accounts, etc.). Article 4 bears the title “Urgent provisions for the liberalization of the production of bread. The purpose of the rule stated in paragraph 1, is to “foster the promotion of a competitive order in the baking industry and ensure wider accessibility of consumers to their products”. It repealed the authorization regime of law of 1956 and the new procedure gives the administrative function to municipalities. Beyond statutory provisions for the liberalization of the production of bread, the law encourages the identification of certified quality schemes, compatible with European rules, aimed at supporting and protecting products obtained from species of traditional varieties with specific territorial links, and the identification of traceability schemes under the current regulations, which are as homogeneous as possible for all operators.
Annex 2 – Revision of 24 attributes according to literature and quick scans

<table>
<thead>
<tr>
<th>ATTRIBUTE (WP2 COMPARATIVE REPORT)</th>
<th>DEFINITION (FROM WP2, IT REPORT OR WP2 COMP REPORT)</th>
<th>Literature analysis</th>
<th>SCIENTIFIC ARTICLES AND CONFERENCE PAPERS RELATED TO THE BREAD CHAIN</th>
<th>DIFFERENCES AMONG CHAINS (LOW MEDIUM HIGH)</th>
<th>SUPPLY CHAIN WITH BEST (EXPECTED) PERFORMANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AFFORDABILITY</strong></td>
<td>Price levels for consumers in relation to their purchasing power</td>
<td>Possibility to access nutritious and healthy bread for low income families, across cities and city areas, in developing countries</td>
<td>Smith et al. 2013; Flynn et al. 2012; Olaoye and Ade-Omowaye 2013; Mason et al. 2011; Lopez-Class and Hosler, 2010; Caraher et al. 2010; Duvenage and Schönfeldt, 2007; Ploeg et. al. 2009;</td>
<td>High</td>
<td>Regional: it allows relatively wider access, at an average price for a high nutritional value</td>
</tr>
<tr>
<td><strong>ANIMAL WELFARE</strong></td>
<td>Well-being of the animals involved in food chains. The expression is usually referred to animals likely to be introduced into highly intensive productive processes, intensive vs extensive breeding, the amount of space that each animal can have during the day, the feeding conditions (adequacy and quality of what they eat), medical care when needed and animal welfare before abatement.</td>
<td>Not relevant</td>
<td>Not relevant</td>
<td>Not relevant</td>
<td>Not relevant</td>
</tr>
<tr>
<td><strong>BIODIVERSITY</strong></td>
<td>Ability of food supply chains to preserve the stock of natural resources. Domestic biodiversity and</td>
<td>Effects of the decrease in bread wheat genetic diversity in terms of environmental change</td>
<td>Bonnin et al. 2014; Coda et al. 2014; Bonneuil et al. 2012; Dawson et al. 2012; Gallo et</td>
<td>High</td>
<td>Local: it experiments with ancient wheat landraces and organic agriculture methods</td>
</tr>
</tbody>
</table>
| **local varieties, Wild biodiversity** | Ancient varieties of wheat and sourdough fermentation  
Construction of indicators for measuring biodiversity  
Evolution of bread wheat varieties in organic farming  
Quality of bread prepared with old varieties vs bread prepared with improved ones  
Role of agricultural cooperatives in sustaining wheat productivity and diversity | Falco et al. 2009; Falco et al. 2008 |
| **CONNECTION** | Consumers awareness and consumers' activism around food  
Role of social relationships in organic cereal networks  
Embeddedness in conventional and alternative bread supply chains  
Identity preserved sourcing relationships between wheat growers and bakeries for improved coordination and quality chains | Milestad et al, 2010; Magnan, 2011; Penker, 2006 |
| **CONSUMER BEHAVIOR** | Consumer behaviour in relation to dietary practices or habits  
Consumer bread consumption in relation to health and nutritional information  
Consumer behavior of vulnerable societal groups (pregnant women, children, poor) | Hellyer et al. 2012; Barre et al, 2011; Freedman and Bartoli, 2013 |
| **ECONOMIC AND ECOLOGICAL EFFICIENCY** | Productivity: ratio between input and output  
Ecological efficiency, explained by rising costs/scarcity of key inputs like  
Genetic progress in wheat yield vs nitrogen use  

Local chain is integrated with the organic cereal network, the rural seed network, with research and cooperatives. Regional is connected by definition. The global chain has many connections but more widespread.

Incomparable. The global, regional and local chains are very different in terms of consumer behavior which characterizes as: daily consumption for regional, substitution role for industrial, occasional consumption for the local.

Global and Local respectively perform well in economic and ecological efficiency.
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
<th>Methodology/Findings</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy and Fertilisers, linked to the need of improving emission and energy performances, lower waste systems and ecological footprint.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAIR TRADE</td>
<td>The notion of fairness and equity under this attribute is principally concerned with the trading relations between developed and developing countries</td>
<td>Not relevant</td>
<td></td>
</tr>
<tr>
<td>FARMERS INCOME AND VALUE ADDED RECEIVED</td>
<td>Fair and/or stable producers’ incomes</td>
<td>Role of farmers cooperatives for aggregation, increased yields, adaptation to scarcity and , impact of subsidy policies, price transmission along the chain.</td>
<td>High</td>
</tr>
<tr>
<td>FOOD SECURITY</td>
<td>Availability of food conditions and stability of access</td>
<td>Increased wheat productivity in relation of scarce resources, conservation of adaptable local landraces, political instability, impact of biofuel on food availability and sustainability.</td>
<td>Medium</td>
</tr>
<tr>
<td>GOVERNANCE AND EVEN DISTRIBUTION OF POWER</td>
<td>How food systems are regulated and decisions made</td>
<td>Governance responses to socio ecological risk Governance changes to increase transparency in the chain and allow full traceability</td>
<td>High</td>
</tr>
<tr>
<td>INFORMATION AND COMMUNICATION</td>
<td>Amount of information transmitted to consumers</td>
<td>Consumer perception of bread quality, organic vs conventional bread. Effects of information on consumer preference.</td>
<td>High</td>
</tr>
</tbody>
</table>

Regional: premium prices are secured by contract. Farmers with Barilla are secured by contracts. Floriddia is autonomous and retains the added value he produces.

Global and Regional and Local chains contribute to food security in different ways (increased wheat and bread productivity vs. adaptability of local varieties).

Regional and Local: both bread chains contribute drastically to increased chain transparency, in response to socio ecological risk.

Global Information and communication activity is very intense in the global chain, also on sustainability matters.
<table>
<thead>
<tr>
<th>NUTRITION</th>
<th>Nutritional qualities associated with food in terms of its composition and ability to contribute towards physical health and well-being</th>
<th>Ingredients, baking methods, and types of bread can have health impacts: salt reduction, wholegrain, variety of grains, fiber. Potential of sourdough fermentation and baking techniques to improve nutritional properties of bread. Fortification of staple foods. Consumer attitude towards gluten free products. Value of label design and nutritional labeling format on consumer attention.</th>
<th>Antúnez et al. 2013; Talaei et al, 2013; Békés, 2012; Belz et al. 2012; Jones, 2011; Dewettinck et al. 2008; Katina et al. 2005; Yusufali et al, 2012; Ozola and Straumite, 2012</th>
<th>High</th>
<th>Local has the best performing product with respect to most parameters emerging from literature. Regional chain is also very focused on nutritional quality.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROFITABILITY FOR FARMERS, PROCESSORS AND RETAILERS / COMPETITIVENESS</td>
<td>Ability of the supply chain to make profits and be competitive in the market</td>
<td>Selection decisions on healthier foods by retailers in terms of profitability. Competition enforcement in the wheat to bread sector to guarantee lower prices for consumers. Concentration in the milling and baking sectors as barriers to market entry. Quality of relationships impact on SMEs competitiveness</td>
<td>Ayala et al. 2012; Bonakele and Mncube, 2012; Tsegaye, 2012; Gracia et al. 2010; Louw et al, 2013</td>
<td>Medium</td>
<td>Not enough information to date</td>
</tr>
<tr>
<td>RESILIENCE AND LOCAL DEVELOPMENT</td>
<td>Reliability, which characterizes food chain performance in terms of needing to provide a stable, consistent and trustworthy supply and range of quality safe foods</td>
<td>Innovative governance responses to socio-ecological risk and roles of cooperatives; Benefits for production, resilience and conservation are linked to biodiversity</td>
<td>Bardsley, D.K., Bardsley, Medium 2014; Enjalbert, 2011</td>
<td>Medium</td>
<td>Local: organic and ancient wheat varieties increase adaptability, while short chain reduces dependence from policy support and adds quality to the product</td>
</tr>
</tbody>
</table>
### Resource Use and Pollution

Any input into the natural environment which causes adverse changes to ecosystems. Resource use concerns the use and management of the flows of available resources through global and local food chains. It has two main elements: 1) resource consumption (land, energy, other materials) used to make food. 2) tools (techniques) used to measure the resource use performance of food chains (ecological footprinting, ecological efficiency and food miles).

| Local. Industrial bread LCA identifies that what impacts the most is wheat production and consumer behavior, thus the local organic case is best in this sense. The industrial prototype (high level technology) also guarantees a lower environmental impact and resource use during processing. Consumer behavior in terms of waste is low across chains. The local uses paper package, not plastic. |

### Responsibility (Chain and Market, State)

Consumer, supply chain actors and policy makers responsibility.

| Corporate social responsibility of processors and retailers Bread subsidies and social/political stability (e.g. Egyptian uprising) | Magnan, 2011; Forsman-Hugg, 2013; Salevurakis |

| High Global is relevant in terms of CSR, Regional entails a political responsibility related to financial support |

### Safety

It includes food hygiene, standards and certification to guarantee food integrity, the prevention of food fraud [and food terrorism], food freshness and/or adequate conservation.

| Food safety challenges of traditional foods and role of good manufacturing practices Effects of sourdough fermentation on mycotoxins Dissipation of pesticides during bread making | Lücke and Zangerl, 2014; Low Vidal et al, 2014; Cauvain, 2012; Sharma, 2005 |

| Local, regional and global chains have all a high safety profile |

### Technological Innovation

Applications of advancements in scientific knowledge in farming, food manufacturing and transportation, which affect food chain performance. There are two main aspects in which innovation serves the food chain: 1) food quality

| Genetic improvement of wheat cultivars, yield improvement; innovations in machinery for milling and bread processing; standardization of sourdough technology; Suitability of commercial starters for the | Martinez-Monzo et al. 2013; Campbell et al. 2012; Skudra and Linina, 2011; Moroni et al. 2010; Sener et al. 2009; Clarke and Arendt, 2005; Rolfo et al. 1993. |

| Medium Regional: innovation all along the chain (financed), traceability (including grains) and standardization of sourdough technology. Also the local chain has made a lot of investments in innovative technologies. |

### Economics

| Economic analyses of food chains including the cost of food production, distribution, and consumption, and the social, environmental and economic impacts of food choices (e.g. life cycle assessment) | LCA, Environmental impacts of bread production at different scales (industrial, artisanal, home baking), of different baking methods and other parameters: country of origin of wheat, production method, type of flour, type of packaging (plastic and paper bags), bread losses and waste |

<p>| High Global is relevant in terms of CSR, Regional entails a political responsibility related to financial support |</p>
<table>
<thead>
<tr>
<th>TERRITORIALITY</th>
<th>Capability of a supply chain to represent and promote the localness of a product and its link with a specific terroir or place of production.</th>
<th>Perception of consumers and willingness to pay for locality and organic Protected Designations of Origin and bread quality features Locally adapted bread varieties and ancient wheats Naspetti and Bodini, 2008; Pasqualone, 2013; Piergiovanni, 2013</th>
<th>Local and regional have a very strong link to territory</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRACEABILITY</td>
<td>Traceability is related to information, but it is not intended specifically for the end user in terms of enabling them to make a food choice. Instead its focus is more on ensuring the safety of the FSC and protecting people and the environment from harm. It is particularly important in the policy sphere as a means of helping to prevent the contamination or adulteration of food and being able to trace the cause of any pollution that may impact on the environment as a result of FSC activities. It is in effect compulsory for all FSC in the EU as set out by Regulation (EC) No 178/2002.</td>
<td>Ethical aspects of traceability and communication to the consumer Shift towards higher quality and identity preserved wheat (varietal traceability) Barling et al., 2009; Magnan, 2011; Pasqualone, 2013</td>
<td>Local and regional chains guarantee full traceability (including wheat provenance)</td>
</tr>
<tr>
<td>WASTE (OF BREAD)</td>
<td>Food waste production, Food waste disposal Identification of bread waste determinants Innovation to retard bread staling and role of packaging in Vandermeersch et al, 2014; Fadda et al. 2014; Freedman and Bartoli, 2013; Espinoza-Orias et al. 2011; Williams</td>
<td>High</td>
<td>Global bread and Local bread have low levels of waste but for different reasons. Wasted bread is nevertheless a considerable problem</td>
</tr>
</tbody>
</table>
preventing bread loss
Bread waste valorization options (and environmental impacts)
Comparison of bread production at different scales and different waste management options
and Wikiström, 2011; Mohammadi, 2007; Rosing and Nielsen, 2004; Andersson and Ohlsson, 1999

at consumer level and at retailers level (for fresh bread in particular)
Annex 3 - Questionnaire used (adaptation to Barilla)

GLAMUR Project: what distinguishes a ‘global’ from a ‘local’ food supply chain?

Interview Guide and questions for case study: wheat to bread supply chain

Introduction

The EU-funded GLAMUR project is examining what distinguishes a ‘global’ from a ‘local’ food supply chain. As part of the research, FIRAB is conducting a case study of Italian wheat to bread supply chains and is attempting to map and analyse the industrial (more global) chain and two chains with more local characteristics. We are particularly interested in how you perceive the differences between global and local aspects of the wheat to bread supply chain.

The interview takes about 30 minutes and asks about your knowledge of the supply chain focussing on your own role and position in the chain, and on your perceptions of local and global aspects of the supply chain. The interview focuses on a set of questions about biodiversity; technological innovation and nutritional value. These factors emerged as important in our earlier scoping work and we feel that more in-depth analysis will provide valuable insights into how global and local wheat to bread supply chains are adapting and innovating in Italy. At the end of the interview we ask for your response to a set of short statements and there is also an opportunity for you to ask questions and suggest any additional factors that you consider important.

We hope that you find this research interesting and that your participation will not only provide an opportunity to improve your own knowledge but also offer new insights and potential marketing opportunities. We should add that data collected in Italy will be used for comparative analysis with data collected in UK, thus providing further insights within the European context. Data collected will be kept anonymous and written feedback will be provided at the end of the research process.

Thank you for your participation!

FIRAB

Confidential

Name:

Company:

Job title of the respondent:
Section 1 – Local and global aspects of the Pan Bauletto supply chain

1.1 To help us map how the industrial (more global) and local wheat to bread supply chains differ (or overlap), please consider the diagram below that models the stages in the Pan Bauletto supply chain - and provide feedback on the following:

a.) Do all these stages apply to your supply chain? If any stages do NOT apply, please provide details.

b.) What are important intermediate stages not shown in the model?

c.) Are there any stages that present particular challenges for maintaining your own position in the chain? (e.g. competition, law, consumer trends, retailers needs, etc...).
d.) Please mark any stages in the chain where more knowledge/information would benefit your business. Please provide details.


e.) Please mark any transport distances between stages in your supply chain that you are aware of.


f.) With reference to Pan Bautetto production, with which stakeholders do you have direct trading relationships? Please mark below

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Direct trading relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input suppliers (seeds, fertilizers, etc.)</td>
<td></td>
</tr>
<tr>
<td>Farmers</td>
<td></td>
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<tr>
<td>Collectors/grain merchants</td>
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<td>Millers</td>
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</tbody>
</table>
Input/additive suppliers (improvers, vitamins, yeast etc.)

<table>
<thead>
<tr>
<th>Bakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retailers</td>
</tr>
<tr>
<td>Consumers</td>
</tr>
<tr>
<td>Waste services</td>
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<tr>
<td>Others: please specify</td>
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</tbody>
</table>

**g.)** Do you own other companies in the supply chain? Which ones?

**h.)** How much flour (soft wheat and other grains) is needed for “Pan Bauletto” per year? How much flour is milled internally and how much is bought on the market? Where from? Average price per tonn?

**i.)** What is your average Pan Bauletto (overall) production per year? Is Pan Bauletto affected by seasonality?

Please fill in the table below

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What is your average Pan Bauletto (white) production per year? Please fill in the table below

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**l.)** What is the average selling price of Pan Bauletto (overall)? What are the main factors that influence price? Please fill in the table below

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What is the average selling price of Pan Bauletto white? What are the main factors that influence price? Please fill in the table below

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</tbody>
</table>
m) Who are your main customers of Pan Bauletto? Where are they based?

Please describe the recent evolution of the marketing channels for Pan Bauletto bread, highlighting the differences among types of breed.

n) What sort of packaging do you use?

1.2 What do you perceive as the main differences between a local and global supply chain?

1.3 What do you perceive as more local aspects of your own wheat to bread supply chain?

1.4 What do you perceive as more global aspects of your own wheat to bread supply chain?

1.5 If all food chains were placed on a gradient from local (1) to global (10), where would your own supply chain be situated?

\[
\begin{array}{cccccccccc}
1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 \\
\end{array}
\]

(very local) \hspace{2cm} (globalized)

4 Section 2 - Focus on biodiversity technological innovation and nutritional value.

Biodiversity of wheat

1.1 Indicator 1: Locally adapted varieties and breeds

- Which soft wheat varieties are included in the flour mix used for Pan Bauletto Bianco? How do you choose them?

- In your perception, is the final consumer driven by an interest in biodiversity, with reference to Pan Bauletto bread? Is it part of a marketing strategy?

- What are the main obstacles in introducing traditional wheat varieties in the production process? What technological innovations should you introduce?

1.2 Indicator 2: Saving of seeds and breeds
Where does the seed come from (purchased/self-produced)?

Do you currently practice seed-saving? please briefly describe why and provide details (including number of hectares used for growing wheat).

1.2 Indicator 3: On farm eco-system management

Is there an on-farm eco system management in practice? [ex. crop rotations, hedgerows, buffer strips, fallow]. Do you get payments for agro-environmental measures? Which ones?

How does the implementation of agri-environmental measures affect operating efficiency, profits, business image?

Who do you perceive is important for setting the standards for natural resource management for wheat growers? Does the consumer play a role in your decision-making? If so, how?

Technological Innovation

Indicator 1: Technologies to minimize losses/waste

What are the main sources of losses/waste (if any) along the production process of Pan Bauletto? Which technologies do you employ to minimize losses?

Who do you perceive is important for setting the standards for technological innovation to minimize losses?

Does the consumer play a role in your decision-making? If so, how?

Indicator 2: Innovations in baking processes and facilities

Is sourdough feasible in your production process? If not, what are the constraints (ex. Strength of flour, time length of production process, standardization of leavening process)

Have you invested in new technologies to improve the economic efficiency of baking processes/plants?
Have you invested in new technologies to improve the environmental efficiency of baking processes/plants?

**Nutrition**

**Indicator 1: Nutritional quality of bread**

- For flour milled internally, how much flour is milled per hour on average?
- Is kernel present in the flour? Would it be feasible to use flour with kernel in the production process’?

**Indicator 2: Nutritional value and position in the price segment**

- What is the nutritional performance of the product compared to competing products in the same segment?
- Do you think that consumers relate price to nutritional value of bread?
  - Have you carried out consumer studies in relation to nutrition and health?
- How has the communication strategy developed in relation to health and nutritional aspects?
- How has the production process developed in relationship to nutritional aspects in the past ten/twenty years? What role does innovation play?

5 Final question

Do you agree/disagree with the following statements? *Please circle your answers.*

a. wheat growing needs to be combined with more mixed farming to maximise environmental benefits
   
   **agree/disagree**

b. public policies have led to better environmental procedures for growing wheat
   
   **agree/disagree**

c. implementing more sustainable practices is an added financial cost
   
   **agree/disagree**

d. changing consumption habits mean that bread sales are in overall decline
   
   **agree/disagree**
e. technological innovation is addressing increased consumer demand for more healthy and speciality breads

agree/disagree

Please suggest any other factors (excluding biodiversity, technological innovation and nutritional value) that you consider important in your supply chain.
Annex 4 - Questionnaire used (adaptation to Barilla)

Local wheat to bread chain: Azienda Agricola Floriddia – Floriddia's farm

Actor's info

Enterprise: Floriddia's farm.  
Name: Rosario Floriddia.  
Position: Owner and manager.

Interviews

Type: in-depth, semi-structured.  
Date: (i) December, 16, 2013; (ii) October, 18, 2014.  
Place: Floriddia's corporate headquarters, Peccioli (PI), Italy.  
Duration: (i) 72 min; (ii) 65 min.

Regional wheat to bread chain: Pane Toscano a Lievitazione Naturale – Sourdough Tuscan Bread

Actor's info

Enterprise: Farmers’ Cooperative of Siena - Agricultural production.  
Name: Roberto Ceccuzzi.  
Position: Agronomist.

Interview

Type: In-depth, semi-structured.  
Date: October, 9, 2014.  
Place: Farmers’ Cooperative of Siena branch, Colle Val d'Elsa (SI), Italy.  
Duration: 74 min.
Enterprise: Domenici’s bakery.

Name: Marzio Domenici.

Position: Associate.

Interview

Type: In-depth, semi-structured.

Date: October, 15, 2014.

Place: Domenici’s bakery headquarters, Livorno, Italy.

Duration: 100 min.

Actor’s info

Enterprise: Giambastiani’s milling company.

Name: Ugo Giambastiani.

Position: Legal Representative.

Interview

Type: In-depth, semi-structured.

Date: January, 28, 2014.

Place: Giambastiani’s milling company headquarters, Ponte a Moriano (LU), Italy.

Duration: 97 min.

Actor’s info

Enterprise: Consortium for the Promotion an Protection of Tuscan Bread.

Name: Roberto Pardini.

Position: Director.

Interview

Type: In-depth, semi-structured.

Date: October, 6, 2014.

Place: University of Pisa – Department of Agriculture, Food and Environment, Pisa, Italy.
Global wheat to bread chain: Mulino Bianco Pan Bauletto

Actor's info

Enterprise: Barilla – Bakery.

Name: Guido Calò.

Position: Quality and Food Safety Director.

Seminar on “How food industry products are developed: from the generation of ideas to realization”

Date: October, 15, 2014.

Place: University of Pisa – Department of Agriculture, Food and Environment, Pisa, Italy.

Duration: 2 h.

Actor's info

Enterprise: Barilla – Center for Food & Nutrition.

Name: Meeting with key managers of the company including: marketing and intelligence, quality control, provisioning of grains and flours, provisioning of all raw materials different from grains.

Meeting at the company headquarters

Date: October, 31, 2013 and November, 6, 2014

Place: Barilla headquarters, Parma, Italy.

Duration: all day
Annex 5 – Documents accessed for each case study

<table>
<thead>
<tr>
<th>Accessed documents (links)</th>
<th>Accessed external links</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Local supply chain</strong>, URL: <a href="http://www.ilmulinoapietra.it/">http://www.ilmulinoapietra.it/</a></td>
<td></td>
</tr>
<tr>
<td>“Effetti del pane e della pasta realizzata con grani antichi” (Health effects of bread and pasta made with old varieties of wheat) <a href="http://www.ilmulinoapietra.it/uploadFile/Effetti_pane_pasta_con_grani_antichi.pdf">http://www.ilmulinoapietra.it/uploadFile/Effetti_pane_pasta_con_grani_antichi.pdf</a></td>
<td><a href="http://www.lineaverde.rai.it/dl/portal/site/puntata/ContentItem-e3129e7e-2407-4b6-a74c-c9f0a543e4f7.html">http://www.lineaverde.rai.it/dl/portal/site/puntata/ContentItem-e3129e7e-2407-4b6-a74c-c9f0a543e4f7.html</a></td>
</tr>
<tr>
<td>“Come usare la nostra pasta madre” (How to use our sourdough) <a href="http://www.ilmulinoapietra.it/pasta_madre_italiano.php">http://www.ilmulinoapietra.it/pasta_madre_italiano.php</a></td>
<td><a href="http://www.cucinanaturale.it/section/article/varietadi_grano_antiche_per_l_agricolturapiu_moderna">http://www.cucinanaturale.it/section/article/varietadi_grano_antiche_per_l_agricolturapiu_moderna</a></td>
</tr>
<tr>
<td></td>
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<tr>
<td><strong>Regional supply chain</strong>, URL: <a href="http://www.panetoscano.net/">http://www.panetoscano.net/</a></td>
<td></td>
</tr>
<tr>
<td>“Il germe di grano” (Wheat kernel) <a href="http://www.panetoscano.net/images/il_germe_di_grano.pdf">http://www.panetoscano.net/images/il_germe_di_grano.pdf</a></td>
<td></td>
</tr>
<tr>
<td>“Dal grano al pane toscano” (From Tuscan wheat to Tuscan bread) <a href="http://www.panetoscano.net/images/dal_grano_al_pane.pdf">http://www.panetoscano.net/images/dal_grano_al_pane.pdf</a></td>
<td></td>
</tr>
<tr>
<td>“Storia del Pane Toscano” (Tuscan Bread’s history) <a href="http://www.panetoscano.net/images/storia_del_pane_toscano.pdf">http://www.panetoscano.net/images/storia_del_pane_toscano.pdf</a></td>
<td></td>
</tr>
</tbody>
</table>

99
“2014 Double Pyramid – Food styles and environmental impact”

“Dichiarazione Ambientale di Prodotto applicata a Pan Bauletto”
(Environmental Product Declaration applied on Pan Bauletto)
### Annex 6 - Descriptors

<table>
<thead>
<tr>
<th>Product qualification</th>
<th>Qualitative aspect</th>
<th>Quantitative aspect</th>
<th>Local</th>
<th>Regional</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>functional unit</td>
<td>description of unit of product studied in the case, consistently used for further &quot;calculations&quot;</td>
<td>kg bread</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>local name</td>
<td>name of the product in the local language and brand</td>
<td>Pane</td>
<td>Pane Toscano a Lievitazione Naturale</td>
<td>Pan Bauletto bianco Barilla</td>
<td></td>
</tr>
<tr>
<td>content of the product</td>
<td>list of ingredients necessary in the manufacturing of the product</td>
<td>Mix of flour (all old varieties of both soft and durum wheat), water, emmer wheat flour, sourdough, bakers’ yeast, salt</td>
<td>All-purpose soft wheat (allowed varieties only) with kernel, water, sourdough</td>
<td>Wheat flour type “0”, water, extra virgin olive oil (2.3%), baker’s yeast, salt, sugar, barley flour (malt)</td>
<td></td>
</tr>
<tr>
<td>nutritional content</td>
<td>list of nutrients</td>
<td>g/100g proteins, carbohydrates, fats, fibre, salt; mg/100g minerals, vitamins</td>
<td>g/100g proteins, carbohydrates, fats, fibre, salt</td>
<td>g/100g proteins, carbohydrates, fats, fibre, salt</td>
<td></td>
</tr>
<tr>
<td>Included processes</td>
<td>Grinding</td>
<td>names of processes, with for ex times of processing (e.g. maturation)</td>
<td>stone mill+cylinder</td>
<td>cylinder mill with reduced speed and temperature control</td>
<td>cylinder mill</td>
</tr>
<tr>
<td></td>
<td>Baking</td>
<td>leavening process and type of oven</td>
<td>Sourdough and bakers' yeast, wood oven</td>
<td>Sourdough, wood/electric/gas oven</td>
<td>Bakers' yeast, gas oven</td>
</tr>
<tr>
<td>Packaging material description (is there a label for material used, recycled, etc)</td>
<td>Packaging material</td>
<td>Paper, recyclable</td>
<td>Paper and plastic, recyclable</td>
<td>Plastic, recyclable</td>
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</tr>
<tr>
<td>Differentiation of the product is there a specification on the label differentiating the product from similar products</td>
<td>yes/no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>if yes existence of a product specification</td>
<td>yes/no</td>
<td>no</td>
<td>yes, PDO requested</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Differentiation on quality whole grain, sourdough leavening</td>
<td>whole grain, sourdough leavening, ancient wheat</td>
<td>sourdough leavening, no salt, regional wheat</td>
<td>whole grain, long shelf life</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differentiation on production methods (organic, fair trade, ..) conventional, integrated, organic farming</td>
<td>organic farming</td>
<td>conventional or integrated farming</td>
<td>conventional farming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology short description of the technology employed for the transformation (artisanal VS technological)</td>
<td>names of processes and technical characteristics</td>
<td>craft bread, discontinuous baking, wood oven</td>
<td>craft bread, discontinuous baking</td>
<td>industrial bread, continuous baking</td>
<td></td>
</tr>
<tr>
<td>Product quantification Production volumes how much bread per year do you produce?</td>
<td>tons/year</td>
<td>20,8</td>
<td>200</td>
<td>&gt;19815</td>
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</tbody>
</table>
Seasonality of production is affected by seasonality. Yes (during summer months quantities increase for tourism).

<table>
<thead>
<tr>
<th>Price</th>
<th>€/kg</th>
<th>3.50 on-farm shop, 4.20 grocery</th>
<th>3.00 to 3.50</th>
<th>3.00 white Pan Bauletto</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price to consumer</td>
<td>€/t farmers get for raw wheat</td>
<td>Self-supplier; 4.50 (paid to additional suppliers)</td>
<td>20 cent to ... (minimum - medium - maximum prices defined by contract)</td>
<td>Bologna market price (19.2 cent, October 9, 2014)</td>
</tr>
<tr>
<td>Price paid to farmers</td>
<td>€/t</td>
<td>Self-supplier</td>
<td></td>
<td>self supplier for a share</td>
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<tr>
<td>Price paid to mills</td>
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