POLITECNICO DI MILANO

School of Industrial and Information Engineering

Master of Science in Management Engineering – Ingegneria Gestionale

- Sustainable Operations Management and Social Innovation –

The role of digital technologies as support tool of agri-food traceability: a study case on the olive oil supply chain in Italy

Supervisor: Prof. Alessandro Perego

Co-Supervisor: Dr. Chiara Corbo

Student: Luca Zanzottera

Identification number: 859182

Academic year: 2016/2017

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1. INTRODUCTION

Abstract

Agri-food sector has always been subject to several scandals in the course of history. The world is more and more connected thanks to the introduction of new technologies, that enable the possibility to collect, store and exchange a huge amount of information faster and faster. In this context, agri-food actors are called to face a series big challenges to compete in the market: global population is increasing, as well as food requirements, a large part of it is not even sufficiently fed; in the industrialised world consumers want to know more about what they eat, and need more guarantee concerning food safety; climate changes effect can alter the rhythms of the phenologycal phases of plants, causing problems for the crops. Nevertheless, thanks to digital innovation, today we have the opportunity to deal with these issues. The general strategy of Italian companies of the sector is focusing on that part of market that is looking for quality of "made in Italy". To guarantee this, it is necessary to exploit new technologies able to improve the processes along all the supply chain and, at the same time, meeting the increasing needs of sustainability. This thesis presents an investigation on these issues, focusing in particular in the definitions of food quality and traceability, and going deep with the presentation of a case study concerning olive oil sector.

2. OBJECTIVE AND METHODOLOGY

This thesis started in September 2017, after a brief meeting with Filippo Renga, director of Osservatorio Smart Agrifood of Politecnico di Milano, and Chiara Corbo, researcher of the same observatory. After having demonstrated interest towards the issues concerning traceability, food safety and quality, I accepted the assignment to help the researcher to explore the wide world around which these concepts revolve. The research has been focused on the project recently implemented by Oleificio Zucchi, an Italian olive oil company, in order to have a concrete context on which extrapolate information and have a clearer idea about what "doing traceability" really means. Thesis has been carried out until the beginning of April 2018, all the information collected and reported are the result of the investigation of several sources of different nature:

1. **Sources from web**: scientific papers, university slides, websites. They have been collected and archived in a file Excel, in order to be recovered when necessary. In particular, for each source, it has been specified: date, title, author, source (link), type of document, agrifood sector, technologies mentioned, tag and notes.

Date	Title	Author	Source	Type of document
2010	The olive oil supply chain	Team of EMAF	http://ww2.unime.it/emaf/index.php?option=com_content&view=article&id=54&Itemid=42&lang=en	web site
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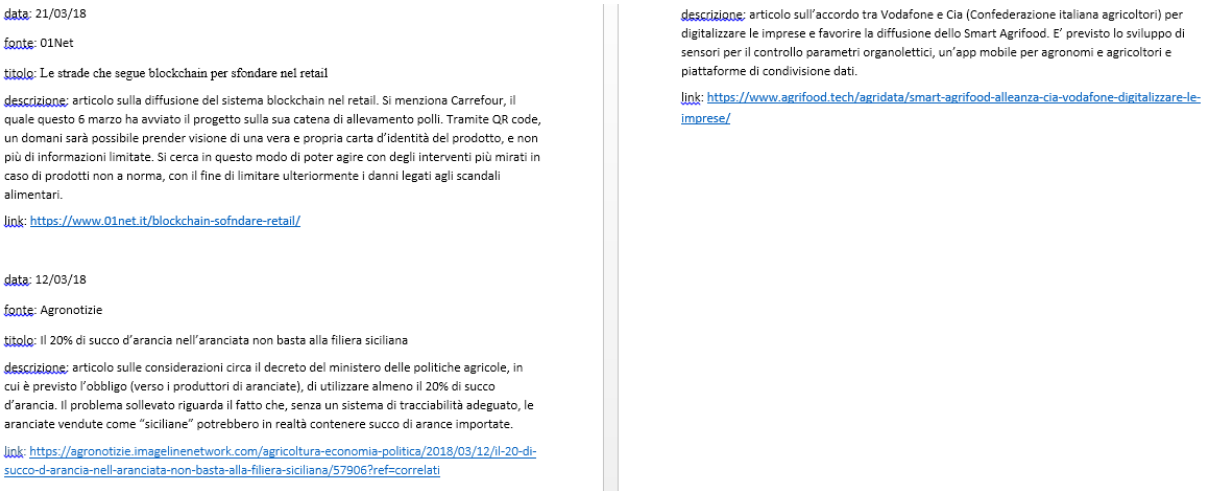
2017	Agri Open Data	Agri Open Data	https://www.agriopendata.it/it/index	web site
2017	EZ Lab sperimenterà la rete 5G di WIND Tre e Open Fiber nel settore Agri-Food	EZ Lab	http://www.ezlab.it/notizie/ez-lab-sperimentera-la-rete-5g-wind-tre-open-fiber-nel-settore-agri-food/	web site
2016	Internet of food per una filiera alimentare più sostenibile	Erika Seghetti	http://www.green.it/internet-of-food/	web site
2017	Tracciabilità alimentare: la app TRusT™	Logisticamente	http://www.logisticamente.it/Articoli/10179/Tracciabilita_alimentare_la_app_TrusT_.aspx	web site
2015	Barilla, arriva la rivoluzione delle etichette intelligenti	Manuela Falchero	http://bimag.it/imprese/prodotti-e-servizi/barilla-arriva-la-rivoluzione-delle-etichette-intelligenti_363609/	web site
	The Challenges 9 Traceability and Food Safety Technology		https://agfundernews.com/the-challenges-9-traceability-and-food-safety-	

Figure 1: Excel file to organize the information searched

2. **Sources from web (2)**: news for and from Osservatorio Smart Agrifood newsletters. It has been asked me to send news every week, whose date of publication was possibly recent (generally not older than two weeks). In particular, for each news found, I had to specify: date, source, title, description, link. The key words I used most frequently during the researches were: food traceability, food safety, food quality.



data: 21/03/18

fonte: 01Net

titolo: Le strade che segue blockchain per sfondare nel retail

descrizione: articolo sulla diffusione del sistema blockchain nel retail. Si menziona Carrefour, il quale questo 6 marzo ha avviato il progetto sulla sua catena di allevamento polli. Tramite QR code, un domani sarà possibile prender visione di una vera e propria carta d'identità del prodotto, e non più di informazioni limitate. Si cerca in questo modo di poter agire con degli interventi più mirati in caso di prodotti non a norma, con il fine di limitare ulteriormente i danni legati agli scandali alimentari.

link: https://www.01net.it/blockchain-sofndare-retail/

data: 12/03/18

fonte: Agronotizie

titolo: Il 20% di succo d'arancia nell'aranciata non basta alla filiera siciliana

descrizione: articolo sulle considerazioni circa il decreto del ministero delle politiche agricole, in cui è previsto l'obbligo (verso i produttori di aranciate), di utilizzare almeno il 20% di succo d'arancia. Il problema sollevato riguarda il fatto che, senza un sistema di tracciabilità adeguato, le aranciate vendute come "siciliane" potrebbero in realtà contenere succo di arance importate.

link: https://agronotizie.imagelinenetwork.com/agricoltura-economia-politica/2018/03/12/il-20-di-succo-d-arancia-nell-aranciata-non-basta-alla-filiera-siciliana/57906?ref=correlati

descrizione: articolo sull'accordo tra Vodafone e Cia (Confederazione italiana agricoltori) per digitalizzare le imprese e favorire la diffusione dello Smart Agrifood. E' previsto lo sviluppo di sensori per il controllo parametri organolettici, un'app mobile per agronomi e agricoltori e piattaforme di condivisione dati.

link: https://www.agrifood.tech/agridata/smart-agrifood-alleanza-cia-vodafone-digitalizzare-le-imprese/

Figure 2: Word file to organize the news searched

3. **Sources from interviews**: directly at the plant of Oleificio Zucchi in Cremona, in which the company's responsible have proved to be kind and available to tell their project. Five meetings have been organized: the first one in October, to introduce the general framework; three in November, to sum up and better clarify what has been learnt, to go in detail with softwares and marketing's role, to discuss about quality and costs related the project; the last one in December, to return a final result about all that has been discussed until that time. Different members of the company, dedicated to different areas (e.g. quality, marketing, costs, software…), have been interviewed, in order to have the most possible complete vision concerning the project. For privacy issues, it has been asked me to be a bit sloppy in reporting sensitive information (e.g. investment costs and data exchanged between supply chain operators).

4. **Sources from events**: in occasion of four events, I have been invited to attend several testimony from responsible of companies involved (directly or indirectly) in agri-food sector. The common thread that links all of them is the role of digital that, regardless of context and type of product/service delivered, is perceived as a fundamental key to grow for maintaining competition on the global market and facing food challenges (i.e. food and nutrition security, food waste and loss, sustainable agro-food supply chain). Finally, in order to have also a "more external" point of view, this February was done a call interview to a forest agronomist, member of an organization of producers (OP) involved in the project.

Figure 3: UniCredit AgriTalk event (18/10/17, Milan)

1. INTRODUZIONE

Abstract

Il settore dell'agroalimentare è sempre stato soggetto a svariati scandali nel corso della storia. Il mondo è sempre più connesso grazie all'introduzione di nuove tecnologie, che garantiscono la possibilità di raccogliere, immagazzinare e scambiare una vastissima mole di informazioni sempre più velocemente. In questo contesto, gli attori del settore sono chiamati a far fronte ad una serie di grandi sfide per competere nel mercato: la popolazione globale è in continuo aumento, così come il fabbisogno nutrizionale, una larga parte di essa non è neanche sufficientemente nutrita; nel mondo industrializzato i consumatori vogliono sapere di più riguardo ciò che mangiano, e necessitano di una maggior garanzia in termini di sicurezza alimentare; l'effetto dei cambiamenti climatici è in grado di alterare i ritmi delle fasi fenologiche delle piante, causando problematiche alle colture. Tuttavia, grazie all'innovazione digitale, oggi si ha l'opportunità di far fronte a tali questioni. La strategia generale delle aziende italiane del settore si sta concentrando su quella parte di mercato che cerca la qualità del "made in Italy". Per garantire ciò, è necessario sfruttare nuove tecnologie in grado di migliorare i processi lungo tutta la filiera e, allo stesso tempo, andare incontro alle crescenti esigenze di sostenibilità. Il seguente elaborato presenta un'indagine di queste tematiche, facendo un particolare approfondimento sulle definizioni di qualità alimentare e tracciabilità, e sull'illustrazione di un caso di studio riguardante il settore olivicolo.

2. OBIETTIVO E METODOLOGIA

Questo elaborato racchiude un lavoro iniziato a Settembre 2017, dopo un breve colloquio con Filippo Renga, direttore dell'Osservatorio Smart Agrifood del Politecnico di Milano, e Chiara Corbo, ricercatrice presso la stessa sede. Dopo aver dimostrato interesse verso le tematiche relative a tracciabilità, sicurezza alimentare e qualità, ho accettato l'incarico di aiutare la ricercatrice nell'esplorazione del vasto mondo attorno cui questi concetti ruotano. La ricerca si è focalizzata su un progetto recentemente implementato da Oleificio Zucchi, una compagnia olivicola italiana, in modo da avere un contesto concreto da cui poter estrapolare informazioni e avere un'idea più chiara riguardo il vero significato di "fare tracciabilità". L'elaborato è stato portato avanti fino agli inizi di Aprile 2018, tutte le informazioni raccolte e riportare sono il risultato dell'indagine di numerose fonti di diversa natura:

1. **Fonti dal web**: articoli scientifici, slides universitarie, siti web. Sono state raccolte e archiviate in un file Excel, in modo da poterle recuperare quando necessario. In particolare, per ogni fonte, è stato specificato: data, titolo, autore, fonte (collegamento), tipo di documento, settore agroalimentare, tecnologie menzionate, parole chiave e note.

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2010	The olive oil supply chain	Team of EMAF	http://ww2.unime.it/emaf/index.php?option=com_content&view=article&id=54&Itemid=42&lang=en	web site
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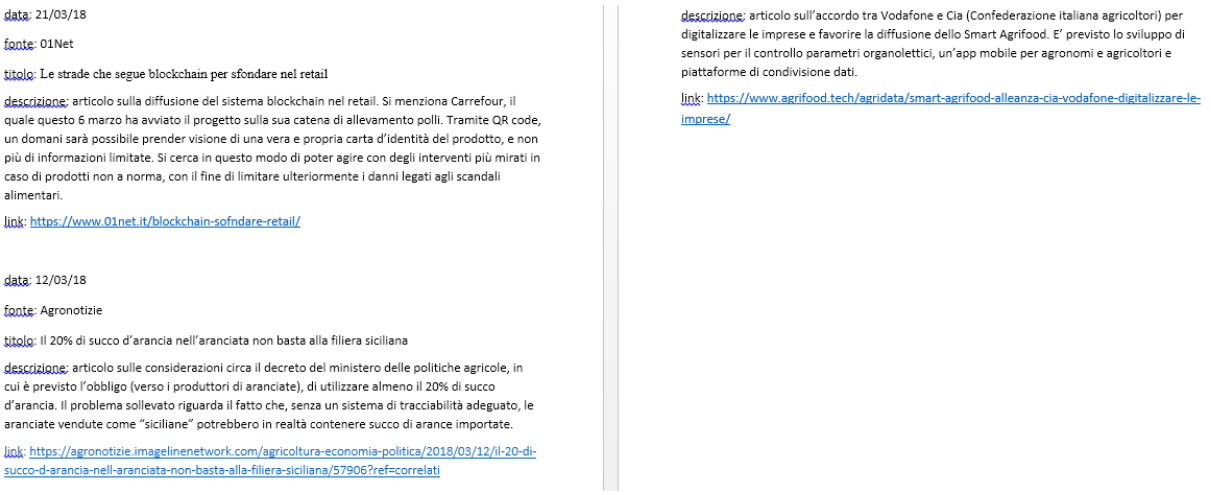
Figura 4: Documento Excel per organizzare le informazioni cercate

2. **Fonti dal web (2)**: notizie per e dal notiziario dell'Osservatorio Smart Agrifood. Mi è stato chiesto di mandare delle notizie ogni settimana, la cui data di pubblicazione fosse possibilmente recente (generalmente non più vecchia di due settimane). In particolare, per ogni notizia trovata, dovevo specificare: data, fonte, titolo, descrizione, collegamento. Le parole chiave che ho usato più frequentemente durante le ricerche sono state: tracciabilità alimentare, qualità alimentare, sicurezza alimentare.



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link: https://www.agrifood.tech/agridata/smart-agrifood-alleanza-cia-vodafone-digitalizzare-le-imprese/

Figura 5: Documento Word per organizzare le notizie cercate

3. **Fonti da interviste**: direttamente presso lo stabilimento di Oleificio Zucchi a Cremona, in cui i responsabili dell'azienda hanno dimostrato gentilezza e disponibilità nel raccontare il loro progetto. Cinque incontri sono stati organizzati: il primo ad Ottobre, per introdurre il contesto generale; tre a Novembre, per riassumere e chiarire meglio ciò che è stato appreso, entrare nei dettagli con i softwares in uso e il ruolo del marketing, discutere sulle tematiche della qualità e dei costi legati al progetto; l'ultimo a Dicembre, per la restituzione del risultato finale riguardante tutto ciò che è stato detto fino a quel momento. Differenti membri della compagnia, dedicati a differenti aree (qualità, marketing, costi, software…), sono stati intervistati, in modo da avere un quadro del progetto il più possibile completo. Infine, per avere anche un punto di vista "più dall'esterno", è stata fatta questo Febbraio un'intervista via telefono ad un agronomo forestale, facente parte di un'organizzazione di produttori (OP) coinvolta nel progetto. Per questioni di riservatezza, mi è stato chiesto di essere un po' approssimativo nel riportare informazioni sensibili (come i costi legati all'investimento e le informazioni scambiate tra operatori della filiera).

4. **Fonti da eventi**: in occasione di quattro eventi, sono stato inviato a prendere parte a numerose testimonianze da parte di responsabili di aziende coinvolte (direttamente o indirettamente) nel settore agrifood. Aspetto comune che collega tutte queste è il ruolo del digitale, a prescindere dal contesto e dal tipo di prodotto/servizio proposto, è percepito come la chiave fondamentale per la crescita e la competitività nel mercato globale e per far fronte alle questioni legate al cibo (sicurezza alimentare e nutrizionale, spreco, filiera agroalimentare sostenibile).

Figura 6: Evento UniCredit AgriTalk (18/10/17, Milano)

3. LITERATURE REVIEW

3.1 QUALITY DEFINITION

If we make a research, we will discover that the term quality, in the specific referring to a product, has a lot of different definitions (among ISO, scientific papers...).

Let's see some examples of quality definition:

1. Examples of definitions that focus on the product characterization:
- *The complex of the characteristics that make an object suitable for the use or for the function which it is intended* (Treccani).
- *The level in which a group of intrinsic characteristics satisfies requisites* (UNI EN ISO 9000:2005).

2. Examples of definitions that focus on the compliance with consumer need:
- *All the attributes and the characteristics of a product (or service) that contribute to its capability to satisfy specific needs, implicit or explicit* (ISO 8402:1995).
- *The capability to satisfy explicit and implicit needs – civil, productive life, social, economical, moral and material type – resulted in the form of requisites, not generic but concrete and measurable, through appropriate processes of regulation and standardization* (Accredia).

When we talk about consumer needs, we are considering the expected quality, that is related to:

- **Explicit needs**: they are detected with market surveys and direct contacts between customers and suppliers. They are needs that allow the companies to create differentiation from the competitors. They exist until all the companies on the market do not satisfy them (e.g. in the past, sending e-mail from a phone mobile was an explicit need for a lot of consumers. Today the same service becomes an implicit need for all the consumers who own a smartphone). With an explicit need a company can guarantee a satisfied consumer but not necessarily a loyal one.

- **Implicit needs**: they are those for which the consumer considers an obvious satisfaction (e.g. air conditioning system inside a car, the possibility to send sms with a phone mobile…). If they are absent they can provoke significant dissatisfaction of the consumer (exactly as the basic needs in Kano Model, see figure 14).

- **Hidden needs**: they are those that the consumer does not express because he/she does not feel them as such until he/she discovers and sees the benefits. For a company satisfying a hidden need is the key to gain customer loyalty. To detect these needs it is necessary a further step than simply asking the consumers in a direct way: listening them, observing their behaviors, feeling what they really desire (e.g. Fuji, the Japanese electronics company, was the first to introduce a travel adapter that combines all of the

connectors needed to fit any power outlet worldwide, all in one unit. Before it, the people had to carry with them different adapters, dealing with the problem of space.)

The expected quality depends on cultural and social context because this one influences the importance given to a specific need.

3. Example of definition that focuses on the recognition of the market:

- *"The quality of a product (or of a service) is not what the supplier puts in, but what the consumer gets out and is willing to pay for"* (P. Drucker).

3.1.1 The eight dimensions of quality by David A. Garvin (1984) is a model that can be used at a strategic level to analyze quality characteristics:

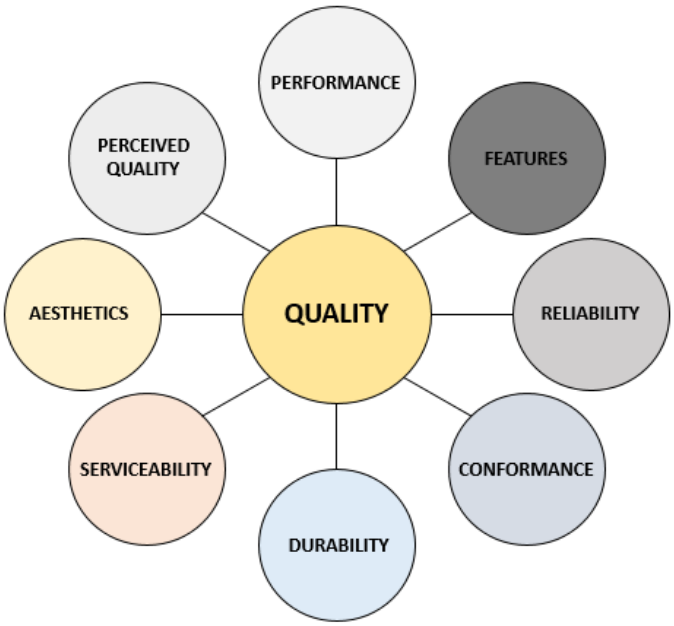


Figure 7: The model of the eight dimensions of quality by David A. Garvin (1984)

1. **Performance**: It refers to the primary operating characteristics of a product and involves measurable attributes. Brands can be ranked objectively on the aspects of performance, the evaluation is based on the functional requirements and not on personal taste.

2. **Features**: they are additional characteristics that increase the appeal of the product to the consumer, secondary aspects of performance (e.g free drinks on a plane).

3. **Reliability**: it is the probability that a product will not fail within a specific time period. It is a major contributor to brand or company image and an important dimension of quality (e.g in the cars market it is one the most desired aspect, especially for women).

4. **Conformance**: it is the precision with which the product meets the specified standards. All products involve specifications, targets (e.g. the materials used or the dimension of the product) and tolerances, that define the range of permitted deviation from the target.

5. **Durability**: it measures the length of a product's life. Estimating it becomes more complex when the product can be repaired. The product will be used until it finishes its useful life and it is no longer economical to operate it.

6. **Serviceability**: it is the speed with which the product can be put into service when it breaks down, as well as the competence and the behavior of the service personnel.

7. **Aesthetics**: it is a subjective dimension that refers the individual's personal preference. The aesthetics properties of a product contribute to the identification of a company or a brand. They refers to how a product looks, feels, sounds, tastes or smells. On this dimension it is impossible to please everyone.

8. **Perceived quality**: it is the quality attributed to a product based on indirect measures. Why indirect? Because the consumers do not always have complete information about a product's attributes (e.g. the durability of a product can rarely be observed directly). Reputation is the most important aspect of this dimension.

3.1.2 The measure of quality on the basis of product's functions:

- **Fe** = functions expected by the consumer. It represents the measure of how a product performs them.
- **Fr** = functions realized by the producer. It represents the measure of how a product performs the functions expected by the consumer and carries out some unexpected, but perceived by the consumer.
- **Fp** = functions perceived by the consumer. It represents the measure of how a product performs the functions expected by the consumer and carries out some unexpected, but perceived by the consumer, in a better way respect with the competitors.

The measure of quality on the basis of consumer's perception:

Quality is:

- A ratio between realization and expectation
- A measurable concept
- A concept whose the measure is in relation to a reference system, the consumer.

Realized quality $= \frac{\mathrm{Fr}}{\mathrm{Fe}}$; if this ratio is equal to 1 we have the minimum condition of fulfilment of consumer's expectations, but not of consumer's satisfaction.

Perceived quality $(Qp) = \frac{\mathrm{Fp}}{\mathrm{Fe}}$; if this ratio is > 1, we have consumer's satisfaction.

The measure of quality in a competitive market:

The perception of quality is substantially influenced from the comparison between the perceived quality and that one perceived for the competitors' products. For this reason, we can introduce the concept of competitive quality:

$$\boldsymbol{Qc} = \frac{\mathrm{Fp}}{\mathrm{Fc}}$$

Functions perceived by the consumer on the competitors = $\boldsymbol{Fc} = \frac{\text{average of competitors}}{\text{best competitor}}$

$$\boldsymbol{Overall\ Qp} = Qp * Qc$$

3.1.3 The spiral of Juran is a representation of how quality is progressing:

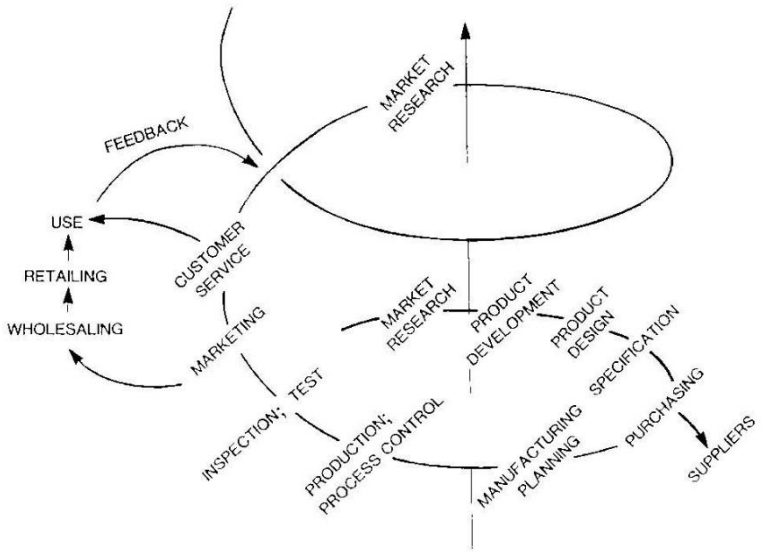


Figure 8: The spiral of Juran (1974)

The spiral represents the concept of continuous improvement of quality. This improvement is led by using the previous experiences, correcting the mistakes and enforcing the positive aspects. As the spiral suggests, at the end of each production cycle a company should not carry on from the beginning, but from a superior level of quality (this is the reason why the line is not a closed circle, but a spiral).

3.1.4 Quality defined by standards:

The increasing awareness of quality, not only concerning the product itself, but also the production process, has led a progressive extension of the horizon of the standards to all the phases of the useful life of a product (from raw material until after-sales service). For example, the standards ISO are voluntary and strategically important for:

- The consumers: as warranty that the companies comply with fundamental requirements of product quality insurance, through the control of the production and support processes.
- The companies: as unique international reference in the contractual relationship with the suppliers and the consumers.

Furthermore, the standards ISO help to spread culture and basic instruments of quality to the companies, in a unique and standardized form.

To the concept of quality we can associate two dimensions:

1. **Horizontal** (or standards-based quality): it is defined by mandatory standards. A mandatory standard is a basic requirement that remains constant until it is replaced by another one. The compliance with a standard is a requisite, not a competitive difference.
2. **Vertical** (or total quality): it is related to competitiveness and continuous improvement. It is a competitive dimension, without limits of reference, that can be evaluated with objective considerations.

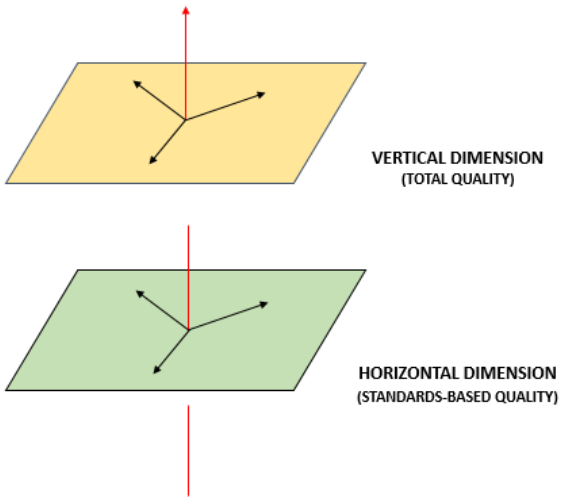


Figure 9: The two dimensions of quality

3.1.5 Problems related to quality in the companies:

- For a small organization, the problems concern technical and methodological issues due to lack of knowledge. In general, it does not have specialized resources and informative channels necessary to be always updated as concerns the evolution of the problems related to quality. At the same time, the communication and the information flows inside the organization are easy to be managed.

- For a big organization, instead, there are generally the dedicated resources for quality in order to guarantee the desired level of technical and methodological knowledge. At the same time, the communication and the information flows inside the organization become more and more critical to be managed.

Here a graph to summarise the concept

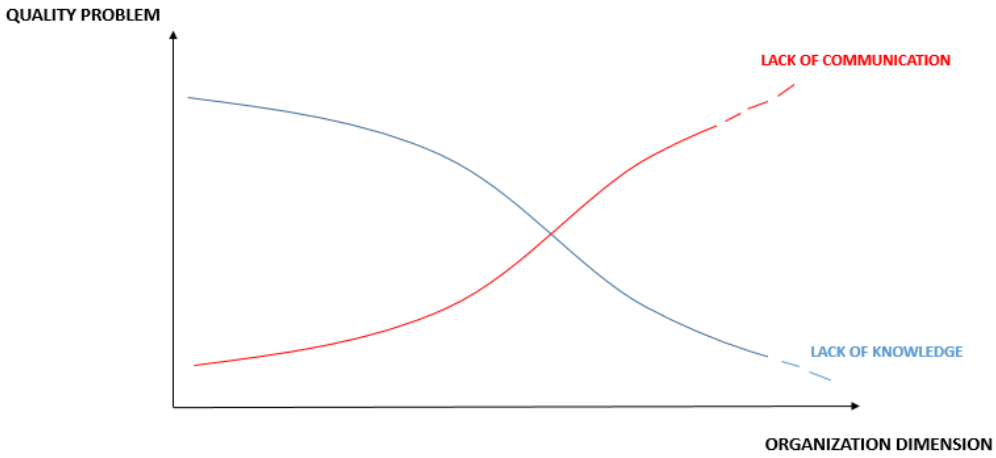


Figure 10: Quality problem-Organization dimension graph

A fundamental element for the success of the application of a quality management system is the correct training of the employees, their motivation and skills. For this reason, at the basis of employees' training there should be an approach oriented to change with a continuous improvement (as the spiral of Juran suggests).

Here some concepts that every members of an organization should take into account:

- Consumer as key element to run a business
- Commitment in a continuous improvement
- Medium/long-term orientation results
- Groupthink instead of individual
- Necessity to be led from information based on data

3.2 FOOD QUALITY DEFINITION

3.2.1 Food quality as a relative concept

When we discuss about food quality, we are going to open a wide world of opinions, models and concepts. Armand V. Cardello claimed that food quality can be considered both the most well-defined and the least well-defined concept in the food industry today. From one side we have the experts, that are able to provide scientific definitions based on objective measurements of parameters (nutritional, microbiological, textural quality…). However, this category represents a small percentage of people concerned with food quality. In fact, the rest consists of consumers whose tastes, needs and perceptions drive the economy of the global food industry. According to Cardello, one of the biggest difficulty, related to find definition and measurement of food quality, lies in the fact that it is a relative concept. This difficulty stems from the subjectivity of the single consumer, but also from a series of situational factors and contexts. If food quality is determined by the consumer perspective, none of the indicators used in the scientific context turns adequate. However, it is false that food quality can not be measure, but the measurement can be done considering a sample of consumers in a specific context. The notion of food quality as a relative concept is from the first volume of "The Food Journal", published in 1870, of which we mention a short sentence to underline this meaning: "A gentleman who will cheerfully eat a tin of preserved meat on a sea voyage, will on shore make out some plea for its not being a prime or acceptable article. Those to whom an article is truly acceptable, are those who cannot get anything at all so good" (H. Clarke, 1870). This perspective has been ignored for at least one hundred years by the field of Food Science, pursuing the idea of the use of quality evaluation systems based on judgements of experts and on scientific measures considered objective. Returning to the concept of relativity supported by Cardello, here an example of food quality definition that focuses on a sensory quality:

"The acceptance of the perceived characteristics of a product by consumers who are the regular users of the product category or those who comprise the target market" (Galvez and Resurrection, 1992)

This definition includes three critical aspects:

1. It uses the consumer as the referent
2. It focuses on acceptability as the key measurement construct
3. It connotes the relativity of judgement reflected in the qualifying concepts of "product category" and "target market"

The paradigm shift to a consumer-based definition of food quality is also a shift from the physical side to the psychological one. It can become critical when people start to view food quality as an inherent characteristic of food itself. For example, one consumer can make the association between the perception of food quality and the perception of an object's color.

3.2.2 The three types of food quality were proposed by Klaus G. Grunert, making a distinction between:

1. **Product-oriented quality**: measured taking into account a food product's physical properties (e.g. fat percentage, cell content in milk…)

2. **Process-oriented quality**: measured taking into account the extent to which the product-oriented quality remains stable within the range of pre-specified levels (e.g. a certain level of fat percentage, of cell content in milk…).
3. **User-oriented quality**: measured taking into account the subjective quality perception of the consumers.

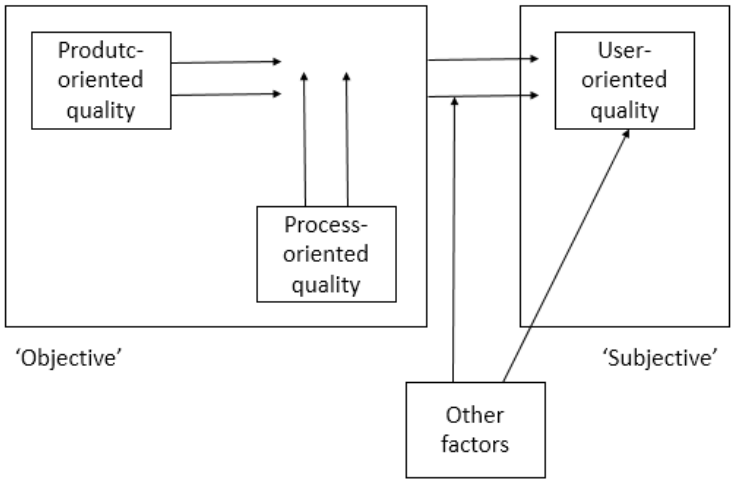


Figure 11: Food quality types model by Klaus G. Grunert (1995)

The first two types of food quality can be considered as objective because measurable for the product itself through physiological methods. The last one, instead, can be measured only in a subjective way so it differs from one consumer to another one. We have a connection, as the scheme shows, among these different types of food quality, in fact, product and process-oriented quality affect user-oriented quality. This in turn can be affected by other factors (e.g. purchase situation, price…). The goal of the author is to explain how the product's objective characteristics influence the subjective quality of the consumer, for this reason it is necessary to understand the association that the consumer makes between these characteristics and the consequences desired.

3.2.3 The means-end chain theory (Gutman, 1982, 1991; Olson, 1989; Olson & Reynolds, 1983; Zeithaml, 1988) is a useful model to reach this aim, showing how a concrete/abstract product characteristic is related to functional/psychosocial consequences of consumption. We can introduce an example to explain this concept: the concrete characteristic of a product "low fat" is related to the abstract one "fewer calories", in turn related to the functional one "slimming" and the psychological one "social acceptance"; these consequences lead to self-confidence (instrumental) and self-esteem (terminal).

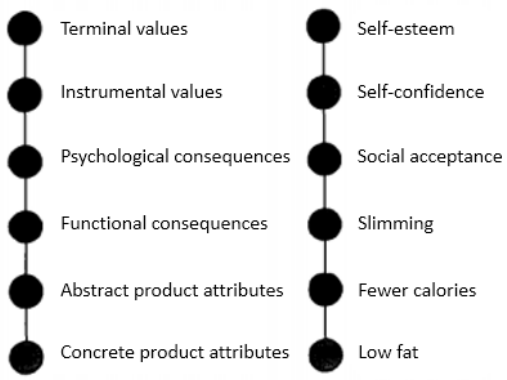


Figure 12: Example of Means-end Chain theory for a lot fat food product

Means-end chains are, in general, obtained by a semi-qualitative technique called "laddering" (Grunert & Grunert, 1995; Reynolds & Gutman, 1988). It is based on a series of interviews with the consumers, with the aim of investigating the associations between product characteristics, consequences and personal values. To each interviewee it is asked to make a list of concrete characteristics related to a specific product category. Successively it is asked to express the personal preferences respect with each one and then a motivation has to be given. Through it, we obtain the clarification of an abstract characteristic or a consequence. This characteristic is investigated with further motivations. The procedure goes on until the achievement of the level of the terminal values. The results obtained are a series of sequences attributes-consequences-values that are called "ladders". All the attributes, consequences and values are coded through some analytics procedures. An implication matrix is computed using these codes, in order to build a hierarchical value map. While the matrix contains the information about how often one category followed another one, the map permits to investigate the reasons of a purchase choice, graphically showing the links between the attributes of the product and the relative benefits perceived. In this way we can consider the possibility to reach the terminal values that the consumption behavior could achieve. These tools may be useful during segmentation and targeting phases, in addition to product development and marketing strategies. Coming back to the example of the product with low fat, the case can be also observed from an opposite situation, in which a non-regular buyer is called to give an opinion about "low fat" attribute: the health motive is not crucial, the production method is not perceived as leading to better health and results in negative consequences on taste.

Here an example of hierarchical value map in the two different perspectives

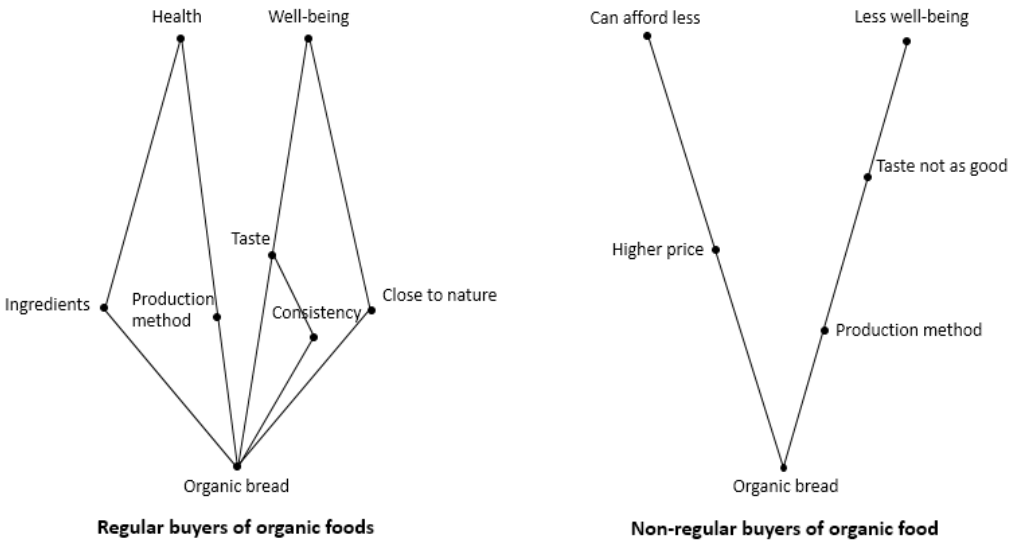


Figure 13: Examples of Hierarchical value maps for two different types of buyer

In order to make a deep analysis we could also consider other aspects that can influence the purchase behavior, as the purchase situation, that includes meal preparations and shopping scripts. Nevertheless, in the interest of this work, we will not go in details with these issues.

3.2.4 The observatory point of view

Osservatorio SmartAgrifood of Politecnico di Milano, taking into account the definition of quality by Drucker, decided to move its analysis to the direction that focuses on the recognition of the market. Starting with this perspective, Osservatorio entered more in the specific, going to define food quality:

"The totality of the attributes and characteristics of a food product (related to the product itself and to the processes carried out to obtain it), that combine to its capability to satisfy specific needs, implicit or explicit, of the intermediate or final client and that find a clear economic sustainability on the market".

There are several actors involved in this definition (the company, the final consumer, the public operator…). The point of view from which we want to start the analysis is that one of the company. We can start to define a list of quality attributes related to:

1. **the product itself**

2. **the process** (all the attributes that a company can enhance in relation to the process with which the product has been made)

These attributes must to find a clear recognition from the final consumers. For this reason, we can make a distinction between attributes related to the process and those related to the product. Osservatorio SmartAgrifood has drawn the quality septagon, a graphical tool that contains the quality attributes identified. The quality septagon concerns what, for the final consumers,

identifies the quality and so how a company can decide to enhance these attributes. Before continuing with the quality septagon, it is necessary to take a step back, with a brief explanation of Kano model.

3.2.5 Kano model is a theory of product development and customer satisfaction (Kano, 1984). About this model, we can just mention three meaningful different kinds of characteristics that connotate the quality of a product:

1. **Performance needs**: qualitative characteristics in which the satisfaction of the client is directly proportional to their presence (e.g. the space available on a cloud storage). Often the clients let the company know what they expect from the product. The company should understand which are the needs of the clients, in order to satisfy them best, to be competitive as much as possible.

2. **Basic needs**: qualitative characteristics that, if absent, can provoke significant dissatisfaction of the client; if there are, they do not provoke satisfaction, because they are considered as basic requirements (e.g. considering a flying company, the possibility to have a seat during the travel). They must be considered in order not to create a serious competitive disadvantage.

3. **Delighters**: qualitative characteristics that provoke surprise and pleasure of the client. If they are present, they increase the satisfaction; if they are not present they do not generate dissatisfaction. They are unexpected characteristics that generate a big positive impact thanks to the element of surprise. (e.g. considering a flying company, a higher quality of food served).

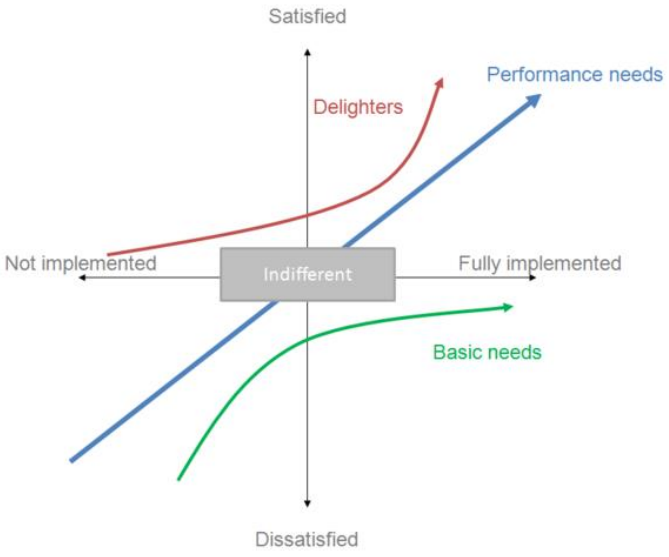


Figure 14: Kano model (1984)

The characteristics identified as "delighters" are the object we want to analyse when we draw the quality septagon: the study does not concern qualitative attributes that the final consumer

expects, but those of differentiation that he/she does not consider. These attributes can increase his/her satisfaction and result in a reward for the company through a premium price.

3.2.6 The quality septagon and a description of the attributes in detail:

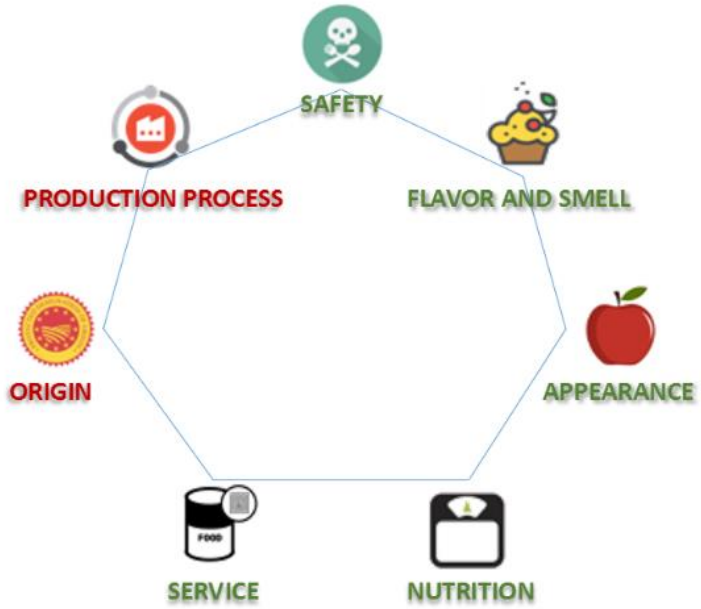


Figure 15: Quality septagon by Osservatorio Smart Agrifood of Politecnico di Milano

1. **Safety**: what we eat must not create health problem to us, avoiding the possibility to send us to the hospital. Food safety is mandatory by law. We can mention some elements able to compromise it, like pathogens, heavy metals, pesticide residues, food additive, residue of medicinal products (e.g. antibiotics).

2. **Flavor and smell**: it is a sensorial attribute. Also the consistency and the texture are included.

3. **Appearance**: pure aesthetic attribute. In the specific, we consider the appearance related to the product (dimension, color, defects presence, consistency…) and the packaging (e.g. its shine could catch the attention of the final consumers that are attracted by bright colors).

4. **Nutrition**: everything about the nutritional aspects. It does not just concern the content of calories, fat, proteins, fibers, mineral…but also the presence of health elements as probiotic, beta-glucans, or the absence of specific components ("gluten-free", without lactose…).

5. **Service**: the level of elaboration of a product (e.g. soup to cook, already cooked and to heat up…fourth range, practicality of packaging, e.g. of salads). We can also mention the label (readability, information given…), procurement possibility, presence/absence of user instructions.

6. **Origin**: attribute that concerns all the aspects related to the identification of the company, of the place of production of the raw materials and of the transformation, the connection with the local tradition.

7. **Production process**: attribute that includes all the aspects related to the production process, in particular in terms of environmental and social impact (use of specific factors and production techniques, e.g. BIO, OGM…; attention to the animal welfare).

Why are the credibility and the price not incuded in this scheme? Because they are more related to the psychological dimension of the final consumers (e.g. the credibility is given from the past experiences and the cultural heritages) than the product itself.

For each qualitative attribute, a company is called to give an evaluation (from 1 to 5 points) about how much it is putting effort to differentiate its offer from the competitor ones. A placement, for a specific attribute, near the value 0 does not mean that a company does not guarantee an acceptable level for that attribute (e.g. if the value of safety is 0 it does not mean that the product is dangerous for human health, but that it is just in line with the standards of law). A placement near 5 means that the company, in relation to the final consumer, is differentiating a specific attribute respect with the competitors. The concept can be simplified in the image below:

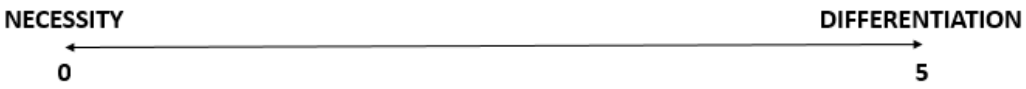


Figure 16: Meaning of evaluation points

The quality septagon implicitly tries to respond to the question *"for which elements can I, as company, ask a premium price to my clients?"*

A producer and a supplier with similar septagons could fit in working together (for this reason a septagon could be also considered at level of supply chain).

In occasion of the workshop SmartAgrifood 4.0 in Politecnico Milano, carried out by Osservatorio Smart Agrifood in November 2017, it was asked the participants to draw the quality septagon related to a product of their company. Here we have some examples and comments of what emerged:

- The representatives of Ferrarini drawn two septagons: one for cooked ham, the other for Parmigiano-Reggiano. What it is important to underline is the fact that, while for cooked ham was assigned a score of 3/5 to the attribute of origin, as concerns Parmigiano-Reggiano the score for the same attribute was 5/5 (because of PDO). This shows that in

the same company there could be different strategies to communicate to the final customer the value of different products.

- The representatives of Pomì considered, for the analysis, the tomato sauce 700g, because it is a typical product in the Italian market. They stated the safety is a must. The nutrition is not considered an attribute of distinction compared to the other sauces, same conclusions for the appearance, flavor and smell. In order to generate value, Pomì aims for the production process and the origin (100% made in Italy).

- The representatives of Latteria Soresina put a low score (1-2) concerning the safety, flavor and smell because they consider them as a prerequisite. With their products they are trying to communicate in particular the origin, the animal welfare (so we have 5 points as concern the origin and the production process). As concern the appearance the score is around 1.

Different products of the same company can have different septagons (as we have seen in Ferrarini case). The scores given to the different attributes are nothing more than a qualitative evaluation, the numbers are of significance when compared each other. The representatives of the different companies could have different perceptions about the evaluation. The most difficult part during this activity was not to make confusion between what is an element of differentiation for the company and what is not. For example, while all the companies gave a score of 5 points to the attribute of safety (because they considered it as must), only Latteria Soresina assigned to it a low score. This is not because the company does not care about safety, on the contrary, the company takes it for granted, just being compliant with the law, so it does not consider it as an element of differentiation.

3.3 FOOD TRACEABILITY DEFINITION

Once introduced the concepts of quality and food quality, now let's focus on the core concept of this work: **food traceability**. Here some examples of traceability definition taken from some dictionaries:

- *The requisite of being traceable* (Treccani).
- *The capability to trace something. In some cases, it is interpreted as the ability to verify the history, location, or application of an item by means of documented recorded identification* (Wikipedia).
- *The ability to discover information about where and how a product was made* (Cambridge Dictionary).

Investigating the etymology of the term "traceability" we have the verb "trace", of which the first known use is in the 14th century and the origin is from the Anglo-French "tracer", from the vulgar Latin "tractiare" (to drag) and the Latin "tractus", past participle of trahere (to pull).

However, we can not stop the treatise with a series of definitions taken from the dictionary, because they are in general too approximate and not in line with scientific articles. For this reason, it is necessary going in details with the first definition of traceability, introduced by the international Organization for Standardization in 1994:

- *The ability to trace the history, application or location of an entity by means of recorded identifications* (ISO 8402: 1994)

Successively, this definition has been replaced with another one:

- *The ability to trace the history, application or location of what which is under consideration* (ISO 9000: 2000)

In 2008 another definition was introduced, ISO 22005, but it is exactly the same definition written for ISO 9000. The difference between these is in the context to which they relate: while ISO 9000 is a standard for quality management systems in general, ISO 22005 is a specific standard for traceability in the food and feed chain. In fact, ISO 22005 specifies that "*Terms such as document traceability, computer traceability, or commercial traceability should be avoided".* As concerns all of these three ISO definitions, the term "traceability" relates "*the origin of materials and parts, the processing history, and the distribution and location of the product after delivery".*

Here we have other examples of remarkable definitions related to food traceability:

- *The ability to follow the movement of a food through specified stage(s) of production, processing and distribution* (Codex Alimentarius FAO/WHO, 1997).
- *The ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution* (EU General Food Law, 2002).

- *The ability to track a product batch and its history through the whole, or part, of a production chain from harvest through transport, storage, processing, distribution and sales* (T. Moe, 1998).

Despite the first definition could be anyway considered as a reference point at international level, the last two are more frequently taken into account in scientific papers. In particular, that one by Moe goes deeper specifying the concepts of "chain traceability" and "internal traceability". Furthermore, the introduction of the term "batch" has been done to indicate at which level of detail food products have to be traced.

According to this author, there are two main ways of managing information in a chain:

1. The information about a product is stored in each step of the chain. The product and its sub-descriptors can be traced moving backwards along the chain step by step.
2. The information follows a product along the chain, in order to bring the information of the previous steps to the consumer.

- **Chain traceability**: it is intra-company process, resulting from the combination of the processes of internal traceability for each actor of the supply chain, with efficient flows of communication. The realization of internal traceability is a prerequisite without which chain traceability can not exist. The latter is not a process manageable from a single subject, but based on relations between the operators: for this reason it needs the involvement of each subjects that has contributed to the formation of the product. It is complex and difficult to be realized.

Here a list of advantages:

- To establish the basis for efficient recall procedures to minimize losses
- Information about raw material can be used for better quality and process control
- To avoid unnecessary repetition of measurements in two or more successive steps
- To improve incentive for maintaining inherent quality of raw materials
- To make possible the marketing of special raw material of product features
- To meet current and future government requirements (e.g. country origin confirmation)

- **Internal traceability**: it is traceability along all the process or the transformation made by each subjects on its products. It works independently from the commercial partners, being achieved in a set of internal procedures, specific for each company, that allow to go back to the origin the raw materials, their usage and to the destination of the products.

Here a list of advantages:

- Possibility for improved process control
- Cause-end-effect indications when product does not conform to standards
- Possibility of correlating product data with raw material characteristics and processing data
- Better planning to optimize the use of raw material for each product type

- Avoidance of uneconomic mixing of high- and low-quality raw materials
- Ease of information retrieval in quality management audits
- Better grounds for implementing IT solutions to control and management systems

3.3.1 Causes of food traceability

Before proceeding with other perspectives and potential advantages, let's go back trying to investigate the causes for which traceability has taken hold in the wide and diverse world of food industry worldwide.

Here some examples related a series of scandals that received media attention around the world:

- The use of methanol in wine (1986): emerged in Italy, it is consider as one of the first resounding scandal in the food sector. The artificial manipulation of wine through the adding of methanol, with the aim of increasing alcohol content, had terrible consequences that led to nineteen dead, dozens of intoxicated people and affected by serious injuries. The exportation collapsed of more than one third, causing about 20 millions of hectoliters unsold respect with the previous year.
- The massive Hudson Foods recall (1997): a meat-processing company had to close its plant in Nebraska, expanding its recall of ground beef to 25 million pounds after the discovery of a contamination by hazardous bacteria.
- BSE (2001): acronym of Bovine Spongiform Encephalopathy, commonly known as mad cow disease, it is neurodegenerative disease in cattle that can be transmitted to humans that have eaten infected flesh. The alarm started in United Kingdom and spread in all Europe causing the death of hundreds of people in different countries and wide damages in term of costs.
- Avian influenza (2003): also in this case we are talking about a contagious disease due to animals. Its virus spread in South-East Asia, causing dozens of dead; alarmism in Europe, with a consequent partial block of poultrymeat commercialization and a collapse of the consumptions with a cost of 500 million of euros.
- Chinese mushrooms (2009): during an operation called "Setaccio", in Italy, NAS impounded about 1200000 packages of dangerous products for human health for a value of 8 million of euros. The products impounded were damaged mushrooms, raw materials for preparing bread with falsified expiration date, meat, dairy products in a bad conservation status, expired mineral water.

Other examples we could mention are: the dioxine contamination of chicken feed in Belgium (1999); the drugged buffalo in Campania, Italy (in 2009); the Chinese tomato (2010); the blue mozzarella in Europe (2010); the fake bio eggs in in Germany and Netherlands (2013); the contaminated eggs in Italy (2017).

As we can see, the list is composed of several scandals and persists to this day. The products involved have different nature, both animal and vegetable. These cases happened in different areas of the world, with different damage entities, in the course of the history. However, we are able to identify some common aspects that characterize all of them:

- **Damages in terms of human health**: harmful food can provoke serious health problems for every consumer and, in the worst cases, death.
- **Damages in terms of costs**: these costs are related to health system, that has to spend more resources to cure patients affected by eating issues; companies and industry, that can suffer financially from food scandals. Distortions in markets lead to unfair competition, the legitimate producers are undercut, even risking to be forced out of the market. They can cause huge costs in larger market. The damage is strictly related to reputational issues. The guarantee of safe food systems is a responsibility both for industry, public sector and the impact in case of scandals can involve also the entire economy of a country, due to a significant decrease in sales (both internal and related to the exportations).

  The degree of damage can be affected by the nature both of media reporting and of the evident response to the incident by industry stakeholders and regulators. In the public sector, the enforcement by local and national entities leads to a considerable cost to the public purse in a period of reducing budgets. Guaranteeing the integrity of food systems is very important for dealing with immediate threats, following a preventative approach in order to be cost-effective.

Traceability can be potentially a powerful instrument to avoid or at least limit the risks and the impacts related to these issues. As we saw, it is not a new concept emerged only few years ago. Already twenty years ago T.Moe claimed the necessity to implement traceability systems in a way increasingly careful, in order to meet the need of the integration of more and more information in food production management. This trend is driven by the increasing demands for information along the food processing chain. Furthermore, the author made explicit the fact that in the future, the information flowing in the food manufacturing chain might provide a competitive advantage.

3.3.2 UE regulatory framework

With the issuing of regulations n. 178/2002, UE introduced a standard that specifically deals with the issues related to food safety. The points of the regulations can be recap as follows:

- The adoption of a global and integrated approach "from field to field to the fork" to face the problem of food safety.
- The introduction of mandatory traceability for food products, food for animals, animals that produce foodstuffs and any other substance introduced in food products, starting from the 1st of January 2015.
- Drastic limitation that regulations itself imposes to the legislators of the different Member States about the possibility to legislate autonomously on the problems related to traceability on the agri-food system.
- Identification of the operators in the food sector and of feedingstuffs subject to the standards related to traceability, that are all the actors operating in the phases of production, transformation and distribution of food and feedingstuffs.
- The adoption of the so-called approach "one step back-one step forward", that exclusively implies the obligation for each operator to identify the supplier (immediately upstream) and the customer (immediately downstream).

- The obligation of "having systems and procedures that allow to make available to competent authority the information asked"
- The obligation of an adequate labelling or identification for food and feedingstuffs intended for being put on the market by the European Community, in order to facilitate traceability "through documentation or appropriate information following the requirements.

From these regulations emerged that mandatory traceability, despite not designed in a particularly sophisticated way, is intended as a tool with the aim of achieving higher levels of food safety. Furthermore, the regulations do not put significant obstacles to the realization of all the other possible declinations of traceability in the agri-food system. The realization is left to the discretion of the single operators. The achievement of higher levels of food safety is also at the basis of other Community regulations that have introduced mandatory traceability in specific sectors (e.g. bovine meat and, recently, food and feedingstuffs genetically modified). As a result of the crisis provoked by BSE, with the adoption of regulations related to the identification and the registration of bovine animals and of labelling of bovine meat, it was intended to ensure a control in the course of the entire process "from the producer to the consumer". The reference is called regulations 1760/2000. For the bovine meat, mandatory traceability has been designed by the Community legislator in a more sophisticated way than regulations 178/2002. The regulations 1830/2003 have as aim the establishment of a "regulatory framework for traceability of products, feedingstuffs obtained with OGM, with the scope of facilitate an accurate labelling, the monitoring of the effects on environment and, in case, on human health, as well as the implementation of adequate procedures for the risks management, including, if necessary, the withdrawal of the products".

As in Europe, also in USA the approach "one step back, one step forward" has been adopted, in order to ensure that the vertical portion of the chain every operator has to control, has the minimum possible extension. Another common aspect is the granting to the operators of a certain freedom of choice about the procedures that allow to make available the necessary information for the competent authorities, about the type of format in which drafting and storing the relative documentation. The most important implication, that these similarities have for the operators of each country, is the fact that a version of mandatory traceability designed in this way have a pretty slight impact in terms of organizational, informative, administrative costs for the companies. What are different from the two cases are the genesis, the aim, the general approach of the regulations. The Community regulations is, in fact, explicitly aimed to guarantee a high level of food safety not only for the emergency situations, but also and especially for ordinary ones, in homage to an overall view (from the farm to the fork) already developed by the European Commission in the White Book about food safety in 1999. The adoption of regulations in USA can be attributed to the objective of Bioterrorism Act in 2002, concurrently with the series of terrorist attacks that involved USA since the 11th of September 2001, so the reaction to emergences intentionally caused by hostile subjects. The crucial aspect in USA is the logistic chain, in fact, the long distances that often food has to cover, before arriving to the final consumer, and the several transshipments from a transportation to another one, increase the possibility to pull off bio-terrorist attacks.

In order to be more specific when we discuss about traceability, the Anglo-Saxon have made a distinction between two specular processes:

- **Tracking** (in Italian "tracciabilità"): the process that follows the product from top to bottom of the chain and makes sure that, in every step through which the product itself goes, appropriate tracks are left (information). The main objective is defining which actors and which information should "leave track".
- **Tracing** (in Italian "rintracciabilità"): it is the opposite process, that should be able to collect the information previously left. The main objective is defining which technical tool is the most suitable for tracing these "tracks".

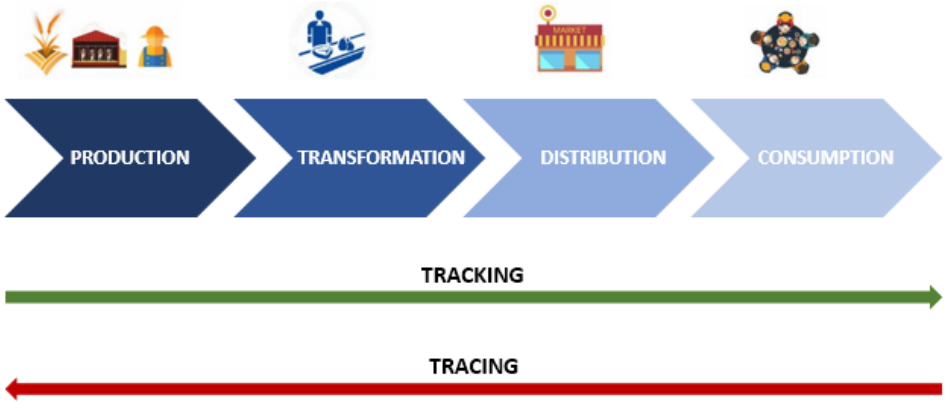


Figure 17: Scheme to describe the direction to which tracking and tracing move according to their logic

However, the two processes are strongly interconnected and based on a system that we will continue to call "traceability".

It is also important not to make confusion between traceability and labelling. Often the two terms are overlapped even at legislative level. With traceability we are identifying the companies that participated to the generation of each product unit, singularly and materially identifiable, on which they have responsibility. What concerns labelling is the communication of a production process, the geographical origin, the category and the composition of a product unit. The obligation to bring information to the consumer introduces the necessity of transferring data along the chain and makes essential the implementation of robust systems of internal traceability and an effective system of communication.

The realization of traceability systems in the agri-food supply chain is mainly related to the necessity, from institutions and competent authorities, of guaranteeing food safety and focusing actions and controls in case of emergence. The supply chains represent an articulated and complex system. During emergence or risk situations is difficult to reassure the consumers and to apply effective measures of control and management. With traceability we are able to identify the causes of the risks, trying to avoid that the problem will happen again.

More in detail, the identification of a product and its traceability have the following objectives:

- Coming back to the features of the product (raw materials, batch, production process)

- Reconstructing technical-commercial history (transferring property, destination change…)
- Recalling the product in case of risk for human health and/or environment.
- Facilitating the identification and the control of unexpected long-term effects on environment, human and animal health.
- Contributing to the control of the information on the label.

Subjects involved in traceability issues and reference bodies:

1. **Institutions**:
   - Fraud prevention

2. **Company**:
   - Commercial advantage
   - Risk management
   - Integration with other management systems: quality, production, logistics

3. **Consumer**:
   - Necessity of increasing consumer confidence
   - Need of more information

The implementation of traceability systems can not ignore the specificities that characterize each agri-food supply chain. Therefore, given the regulations, that states the principles and the essential requisites of traceability, an effort should be done by the operators, in order to realize and spread, on common criteria, an integrated and consensual organizational system able to guarantee traceability and food safety.

Another important aspect that should be pointed out is that we do not have to make confusion between:

- **Mandatory traceability**: it is imposed by law (i.e. regulations n. 178/2002). The inherent information are mainly intended for public authorities, with the objective of allowing them to do regular controls without obstacles, to have an intervention speed as fast as possible in case of emergence and to ensure the recall from the market of food eventually considered "dangerous" for human health.
- **Voluntary traceability**: it is not imposed by law (e.g. ISO 22005: 2008). It is intended for the companies, for their connections and in relation to the final consumers. It guarantees to them the availability of further information respect with those just required by mandatory law. This information is exposed on the labels, on the packages, on the food shops or in other ways. Moreover , this information can be related to the origin, the environment, the production and storage process, the intrinsic certified characteristics of quality…

3.3.3 The Italian regulatory framework

Actually the Italian legislation does not impose further standards as concerns mandatory traceability. However, different interventions from Ministro delle Politiche Agricole and

Consiglio Nazionale dell'Economia e del Lavoro (CNEL) contributed to the issuing of a general framework agreement: "Patto Nazionale per la sicurezza e la qualità alimentare", with the objective of certifying quality of the Italian agri-food sector, basing on the confrontation between Government and special forces of work and company. This agreement concerns specific food sectors: fresh and transformed meat, milk, fish, fresh fruit and vegetable products. It can not replace or be replaced by Community regulations. Obviously, the development of the activity of self-regulation, voluntary traceability and quality certification starts from the respect of mandatory regulations, and it is addressed to differentiate and valorize the national supply, in terms of environment, job, product processes, informing the consumer in order to identify it and to do a conscious choice in price-quality ratio. In order to achieve these types of result it is necessary to implement a system of controls, guarantees, mandatory regulations of public order and, in particular, a self-discipline for all the agri-food supply chain able to become the propulsive strategy for a competitive system.

Traceability allows the companies to send two messages:

1. The product does not hide any mystery behind its production process.
2. The company attests the product as a formal admission of responsibility

These two messages establish a more reassuring relationship between the consumer and the producer. In fact, traceability allows to know, in every moment, what is being done, to identify with speed and safety the causes of non-conformity and to come back on the recipients of a consignment that is not appropriate for sale, optimizing the recall of the products in case of necessity. Furthermore, the realization of traceability systems represents a fundamental tool of process control, allowing to rationalize the flows, to improve the logistic efficiency and to reduce the costs. Traceability is also an important tool for the management of quality because it allows to follow the product through all the phases of production and, in case of non-conformity of it, to come back to the causes and to take corrective actions. Despite the increasing food quality and safety in the last years, the trust of the consumers, especially in the agri-food sector, decreased. This is due to the fact that the contacts between consumers and food producers have become larger, leading to consumers the feeling of little comprehension of the mechanisms which regulate the supply chain. For this reason, traceability is an attempt to give back trust to the consumer, making the system transparent and allowing a contact between the consumer and the producer.

Traceability consists in four main elements:

1. **Identification**: it is based on the identification of logistic units and productive batches that have been processed with the same transformation. The management of productive processes has to be done per "batch", in order to have the possibility every moment to identify all the companies that contributed to the production of a raw material or of a semi-finished product or of a batch of packaging. Managing traceability means giving an unique identifier to each group of products and following the route until the consumer.

2. **Registration**: traceability is based on the detection and the registration of the information that describe the process of formation and transformation of the product.

Managing traceability means defining which information has to be registered in the course of the production and the transformation of the product and along all the supply chain. The technique for registering can resort to a manual documentation based on paper or to the adoption of technologies. Later we will discuss more in details about these technologies, however, just to give a first idea about the two techniques that can be adopted, I show here some differences in terms of advantages and drawbacks:

PAPER		TECHNOLOGIES	
vantages	disadvantages	vantages	disadvantages
easy implementation	time loss for the necessity of registering often a big number of data; risk of imprecision during the registrations due to human error; problems of storaging data; difficulty in realizing a precise archive; easy loss of documents and so loss of proofs	simple and fast use; speed of acces to the information; reduction of the errors of transcription; easy integration with the other instruments of rationalization of the company management (e.g. production, stock, orders)	necessity of an initial investment

Figure 18: Vantages-disadvantages scheme to compare paper and technologies usage

3. **Links to data**: in order to ensure traceability, it is not sufficient that a company knows how to document which are its suppliers and its clients. It is fundamental registering the links between the batches and the successive logistic units in the course of transformation and guaranteeing the link of traceability along the supply chain (i.e. the link between all the working operations that happen along it). Inside a company only a correct and punctual management of the links allows to come back on the connection between the inputs and the outputs, and vice versa. Each company should be responsible about the links between its suppliers and its clients. We lose traceability when at least an operator of the supply chain does not manage these links in an appropriate way. The links to be assured, in order to monitor the products along the transformation processes, are:

    - **Between production batches**: they regard the raw materials, the packages and the related finished products. Furthermore, all the links between all the intermediate batches have to be registered.
    - **Between production batches and logistic units**: it could happen that the logistic units are not directly assembled when they leave the production chain. For this reason, it is necessary to register the links between the intermediate stock units and the logistics units.

- **Between logistic units**: the complexity of the links between logistic units received and sent depends on logistic procedures.

4. **Communication**: the process of communication guarantees inter-operability of the system and represents the core part of traceability along the supply chain. With the aim of ensuring a continuous flow of information, each operator of the supply chain has to communicate to the next operator the identification of the traced batches in order to let this one to apply in turn the principles at the basis of traceability. The willingness of transferring product information to the consumer increases the importance of the communication between the operators. In this way each physical flow is associated to an information flow. The communication is an intra-business, for this reason we have to face the issue related to the language and the method, that should be common for the supply chain operators, in order to reduce the waste of resources.

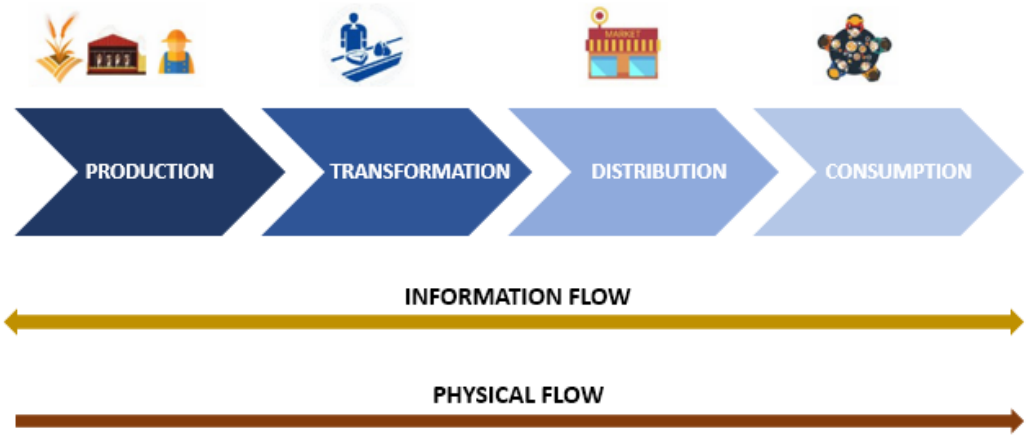


Figure 19: Scheme to describe the direction to which information flow and physical flow move according to their logic

Traceability implies the physical flow of a product along all the supply chain and a related information flow. While the first one moves from raw material to consumer, the other should be able to move both to downstream, with the aim of delivering the information to consumer, and upstream, for retrieving the "tracks" left by the product.

3.4 FOOD TRACEABILITY AND TECHNOLOGIES

3.4.1 Industry 4.0

Technologies and agriculture are two aspects that, since the 1990s, have already had a profound contact with the introduction of precision agriculture, term with which it is called the third wave of modern agricultural revolutions. It is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. Its objective is to define a decision support system for whole farm management, for optimizing returns on inputs while preserving resources. This practice has been enabled by the event of GPS and GNSS. The ability of locating the position in a field leads the creation of maps of variables (e.g. crop yeld, terrain features, pH, organic matter content…). Today, thanks to the continuous evolution of technologies, we are living in a new technological era called industry 4.0, considered the fourth industrial revolution, starting from 2014 with the implementation of the first real time, self-optimizing connected systems. Here a list of principles related to it:

- **Interoperability**: the ability to collaborate between man and machine. This is guaranteed by a communication technology called Internet of Things (IoT). IoT is growing over three times as fast as traditional ICT, and by 2020 will nearly equal all other ICT spending. Thanks to it, buyers and users can realize huge business benefits.

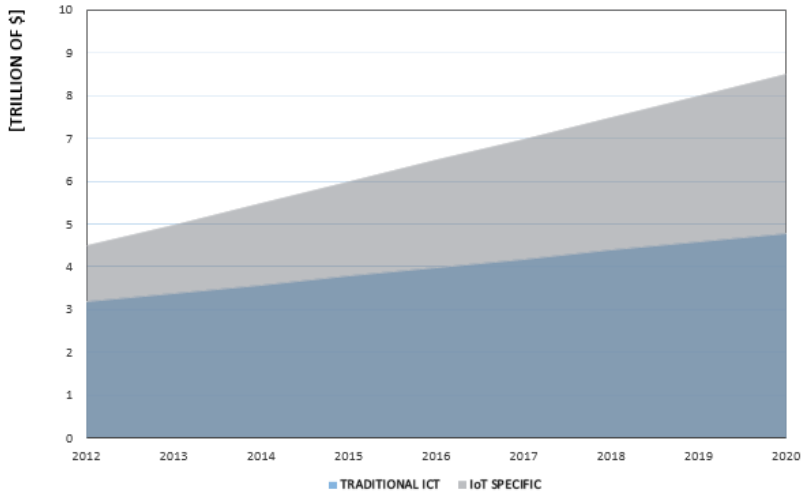


Figure 20: IoT Specific and Traditional ICT growths over the years

- **Virtualization**: a virtual image of the real system can be obtain in order to simulate the process under analysis. The aim is to keep the production process as much automatically linked together and as clearly visible as possible through a system called Cyber-Physical System (CPS).

- **Decentralization**: the aim is to decentralize decision making related the machine control while solving problems in a fast and accurate way.

- **Real-Time Capability**: the possibility of making instant decisions through the communication system.

- **Service Orientation**: the innovative service model of information system, called Internet of Services (IoS), is used to control the monitoring and the analysis of data collected from the smart sensor devices.

- **Modularity**: it is a characteristic feature of the flexible manufacturing system. In order to overcome the complexity of a system, the production process can be separated from each other. This possibility also guarantees the fact that in a plant it is possible to modify the machines or the manufacturing process, in order to respond some needs in a fast way.

Here a list of pillars of industry 4.0

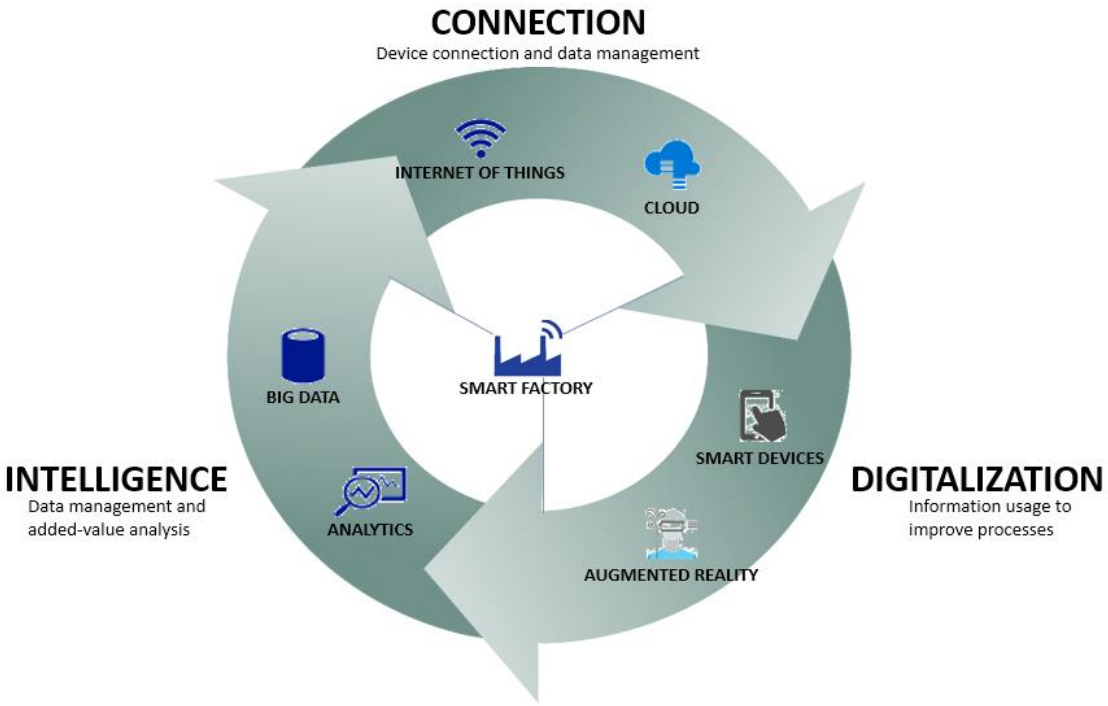


Figure 21: Industry 4.0 pillars

- **Connection**: it refers to device communication through sensors and data collection thanks to the spreading of Cloud Computing technologies. It is also linked to IoT paradigm, a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on interoperable information and communication technologies, helping companies to create new value streams for customers.

- **Digitalization**: it is the use of digital technologies (smart devices and augmented reality) to change a business model and provide new revenue and value-producing opportunities.

- **Intelligence**: it refers to data management and added-value analysis.

Data are fundamental for the development of industry 4.0. Thanks to cloud technologies, data acquisition becomes easier and faster. In factories embedded with sensors and digital systems, data are continuously produced and need to be properly collected and analyzed in order to generate value.

3.4.2 Agriculture 4.0

Agri-food is one of the most involved sectors by this trend of rapid transformations of the whole sphere of industrial production, by merging digital technology and internet with the conventional industry. For this reason, we talk about agriculture 4.0 (or smart/digital agriculture), precisely to underline the fundamental link of the technologies on the field with internet, the usage of computer, the sharing of data and information not only between machines, but also among different operators of the supply chain. A document, published by the European association CEMA (Comité Européen des groupements de constructeurs du machinisme agricole), highlights some points related to agriculture 4.0:

- The arrival on the market of sensors, microprocessors and communication tools at a lower price, so more affordable.
- An improved access to internet and an always higher work with Cloud, in which there is an accumulation of data to share.
- The arrival of technologies able to analyze big quantity of data.
- The arrival on the market of agricultural machinery equipped with computer tools (e.g on board computer, sensors, processors able to allow the communication among the agricultural machinery).
- The optimization in the automation of the operations in many machines.
- The possibility of monitoring in real time the work on field and so adapting, if necessary, the working plan in order to reach a higher efficiency.
- The cooperation among the different operators of the supply chain (e.g between suppliers and clients, guaranteeing higher safety, traceability, cost optimization).

Agriculture 4.0 is based on cooperation and sharing of data and information, between different machinery, different operators, along the supply chain. The vision is not anymore related to the single step, but to the overall process. The tractor communicates with the harvester and can send a signal to the local supplier (e.g when a component is not working). The farmer can have a complete vision of all the activities of the machinery on field, ensuring that these are working at best. He can also monitor the results and the operations costs, in each phase of the process, putting them in relation to the possible final price of his product on the market.

Figure 22: Image to represent ideally the complexity and the richness of information achievable through Agriculture 4.0

In order to make Agriculture 4.0 a reality more and more present in the EU, it is necessary a dedicated joint effort between public institutions, industry actors and the farming community. The European Community and the national governments need to guarantee a working digital infrastructure in terms of network coverage and transmission rates in rural areas, to allow a rapid transfer of data. Supportive public policies are necessary in order to boost farmer's ability to invest in the innovative digital technologies. More and more farm data are stored in cloud-based data platforms to facilitate data processing, analysis and flow of information. Thanks to Industry 4.0, the people can have a world of information and entertainment, being in contact with friends and colleagues, always and everywhere. The farmers can have the same possibility now, adapting these technologies to their particular needs. They can run, in a totally controlled way, their farms on new levels of automation, sustainability and productivity.

A company can use computerized procedures, consisting in specific software that fit the production process and, if correctly designed, allow to trace the history of every single product packaging exploiting the label.

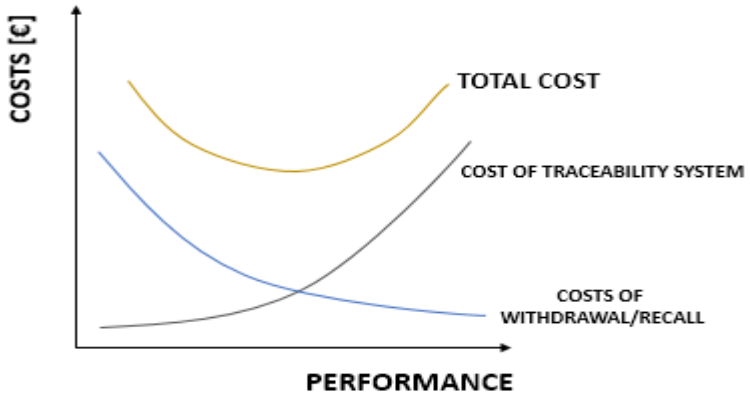


Figure 23: Performance-Costs qualitative graph for traceability

3.4.3 The role of traceability

Traceability can become a competitive leverage for the companies when its restricted idea of an instrument only to manage risk is outdated by an approach in which the strength is represented by the optimization of the logistic processes. In this way a company is able to replace the "reactive" management of the internal processes with a "proactive" management. This approach is justified by the fact that, in several food-sector, products and their quality represent an assumption for a competitive advantage, while logistics management represents the discriminating element for this advantage. Traceability systems are a valid instrument to optimize the company processes. In fact, a system designed to collect and storage the information related to the products flowing the entire supply chain in a transparent way, also allows to exploit this information to optimize the logistic processes related to the flows. In this way, a traceability system become a tool to monitor in real-time and check the product flows through the supply chain and optimize the logistic processes thanks to the real-time information. To summarize:

1. **Reactive approach**: the implementation of traceability has the scope of identifying and turning back compromised batches.

2. **Proactive approach**: the implementation of traceability has the scope of create added value through connections. It consists in exploiting the information collected with the system in order to assure added elements of quality to differentiate the product (e.g. quality origin of DOP products). Furthermore, when a traceability system is designed and used as a proactive instrument, the achievable performances allow to significantly reduce the total logistic costs of a company, in relation to different aspects:

- **Accuracy**: the availability of information related to traceability of flows of products through supply chain allows to reduce the errors (of mix, quality, identification…), and the costs related to the management and the correction of them. Furthermore, the higher precision of the processes reduces the necessity of periodic realignments between physical and information flows, that usually are performed through inventories.

- **Inventory**: monitoring in a systematic way the product flows allows to realize two main objectives: stock-out reduction; reduction of the average level of stock in each level of the distribution channel. Traceability affects, first of all, on safety stock, because the demand forecast on the basis of the received orders can be replaced by sure data of demand, resulting from the flows of products inside the supply chain, that are provided by traceability system.

- **Productivity**: the availability of traceability data, related to the logistic processes, allows to reduce the workforce needed to execute these processes and the relative phases, improving the productivity of the operators. The automation of the procedures with which traceability data are collected and its sharing among the partners of the supply chain have a key role in the increase of system productivity.

Figure 24: Pyramid of traceability objectives

We can imagine a pyramid consisting of three levels: safety quality, traceability as tool of risk management, improving efficiency. Respectively listed in order of essential for objectives a company should aim to. As concern the last one, a well-implemented traceability system guarantees visibility on the entire supply chain and more efficient processes, communication included (because I can not communicate quality without data). The system boundaries change in relation to the level in which a company is operating and to the type of subject: what am I tracing? How do the instrument to trace change? Behind everything this issue there are data. The main problem is to manage, identify, transfer data along the supply chain. Traceability has to be functional (absurdly there could be a situation in which quality does not require traceability).

The most recent technological innovations allowed to extend the usage of different solutions both inside a company and along the overall supply chain, reducing the costs and coordination bureaucracy, improving quality and products traceability.

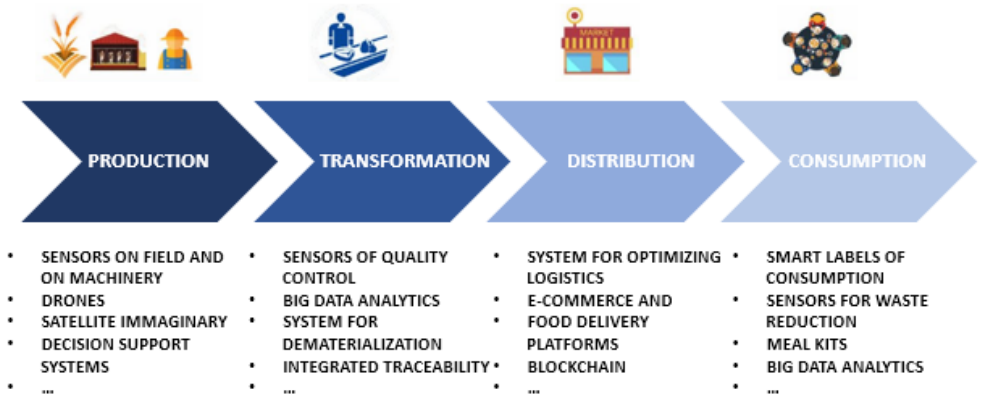


Figure 25: Examples of solutions for each step of a generic agrifood supply chain

3.4.4 Exploring technologies

A traceability system is generally very complex, because it is necessary to store and process a big quantity of data. From an economic point of view it can be a particularly costly system. In order to avoid an excessive cost, it is necessary to adopt the adequate digital technologies for sharing data and simplifying the procedures. Here some remarkable examples:

- **Barcode**: invented in '40s and commercialized in 1966, barcode is an optical, machine-readable, representation of data. Traditional barcode represent data by varying the widths and the distances of parallel lines, in this case we are referring the so-called linear or one-barcode (or 1D). Successively, other variants were introduced using different shapes as rectangles, dots, hexagons and other geometric representations under the name of matrix codes (or 2D). These codes allow to correct reading errors and encode more information, but they need more complex reader than those for linear barcodes. At the beginning, barcodes were only scanned by barcode readers, that are optical scanner. Actually, thanks to application software, it is possible to read images through other devices (e.g. smartphone with cameras). Printing a barcode is a simple operation that can be done with a printer of labels. Barcodes became commercially successful when they started to be adopted for the automation of supermarket checkout systems.

Figure 26: Barcode scan

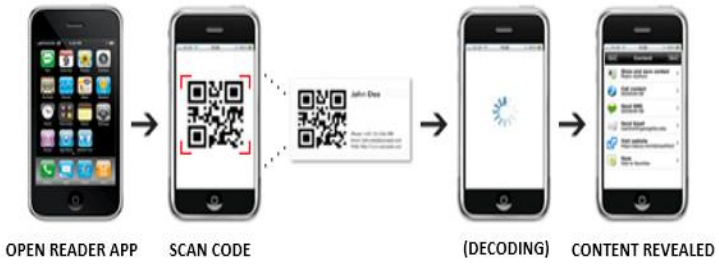


Figure 27: QR code scan

2D barcode recently has become very popular with a specific type: QR codes. These scannable codes became popular in Japan in 2002, when mobile access was still poor. In fact, there is not any need of internet connection for scanning. Several companies started using them for sharing information with customers. A customer can scan a merchant's QR code and a merchant can scan a customer's account code. Introduced by GS1 in 2014, databar is another family of bar

codes, largely used for GS1 discount coupon and also in the retail industry. It included different types of codes that could be intended for points of sale or not. Here a list of benefits:

- Reduction of dimension with the same information contained (and density of printing)
- Possibility to encode big quantities of data only in a symbol, that is readable at the register of the sale point

From these benefits, thanks to the development of different applications that are specific for different sectors or usages, comes the possibility to obtain more of them:

- Encoding of variable weights: the opportunity to put in barcode the information related to the product's weight allows to replace the codification of the variable weights implemented trhough traditional codifications.
- Management of the offers for expiration dates: databar allows the codification of the expiration date in barcode. This leads to the possibility of blocking at the point of sale the products that exceed the expiration date or applying discounts to fresh products that are close to it.
- Traceability: exploiting the possibility to include a big quantity of information, the capability of traceing the product route covers also the register at the point of sale (and sometimes even the consumer), in order to block the selling there or carry out a recall procedure in a more effective way, in case of production batches considered critical.
- More knowledge about consumers habits: more information about selling are available, allowing the retailers to implement more accurate strategies of supply and discounts, in order to increase the level of service offered to the clients.
- Encoding of small products: a smaller dimension allows to identify the products of small dimensions or with curved surfaces that are not easy to be labelled, in order to exceed the encoding through the short codes whose numerical capability can become critical in some markets.
- More information for the consumers: the smaller dimension of barcode make available more usable space on the packaging for the product information. This aspect is particularly important in case of legal obligations related to the communications to the consumer.
- Possibility to reduce the dimension of packaging (or of label)
- Coupon encoding: it is possible to put in the same barcode the coupon codification, the product code under promotion, the dates of validity and the information related to who issued it. In this way it is possible automatically to trace the subject that issued the coupon in order to verify that the product under promotion has been really purchased.

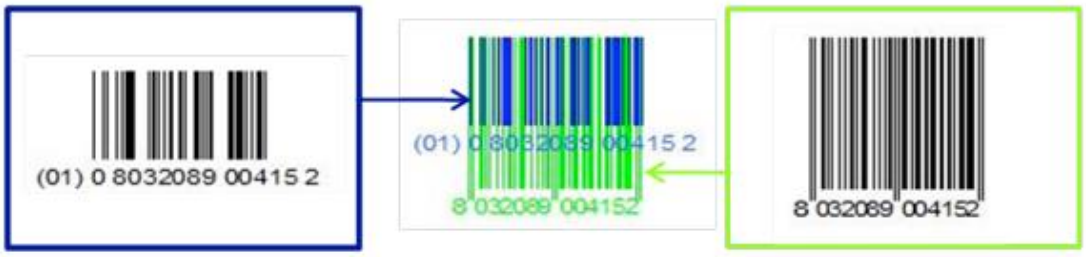


Figure 28: Dimension comparison between GS1 databar and traditional barcode

For example, Iper, an Italian company of GDO sector, implemented barcode in 2016 for all of its points of sale. The technology has been applied for the products that has to be weighted directly in the supermarket, as bread, fruit, vegetables and gastronomy. In this way databar, in addition to identify the product to be priced, enable also the transmission and the registration of other information, as product batch, expiration date, traceability information that, put together with loyalty card, can be directly connected to the specific consumer in case of recall. With a traditional barcode this is not possible.

- **RFID (Radio-frequency identification)**: invented in '30s and commercialized in '80, it has a considerable potential in terms of products identification within the supply chain, acquisition and storage of data and real-time access to the collected information. The information relating a product are stored inside tag and are made available to the different operators of the supply chain through EPCglobal Network. The co-utilisation of RFID technology and EPCglobal Network allow the companies belonging to a supply chain to have a complete visibility of the flows of products inside the system; this visibility can be efficiently exploited to optimize the operations of traceability for agri-food products. In the specific, from the point of view of traceability, the usage of RFID technology allows both the identification and the detection of the product inside of supply chain; these functionalities lead to improve in a significant way the capability of a company to obtain (or supply to third parties) real-time information about the position of a product inside the distribution system. Furthermore, by using RFID tag as traceability unit of products and EPC Network for sharing information, it is possible developing traceability systems that guarantee better selectivity and precision, thanks to a higher level of detail of the information collected. Furthermore, a traceability system based on RFID allows a real-time intervention whenever it is necessary a withdrawal or a recall of products. For example, identifying the secondary packaging instead of the pallets of a product, it is possible to significantly reduce the quantity of goods to be withdrawn or recalled, limiting the activities only to the operators involved and to the cases that have to be withdrawn or recalled. RFID tags can be active or passive: the active ones have an internal battery and enable data to be rewritten or modified, but they

are much more expensive; passive tags do not have a power source embedded and only take power from the radio frequency energy transmitted by the reader, in general they are also cheaper. The results emerged with RFID are quite similar to those of barcode, but it also guarantees:

- A higher reading distance
- A higher speed of data acquisition
- The non-necessity of the code visibility
- The possibility to read more tags at the same time
- The possibility to read and write

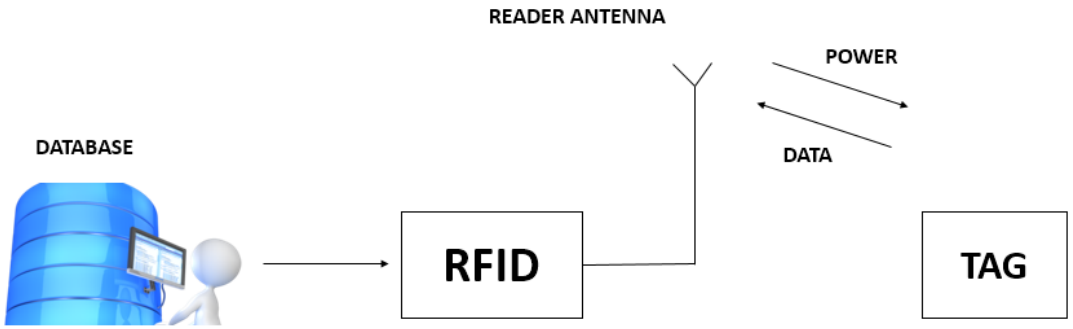


Figure 29: RFID functioning scheme

- **Blockchain**: designed in 2008 and implemented in the next year, blockchain consists in a growing list of records, called blocks, that are linked and secured using cryptography. Each block contains a cryptographic hash of the previous one, a timespam and transaction data. A blockchain is fundamentally an open and distributed ledger that can record the transactions between two parts in a safe, verifiable and permanent way. This database uses a peer-to-peer network collectively adhering to a protocol for validating new blocks. Once recorder, data in a new block can not be retroactively modified without modifying also all the following blocks to it, this could require the collusion of the network majority. This system is suitable in different contexts as medical records, identity management, identity management, transaction processing and food traceability. Despite, as we can see from figure 31, the blockchain is still little explored, it has been mentioned and briefly described here because subject to several experimental projects and media attention. For this reason, the potential benefits related to its implementation still need to be understood. Blockchain is a technology that guarantee a very high level of transparency. Those that participate in them know that their data are made visible by anyone but, in the same time, they can obtain visibility about their supply chain process.

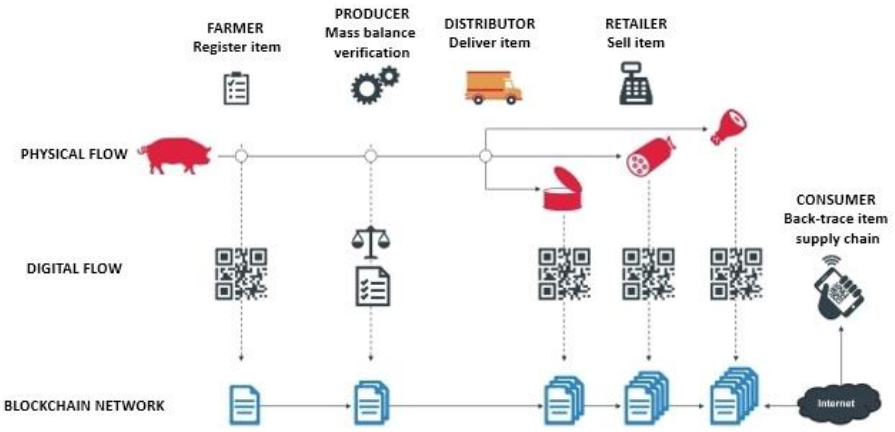


Figure 30: Example of blockchain scheme in swine industry

For example, IPNLF has implemented blockchain and an app that allowed to strengthen traceability of the entire supply chain and significantly reduce the quantity of documentation that is required for supply chain certification.

Another case that embraces blockchain is Gruppo Italiano Vini, the first Italian wine business. To implement this architecture it is necessary, first of all, to consider the voluntary companies and collect the data that are already available in the information systems. In a second phase these data are moved in the blockchain through which all the information become available for the supply chain operators. The scope is supporting the companies and simplifying the administration. This one uploads the information that are public and, once put in the blockchain, can not be deleted. The information are spread and the companies can create apps from which, for example through phone mobile, it is possible to read the label of the bottle of wine. Another important goal is, in fact, giving the possibility the final consumers to check where wine has been made and be informed (through a video) about its history. Furthermore, since having a feedback is fundamental, there is the possibility to interact with final consumers, asking questions and receiving opinions in real time. For each bottle it is needed target NFC (about 0,30 €/unit). The costs related to the registration of data in the blockchain are variable and depend on the desired speed of the operation (from 0.02 €/unit to 0.8 €/unit).

On the basis of 57 case studies, we can see that digital innovation is affecting food traceability, in particular thanks to the utilisation of Barcode (39%), RFId (32%), Management Systems (32%) and Big Data (30%). Of course, a traceability solution can exploit more technologies for working with positive results.

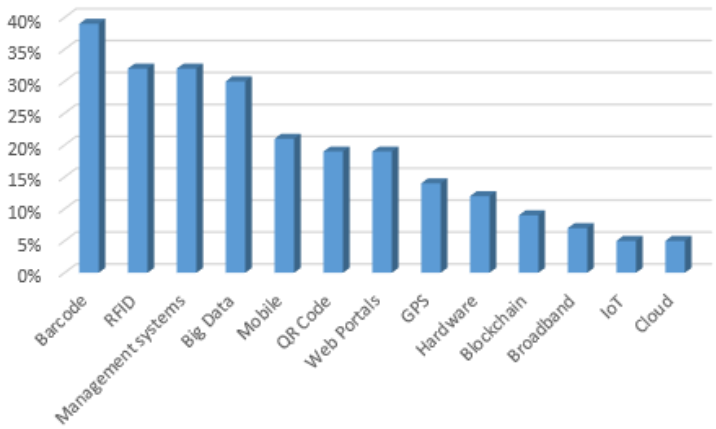


Figure 31: Enabling technologies in digital traceability (on 57 cases analyzed by Polimi). A solution can consider more technologies

3.4.5 Exploring cases

These are some examples of how digital technologies are transforming traceability systems in different agri-food contexts:

- **Electronic veterinarian prescription**: in a test phase since 2015, it is an Italian project promoted by Ministero della Salute – Direzione generale della sanità animale e dei farmaci veterinari. It provides for the obligation, from the first semester of 2018, the digitalization of the management of veterinary medicines, in particular what concerns the prescriptions and the loading an unloading register of medicines.

- **Cà Lumaco**: Italian agricultural holding, it has implemented RFID, cameras and QR code. The real-time monitoring of pigs to pasture required a relevant waste of time and human resources. Actually, thanks to these devices it is possible to significantly reduce the efforts related to these processes but also transfer to the final consumer the information through QR code. The innovation, beyond the QR code, is in the possibility to provide real-time information about product and animal.

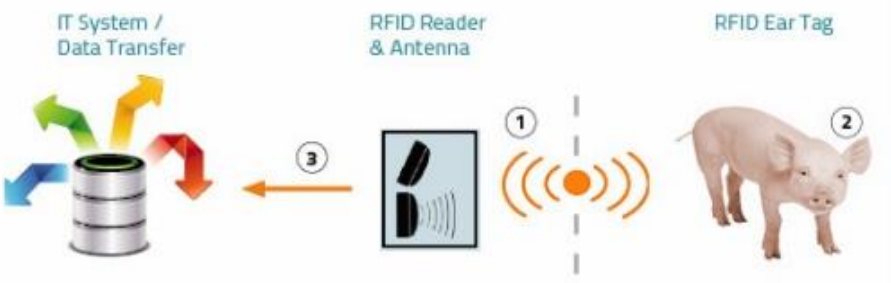


Figure 32: Scheme of Cà Lumaco solution

- **Barry Callebaut**: one of the world's largest cocoa producers and grinders. Through Big Data, in addition to collect the information about thousands of farmers, is provided a system that analyzes data and returns the analysis to the farmers in order to improve both quality of final product and working conditions.

- **Latteria Plac**: Italian cooperative of breeders. It is involved in a project of digitalization that started from a basic pattern for which the breeder is no longer the figure for compiling a paper form, but the information that arrive with the goods from feed industry to the holding are supported by a document in digital format. This one is processed automatically in the web portal and so in the control system of the dairy farm. We have an advantage of operational nature. Furthermore, there is an improvement as concerns supply monitoring and quality of the information, because the utilization on web portal is strictly related to technicians that work as consultants for the holdings. Advantages: economic, the investment (estimated on 40,000 €) can be paid back by saving operative costs; zero implicit costs management (e.g. the costs related to the exclusion of holdings from circuit, downgrade of a batch of cheese…).

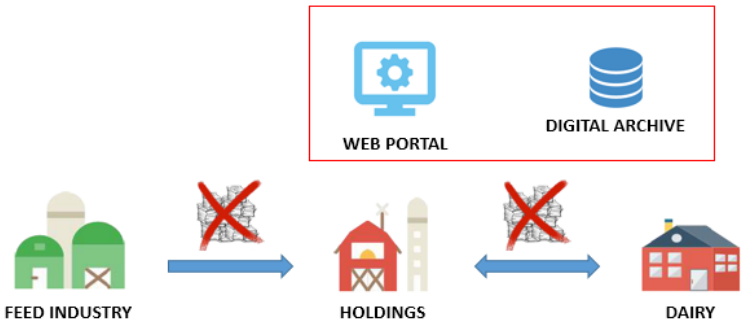


Figure 33: Scheme of Latteria Plac solution

- **Wenda**: Italian startup that proposes an innovative solution for wine world. It consists in a device that, attached to the bottle, allow to monitor the fundamental parameters of perfect preservation (temperature, UV rays, inclination…), guaranteeing wine quality once got out of cellar. Moreover, the product is protected from fraud and, through an app, final consumer can consult the information to better understand its value. This is an example of smart communication.

Figure 34: Scheme of Wenda solution

- **Xnext**: Italian advanced inspection technology company that patented Xspectra, a new X ray technology able to identify in real time physical and chemical characteristics of an object moving on a conveyor. This technology can be use in different contexts: pharmaceutical, food (to detect hazardous substances), airport (to inspect baggage), recycling activities (to identify materials). Thanks to multi-energy analysis, Xspectra analyzes an object that in a deeper way compared to a conventional X ray technology, guaranteeing better effectiveness during the control phase.

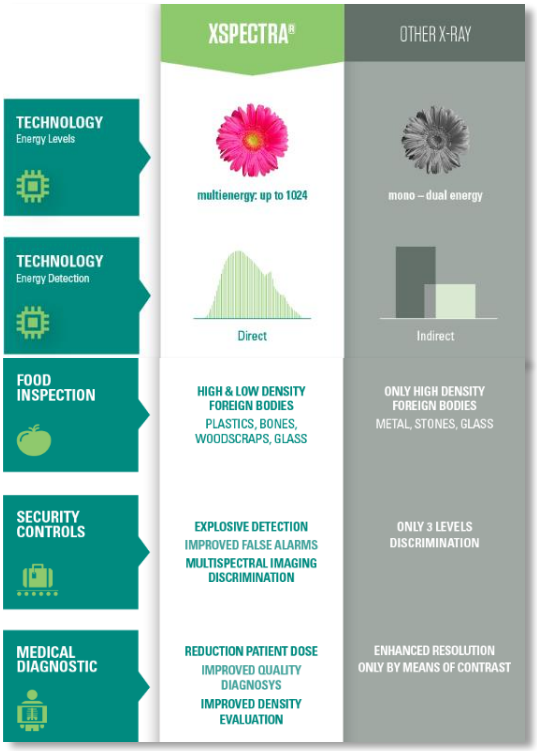


Figure 35: Table to compare Xspectra and other conventional X ray technologies

- **Proxentia**: Italian startup that implemented innovative portable device able to make biomolecular and biochemical analysis for food products of agri-food sector (wine, milk, cereals…) with the aim of making tests concerning safety and control activities. These devices are cheap, versatile, easy to be used and able to provide instant responses.

Figure 36: Proxentia solution

- **Astrona**: American company that patented a system for physical and chemical analysis of food. The information are generated within one hour and are collected on a platform. These regard each phase of production process, with the aim of monitoring the entire supply chain and showing product quality to final consumer.

- **Controlant**: American company that offers a ready-for-use service, base on wireless devices to monitor the cold chain and control products' quality moving during transportation. These devices, installed inside transportation packaging, are equipped with geolocalization system and can monitor and record the temperature during the entire travel of the products (providing, in real time and automatically, reports and notifications through a web portal).

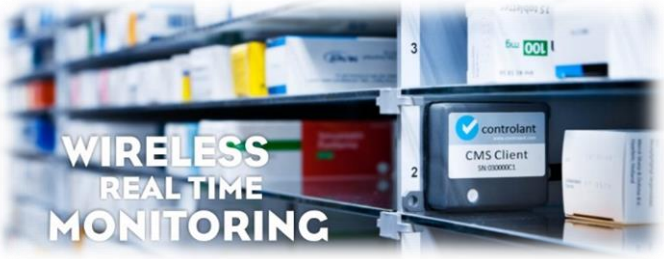


Figure 37: Controlant solution

3.5 FOOD TRACEABILITY AND QUALITY

As we said before, for the fact that consumers have faced numerous food crisis in the course of history, their concern for food quality and safety is consequently growing. Traceability systems can create significant incentives for the companies to improve food quality. Those can gain competitive advantages to differentiate themselves, creating a competitive advantage respect with their competitors. Consumers risk perception of food safety can be decreased and, at the same time, quality perception can increase. An optimal food traceability system can create food exchange value for consumers, because can enable consumers to trust a brand, reducing uncertainty and improving purchase confidence, meeting their rights to do more aware choices during purchase process. A considerable part of them can pay a premium price for traceability labeling. The label, in fact, represents the main tool with which consumers obtain information about a product.

Let's now consider quality considerations described in the previous chapters in order to find a correlation with traceability.

According to a questionnaire, carried out in UK in 2015, among 164 companies involved in the food and beverage industry, nearly 80% of the respondents believe that traceability is associated with tracing, 56% with tracking and around half with safety and quality.

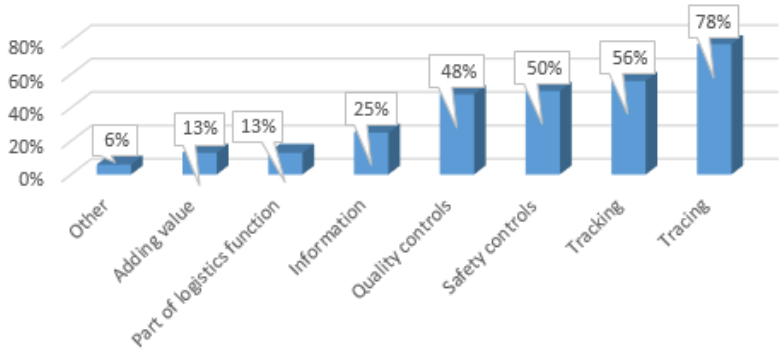


Figure 38: Aspects that companies associate to traceability

Here a graph that show the hierarchy of the most important drivers of traceability considered by the respondents:

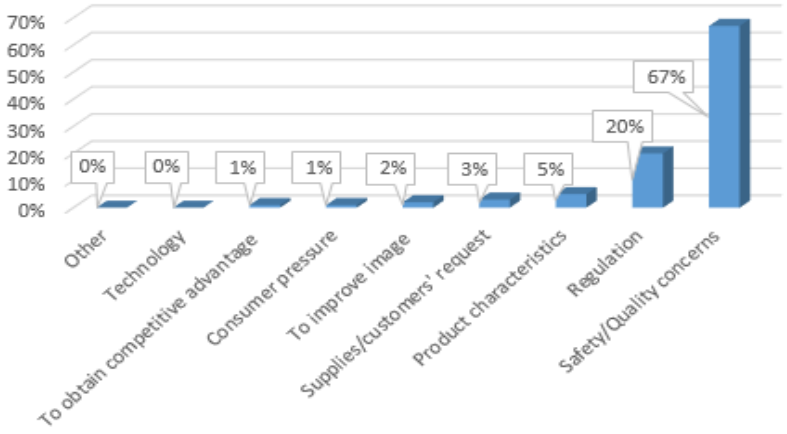


Figure 39: Drivers that companies consider as the most important as regard traceability

Traceability can be linked to the examples of quality definitions that focus on:

- Product characterization: because it is able to satisfy a series of requisites. These are related to different aspects that regard, for example, the quantity of chemical substances included in the product, or the techniques with which it has been made. Thanks to traceability, it is possible to collect all of these information and give to the consumers a clear overall framework about what they are going to purchase. Through this, the companies can increase the level of awareness and ensure the possibility to compare the same product under different brands in a more objective way, going beyond the subjective perceptions.

- The compliance with consumer need: because it is related to expected quality. It can be consider as a need, precisely because it is an instrument for improving food safety and consumers awareness. Before the introduction of regulations, it could be considered an explicit need; in the last years it is becoming more and more an implicit one. This fact is due to the increasing implementation of traceability systems that are spreading in several food sectors, a direct consequence of the introduction of regulations and consumers concerns. Could be voluntary traceability considered as a hidden need?

- The recognition of the market: it can be considered as a factor for which consumers are willing to pay, so it represents a source of added value for the companies. This is not always true, because for being rewarded with a premium price the fundamental prerequisite is the recognition of differentiation elements by the consumers, that can not emerge if all the companies of a sector follow the same regulation standards and share the same information on the market.

3.5.1 Traceability and the eight dimensions of quality

Considering now the eight dimensions of quality by David A. Garvin. Which of them could be affect by traceability?

Figure 40: The influence of traceability on the model of the eight dimensions of quality by David A. Garvin (1984)

As we can see from the image, the dimensions that can answer this question have been highlighted with red rectangles:

- Performance: traceability potentially allows to keep track of measurable product information along all the supply chain and design a sort of "ID card" of the product itself.

- Features: thanks to the possibility of introducing elements of distinction with additional characteristics, it is possible to increase the appeal of the product to the consumer.

- Conformance: as already mentioned, traceability is a tool to guarantee food safety, and it is able to responsibly answer regulations that impose the respect of conformance.

- Durability: with this dimension traceability can play an inverted role, for example, decreasing the level of preserving agents in a product, its expiration date is closer to that one of production, but it is more healthy.

- Perceived quality: since we are discussing about perceptions, this dimension is strongly influenced by the way of communicating traceability to the consumers.

3.5.2 Traceability and the measure of quality on the basis of product's functions

The measure of quality, on the basis of product's functions, can be also observed from traceability perspective:

- Considering realized quality **Qr**, we can have three cases:

    1. **Qr** > 1: the functions realized by a producer are higher than those expected. This could be related to the fact that a company is offering a product that has been made following a process with a rigorous traceability system, that offers to the consumer more information than those expected only respecting mandatory traceability.

    2. **Qr** = 1: there is no any element of novelty compared to what is already expected. This could be related to a situation in which a company is offering a product that is in line with mandatory traceability.

    3. **Qr** < 1: consumer's expectations are partially or totally not satisfied. This could happen, for example, in case of fraud.

- Considering perceived quality **Qp**, we can have three cases too:

    1. **Qp** > 1: the functions perceived by the consumer are higher than those expected. This could be related to the fact that a company is offering a product that appears to the consumer more convenient than those offered by competitors, in terms of traceability information reported.

    2. **Qp** = 1: the perceived functions and the expected ones are the same. This could be related to a situation in which for the consumer the same product does not present any particular element of distinction, in terms of traceability information, among different brands.

    3. **Qp** < 1: the perceived functions are not enough respect with those expected. This could happen when the competitors are offering a product in a more effective way in terms of traceability information. In order to avoid this scenario, the companies should work more deeply in marketing efforts (e.g. label aspect/readability).

3.5.3 Traceability and the two dimensions of quality

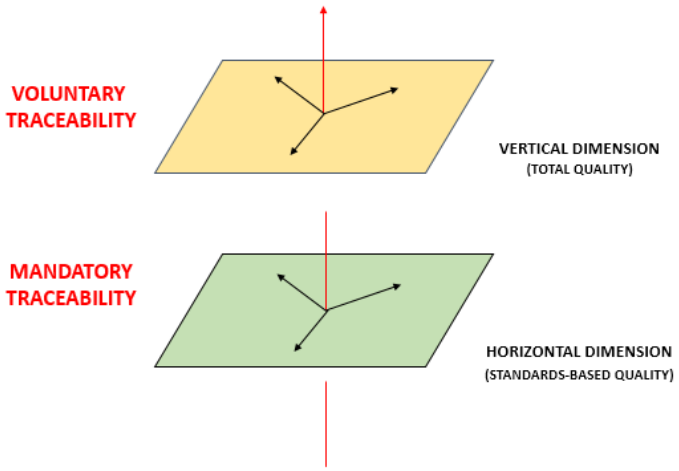


Figure 41: Traceability and the two dimensions of quality

As the image shows, we can position traceability on the two dimensions of quality:

- **Horizontal**: being defined by standards, it is the dimension in which mandatory traceability is positioned. Once defined a regulatory framework, each actor has to align its structure to what has been requested, in order to be complaint with the rules in force and not to risk of compromising its business. Here the threshold is determined by public institutions.

- **Vertical**: voluntary traceability is positioned along this dimension, because through it the companies can pursue their objective to create competitive advantage and foster their positions on the market. Here there is no threshold, each operator can work as it wishes, without limits of decision. Once respected mandatory traceability the rest is a plus and totally to the discretion of companies.

3.5.4 Traceability and the three types of food quality

Also the three types of food quality introduced by Grunert could be dealt with traceability perspective:

- Product-oriented quality: through traceability system we are going to collect a list of information (e.g. the quantity of raw materials used, the production process put in place …) that are stored and can be easily transferred from one operator to the next one until the final consumer, minimizing the risk of loosing useful data that are usable both for internal business objectives and external communication.

- Process-oriented quality: thanks to traceability the companies can, not only record and communicate the physical properties of a food product, but also express their effort to respect a range of pre-specified levels. This concerns, for example, the adherence to ISO certifications.

- User-oriented quality: this comes within the sphere of subjective quality perception, that depends on the level of the consumer's interest as concern traceability information.

3.5.5 Traceability and the hierarchical value map

Here an adaptation of value hierarchical map we could suggest for our analysis:

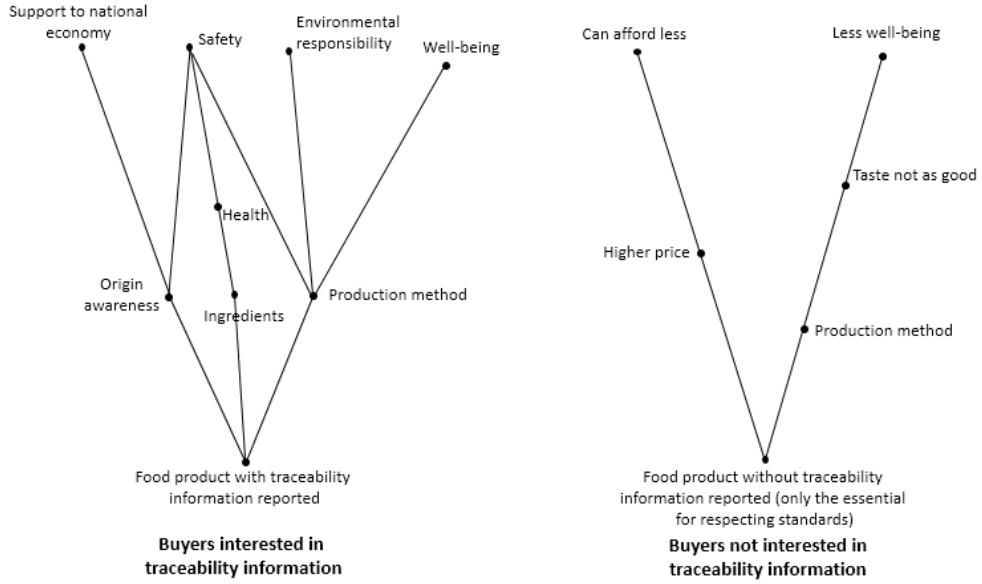


Figure 42: Examples of Hierarchical value maps for two different types of buyer (in relation to traceability information)

Traceability often calls to consumers' mind the concepts of production method, ingredients and origin awareness. Through these attributes we open up different links for others, that can lead the consumers choice during their purchase phase.

3.5.6 Traceability and the quality septagon

Finally, how can traceability interact with the seven attributes defined in the quality septagon?

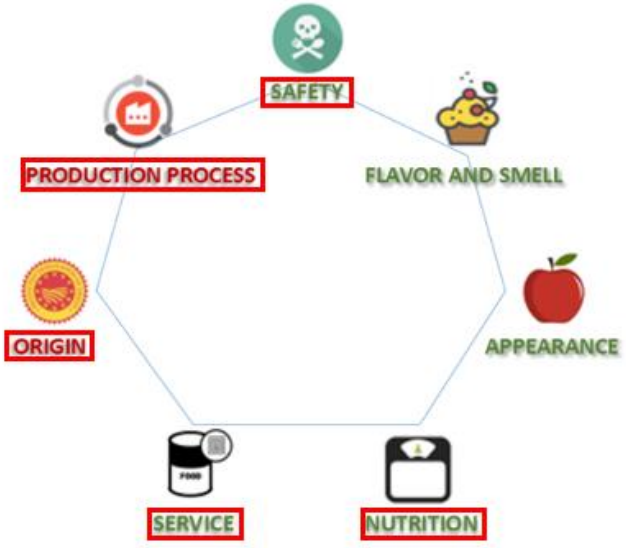


Figure 43: Attributes affected by traceability

- Safety: the most relevant attribute for which traceability has become a concept so discussed and increasingly taken into account by food companies, both for regulations reasons and brand reputation. Safety is the main cause of traceability concern, because this one is considered the most effective tool to guarantee it. Through a developed traceability system it is possible to enforce safety because each operation along the supply chain is monitored and the information related to it are stored and can be easily found in case of controls (both for internal reasons and external audits).

- Nutrition: food content is an attribute that can be crucial for consumers' choices. The presence or absence of particular elements can determine the decision of purchase. Traceability is a tool to support nutrition in terms of warranty of what a food product really contains. For this reason, it is necessary to know the raw materials properties and therefore the information related the previous production steps of the supply chain.

- Service: this attribute is crucial to transmit to the consumers traceability efforts. A good traceability system can not be highlighted without a good service, focused on catching consumers' attention through an easy way to get the information and the product itself. Service represents for companies the occasion to "give voice" to what they are selling and, more deeply, present themselves to the market.

- Origin: communicating the place is a way to increase consumers trust. The higher the level of detail the higher should be the feeling that a food product has been made under controlled circumstances. This is due to the fact that it is potentially possible trace back to the first operator of the supply chain and therefore perceiving a sense of higher responsibility from it as concern the contribution to realization of the finished product. For example, if a primary producer is aware that the name and the address of its company is printed on all the packages a food product at the supermarket, for sure, it will have more incentive to do its best. Another aspect is related to the country of production, that can be an incentive to purchase a product in order to support and protect the economy of the country itself financing local producers.

- Production process: traceability is not considered exclusively as the monitoring of a physical flow, but also as a factor of control of processes. In order to guarantee quality of a finished product, traceability in support of control is crucial.

Flavor and smell and Appearance have not been taken into account because they are both sensorial attributes that go beyond the technical aspect and the objective features of a food product, by leveraging the perceptions of the individual.

4. GENERAL CONTEXT

The world is projected to hold an increase up to 9.2 billion of people by 2050. Furthermore, food requirements of the actual population is increasing, because a large part of it is not sufficiently fed. According to the analysis conducted by FAO and OCSE, in order to sustain the situation forecasted it should need an increase of at least 70% of the overall agriculture production compared with the actual.

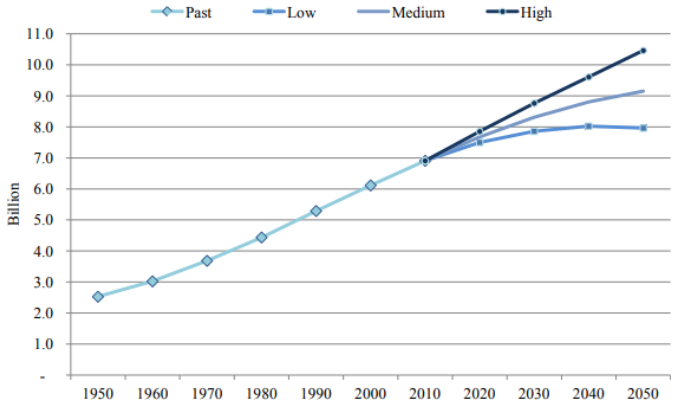


Figure 44: World population growth expectation

Continuing to exploit the resources in a more intense way with the aim of following this trend is not sustainable. For this reason, it is necessary to allow the growth through different innovations that can work on various front generating a synergy. A large part of these innovations is due to the implementation of digital technologies, that are able to set the production in a more effective and efficient way, minimizing the waste of resources involved. The digital innovation in the agri-sector food, also called Smart AgriFood, is wide and spread along all the supply chain and can guarantee to Italy a certain level of competitiveness, in order to deal with the competition from foreign countries. The role of Italy in this scenario is not aiming to economies of scales (because the access to the resources and the dimension of the territory do not allow it) as abroad (e.g. U.S.A., Brasil, China, New Zeland, Irland…), but considering that part of population that is looking for quality of "made in Italy". Agri-food sector accounts for more than 11% of Italian PIL and for 9% of the exportations of the country. This sector is really relevant for the Italian economy, both for the number of workers employed and for the passion related to food. Agri-food supply chain often risk not to have the necessary efficiency because too long, fragmented, not so much sustainable and transparent. The implementation of the digital innovations can allow this sector in Italy to make the leap in quality, because they could be an effective engine for promoting and developing "made in Italy" and make the supply chain very performing from a point of view of efficiency, improvement of yelds, reduction of costs and transparency.

4.1 ITALIAN ISSUES

There are about 1.400.000 agri-food Italian companies, only 7% of these have a web site domain registered in Registro.it (agriculture: 38.52%, wine 10.94%, pasta 7%, livestock 5.13%, extra virgin olive oil 5,78%). The adoption of Agriculture 4.0 in Italy is facing different obstacles:

- **Cultural barrier as concerns innovation**: there is a sort of gap between experience and preparation. Instead of risking by generating changes with an attitude of early adopter, a remarkable part of producers prefers moving as a follower applying a sort of "wait and see" strategy, with a traditional approach. As in all of strategic decisions, there is always a risk, however the first mover can potentially gain a competitive vantage from its actions.

- **Limited awareness**: there is often a little comprehension about the potential benefits of adopting Agriculture 4.0, that are in general intended only in terms of reduction of production costs.

- **Limited communication**: several operators of the supply chain could have difficulty to undertake closer relationships with the others, this is due to the fact that they are generally more inclined to interface themselves with few trusted companies (e.g. a family friend agronomist).

- **Agricultural holdings dimension**: most part of them are small (less than 12 hectars) and under the average of the other countries. Small dimensions means difficulty in investing and small propensity to spend in new technologies.

- **System infrastructures**: the availability of broadband is often absent in the rural areas.

In order to overcome these obstacles it is necessary to spread the benefits of the digital innovations, in all their facets, generating a new conception of agri-food that distances itself from the "strategic immobility" rooted in the country. For example, the 80% of the consumers use a smartphone to find information about a product to be purchased. The challenge is to use the digitalization, trying to create a connection among the different solutions in order to make the supply chain more competitive, by connecting producers, transformers and consumers. In this way there will be more responsiveness towards the desired level of quality. If the information on quality stayed only to one operator of the supply chain, and not transferred upstream and downstream of it, the supply chain could not be competitive. The digital technologies guarantee higher efficiency and effectiveness. In this there is a strong and relevant value of data. It is important to have an awareness of their value, and to know how to manage them. Hundreds of startups are aiming to e-commerce (e.g. farm to consumer) and supply chain activities. Behind the complexity there are opportunities that can emerge only with the competences. It is necessary to demonstrate that in Italy the quality (perceived or real) of agri-food products is higher compared to that one of the foreign market. The important is that the consumer realizes this quality and he/she is willing to pay for it, ensuring that the Italian

companies "are not broken" by foreign competitors. Furthermore, it is fundamental to underline that the new technologies should be able to guarantee environmental, social and economical sustainability (e.g. avoiding the excessive utilization of antibiotics for dairy cattle).

4.1.1 The floor to the companies

What are the main needs that Italian companies underline for the actual context? In occasion of the meetings "UniCredit AgriTalk" (October 2017, Milano), "Lattiero Caseario 4.0" (October 2017, Cremona), "AgriFood 4.0" (November 2017, Milano) and "Coltiva dati. Raccogli valore. La trasformazione digitale dell'agroalimentare" (January 2018, Milano), it was asked the participants to leave a short message about the relevant aspects that should be taken into account. This is what emerged:

- *"Unicredit undertakes to finance, support the development of the Agri-business in a broad sense (about the new techniques concerning Precision Agriculture, new production and distribution processes, traceability, "made in Italy" protection). Agri-food is a sector that is growth of 13% compared with 2008 and it is characterized by a relevant number of startups launched by young entrepreneurs"* Andrea Casini (Co-Head Unicredit Italy)

- *"The market of agriculture is rapidly changing. In particular, this change is moving towards two directions: producing a lot at very low cost (economies of scale); focusing on quality (because the sensibility of people is increasing, the consumers are not settling anymore for only a product, but they also care about its origin). Italy started with this second direction with the scope of implementing an agricultural model able to answer its market needs. It is necessary a more sustainable agriculture (with less energetic input and chemical treatments) and the creation of a relationship of trust between consumer and producer. If a consumer trusts a brand, he/she will be more inclined to purchase its products, also avoiding the cheaper ones from abroad. Today the solution in agriculture is not only in the agriculture itself, but in the alliance between consumer and farmer"* Fabio Brescacin: President EcorNaturaSì s.p.a.)

- *"Traceability is a marketing tool because it represents the first interface with the consumer. Doing marketing overcoming the logic of "it is good because it is good" means to show the real value of a product"* (Francesco Marandino: Founder e CEO Penelope s.p.a)

- *"Innovation and traceability are two fundamental aspects as concern supply chain. It is important to integrate all the supply chain operators, in order to create benefits in terms of competitiveness, and develop traceability as warranty for the consumers"* (Costantino Vaia: DG Consorzio Casalasco del Pomodoro)

- *"It is important to evaluate the constraints for each area (e.g. absence of broadband, cultural barrier…) and try to match them with possible real solutions and applicable in order to implement them quickly"* (Cesare Ronchi: Senior Purchasing Manager Barilla, G & R Fratelli)

- *"Italy is the first country in Europe for number of product of certified quality. Supply chain is fundamental because, thanks to it, all the elements of quality, traceability and product recognition are highlighted"* (Massimo Macchitella: Responsible Small Business & Financing Products)

- *"We can not expect to be leaders of cost, it is necessary to be leaders of price. To reach this goal we need to guarantee to national and foreign consumers some values related to sensorial aspects, food safety, nutritional aspect and information concerning the territory of origin (because when a consumer eats, he/she does not think only about tastiness and health but also the history and the tradition behind the product). All this relates to the concept of credibility and trust, through, for example, the creation of rigorous external audits inside the producers' plants. The digitalization of data, starting from upstream of the supply chain, allows to build a numeric-technological substrate for giving to the credibility the right concreteness and enabling to transfer the information to the distributors clients in a more and more punctual and effective way"* Giovanni Guarnieri (Managing Director, Latteria PLAC)

- *"The future of feedingstuffs industry is taking part in supply chain ensuring that there is a quick and transparent exchange of information"* (Roberto Zaupa: Research and Development Responsible, Veronesi)

- *"At the moment it is very complex to define the benefit of the digital innovations, the best approach should be the evaluation of the costs related to a rejection of adopting them. In some situations the fact of not having the punctual information (e.g. about when and where problems happen and who caused them) is really expensive, also at legal level. It is unavoidable that future is projected to their implementation (also in every context of our life)"* (Yari Rizzoli: Logistics Director, Auricchio)

- *"Market speed in Europe is fast. The Italian product has a level of excellence in quality recognized at global level. This perception is spread also thanks to the level of communication of data. Milk sector should aim to competitiveness, robustness of the system and digitalization"* (Nicola di Marino: Head of BU Food & Beverage, BCUBE)

- *"In order to export our products and interact with distributors smooth procedures are needed. It is necessary to automate the processes"* (Giovanni Martini: Group Controller & Organization Manager, Auricchio)

- *"The big gap in Italy is the difficulty to create forms of integration, collaboration and synergies. It is necessary to work together to spread the brands abroad"* (Valter Molinaro: Innovation and Services Responsible, Coop Lombardia)

- *"It is necessary to be fast, proactive, without renouncing quality, for this reason the contribution of technology is essential. Also the systems and machinery should learn by working"* (Paolo Pasini: HR Department Development Senior Advisor, Unitec)

- *"Team spirit and the creation of a network serving innovation are fundamental. It is also important the capability of mastering Big Data. Thanks to a monitored supply chain and transparency generated through the exchange of data, it is possible to create trust, improvement in quality and decrease of waste. Consumers have the right to know what they eat"* (Carolina Cortellini: President, CRIT-Polo for the Digital Innovation)

- *"All the regulations relating traceability state that each operator of the supply chain should concern to declare its own part of data. The information have to be transferred to all the operators. The consumer, in a traceability process, has never been mentioned. However over the years the consumers are showing an increasing interest in information for better evaluating what they consume. For this reason, regulations that companies have to follow and the consumer's perspective are growing at the same time. It looks like that today the concept of traceability evolved in visibility and transparency. Digitalization is an access point for the next step"* (Giada Necci: New Solution Specialist, GS1 Italy)

- *"It is necessary to switch from a concept of traceability to one of visibility. Traceability is a tool and has the task to make more visible a series of information, both in terms of users (consumer) and also of coverage of information (e.g. identifying, for each product of a specific batch, the final consumer)"* (Massimo Bolchini: Satandard Development Director, GS1 Italy)

- *"The value of data is very important. It is fundamental interpret them, therefore are needed agronomic subjects able to do this work. We need new professional profiles"* (Massimo Salvagnin: Entreprenuer, Agricultural Society Porto Felloni)

- *"Better integrate than compete"* (Tito Caffi: Researcher UCSC & Technological Consultant, Farm Res Uvae)

- *"For small-medium companies the integration will be the only way to bring quality. For big companies future is in industry 5.0 with robotics (e.g. robots without driver).*

- *"Technologies should aim to sustainability"* (Ilaria Locatelli: Specialist in Smart City Solution and Smart Land, Linea Com)

- *"There are the tools, the excellences, awareness and responsibility. All of these elements have to be combined to make the processes the most usable possible. It is necessary the work of all the operators of the supply chain"* (Valerio Cortese: Information Systems Group, Iper Montebello)

- *"It is important to understand the evolution of a product, to avoid that this one degrade, and combine the concept of traceability with the world of insurance to provide the business more tools to save economic resources"* (Mattia Nanetti: Chief Growth Officer & Co-founder, Wenda)

- *"Developing a completely open and integrated system with the companies and information systems of Ministry is crucial (it has essential data to certify certain values): the diversification of data bring value, this is feasible with an integrated system"* (Fulvio Conti: Responsible of Agriculture and Environment practices, Almaviva)

From all of these speeches clearly emerges a common thought of trust and positivity as concerns the future of Italian agri-food sector. In fact, this is considered not only an aspect strictly related to the cultural roots of Italy, but also a driving force able to bring new lifeblood to the economy of the country. Foreign market is perceived as a threatening competitor that, thanks to its land resources, puts pressure through a different economic model, more based on high quantity at low cost. Italy can not just stop and look, even if its high level of food quality is known all over the world. It is perceived a strong necessity to adapt to the times, to evolve the processes in step with the technological progress. Technology can push a business to the next level. For that it is needed to abandon in part the cultural barriers that curbs the implementation of new approaches. For example, young Damiano Angelici (CEO & Co-Founder of Elasian) declared that his family, operating in the olive sector from 80 years and tied a traditional approach, was not very convincing to adopt new technologies for monitoring their fields, but the benefits found have proved him right. Regardless the type of product, it is clear that agri-food producers have in common an optimistic vision of how the role of the digital is crucial to guarantee a higher level of food quality and an improvement of efficiency and effectiveness as regards the processes and the information exchanges among the operators of the supply chains. These changes can happen not only with a relatively low effort in terms of investments, but in particular with the collaboration of all the subjects involved. Collaboration is the key for the success. With a cohesive group is possible to have a transparent communication and an agile flow of information, exploiting synergies and growing together like a community, also thanks to the facilitation of public institutions' measures.

4.2 OLIVE OIL SECTOR

4.2.1 Italian scenario

Olive oil sector in Italy represents about 2% of the overall food industry, while the olive-growing products 2.8%. From a research conducted by Istat in 2013, there was a reduction of 8.5% in the number of olive oil farms compared with 2010, that actually is about 825,000. Within this timeframe occurred an increase of the average farm surface.

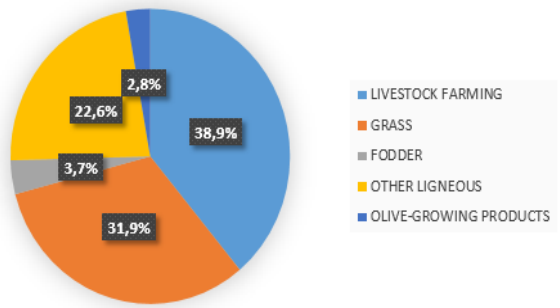


Figure 46: Production at basic prices of agriculture (source: Istat)

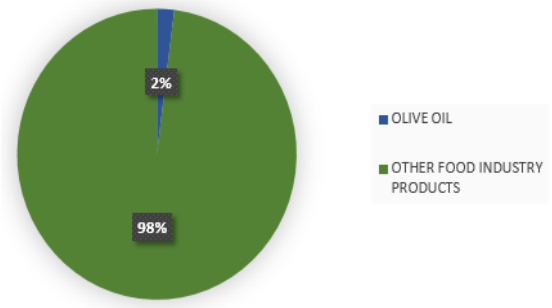


Figure 45: Industry turnover (source: Istat)

	uom	2013-2014	2014-2015	2015-2016	2016-2017
STRUCTURE					
OLIVE FARMS	(n)	825,201	825,201	825,201	825,201
SURFACE	(ha)	1,073,324	1,073,325	1,073,326	1,073,327
HA/OLIVE OIL FARM		1.30	1.30	1.30	1.30
OLIVE OIL MILLS	(n)	4,662	4,500	4,944	3,961
INDUSTRIAL COMPANIES	(n)	220	220	220	220
SUPPLY					
PRODUCTION	(t)	463,701	222,000	474,320	182,326
DOP	(% q.)	2.4	4.4	2.3	4.0
PRODUCTION/CONSUMPTION	(% q.)	73,1	38,9	86,3	33,8
SECTOR TURNOVER	(ml €)	3,000	3,120	3,151	3,214
WEIGHT ON AGRI-FOOD TURNOVER	(% v.)	2,3	2,4	2,4	2,4
EXTERNAL TRADE					
IMPORT	(ml €)	1,224	1,511	1,851	1,792
IMPORT/CONSUMPTION	(% q.)	75.9	116.8	105.7	105.9
WEIGHT ON AGRI-FOOD	(% v.)	3.0	3.6	4.3	4.2
EXPORT	(ml €)	1,1375	1,371	1,527	1,617
WEIGHT ON AGRI-FOOD	(% v.)	4.1	4.0	4.1	4.2
EXPORT/PRODUCTION	(% v.)	83.0	184.9	76.1	198.8
BALANCE	(ml €)	151	-140	-324	-175
NORMALIZED BALANCE	(% €)	5.8	-4.9	-9,6	-5.1
DEMAND					
TOTAL APPARENT CONSUMPTION	(t)	634,000	570,000	550,000	540,000
PER CAPITA APPARENT CONSUMPTION	(kg)	10.6	9.5	9.2	9.0
MARKET					
PRODUCTION PRICE INDEX	(100=2010)	123.3	135.9	194.9	158.8
INDEX MEANS OF PRODUCTION	(100=2010)	108.1	109.3	108.2	106.1

Figure 47: Data on the sector (source: Istat)

On the basis of the declarations of olive oil mills provided, Ismea states a production of about 182,000 t, that is 62% less than the previous year. 2016-2017 is the worst period in the last decade, even worse than 2003-2004, that has been called "annus horribilis" by Italian olive growing, with a production of 222,000 t. The reasons of this result are related to: the terrible weather conditions in December 2016, that created further difficulties in central and south Italy, already under bad climatic conditions in summer-autumn period; the decrease in number of olive oil mills (983 less compared the year before). The decrease in production did not concern only Italy but also other countries. For example, Spain produced 9% less than 2015-2016, with 1.3 million of tons. It is very likely that in 2017-2018 the production will increase, but there are still uncertainties about the possibility to come back to "regular" levels. This is due to climatic and phytosanitary issues. In fact, after a winter and a spring that have already scaled back the expectations, there was a long drought in summer. Irrigation, where it is possible, has mitigate the damages but in the same time has increased the production costs (in particular in Sicily). Import has increased in the last two years. To benefit from this fact is in particular Spain, that in the first four months of 2017 doubled the volumes of the same time period in 2016. In Italy, in fact, the consumption of olive oil is higher than the volume of olive oil the territory is able to produce only with its olive trees. As a direct consequences of what discussed, here a graph to show the trends of price (extra-virgin olive oil) in the course of the last three years.

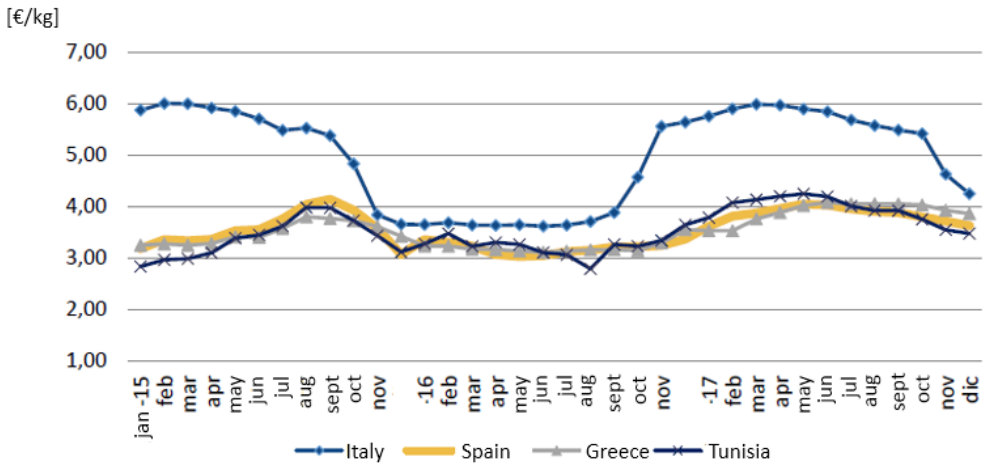


Figure 48: Extra virgin oil production prices, VAT not included (source: Ismea)

In Italy there are more than 350 different cultivar (types of olives), because the soils differ each other by changing territory and therefore environmental conditions. Among more than 825,201 olive farms, it seems that only 37% can sustain market competitiveness.

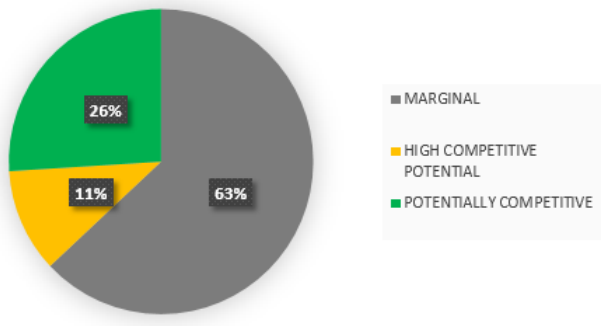


Figure 49: Olive farms census (source: Ismea)

- **Marginal**: medium-big companies, with medium-small olive-growing specialization, prevalent self-consumption and dependence from direct payments (i.e. low market orientation), low labour of manager; small family businesses with high olive-growing specialization, part-time; small family businesses-societies, with medium-high olive-growing specialization, market oriented, high labour of manager and spouse.

- **Potentially competitive**: medium-big companies, with low olive-growing specialization, market oriented, high labour of manager; small businesses-companies high olive-growing specialization, market oriented, with connected and multifunctional activities.

- **High competitive potential**: big companies, with medium-low olive-growing specialization, market oriented, high labour of manager, careful to agricultural context.

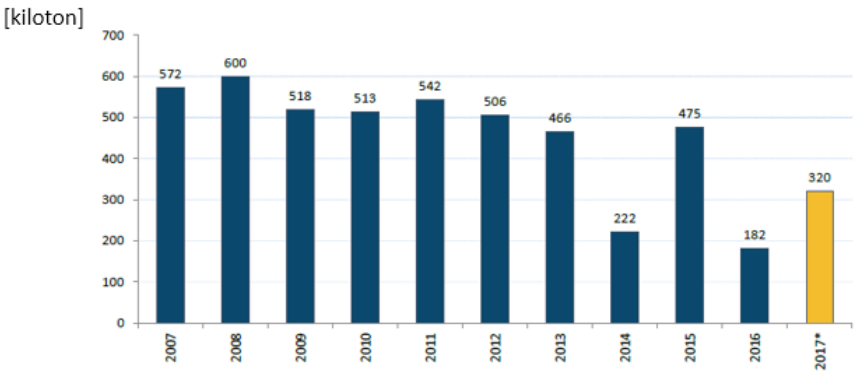


Figure 50: Italian production of olive oil (source: Ismea)

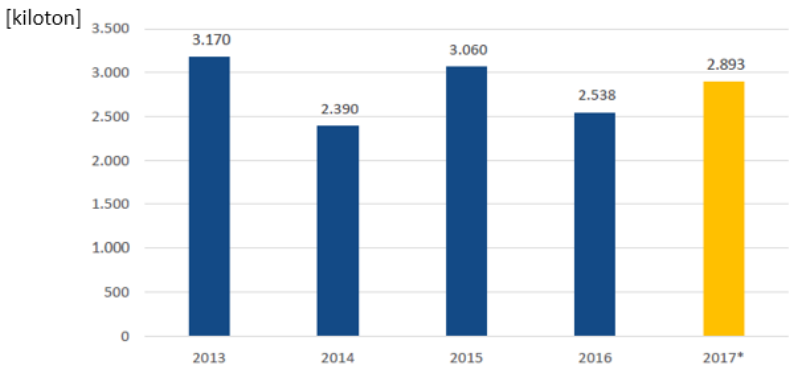


Figure 51: World consumption of olive oil (source: Ismea)

Production of olive is concentrated in central and south Italy, especially in Puglia (49%), Calabria (15%) and Sicilia (10%). These regions are also the places in which there are the highest number of olive oil mills, respectively 885 (20%), 617 (14%) and 521 (12%) (Ismea, 2016).

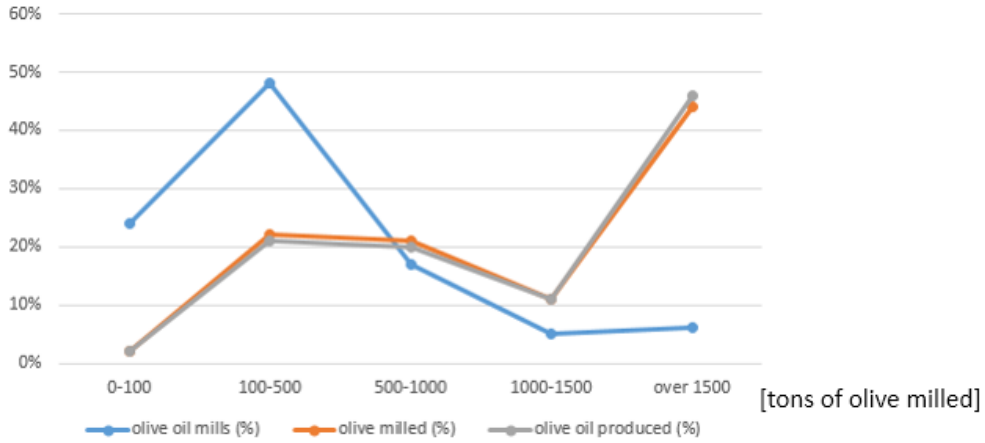


Figure 52: Olive oil mills allocation according to production capacity (source: Ismea)

From this graph emerged that 72% of olive oil mills use less than 500 t of olive.

Italian production is extremely fragmented, in fact, considering for example Spain we have only about 1,600 olive oil mills. If this fragmentation on one side increases the system costs, on the other side could represent assurance of quality. In fact, in order to guarantee this one, it is necessary that an olive oil mill should be close to the olive farm, because olive milling has to be done within 24 hours.

40% of recognized quality olive oil in Europe is represented by Italian brands, with 46 IG, 42 DOP and 4 IGP. Spain and Greece are second with 29 recognitions each. Despite this great result, certified olive oil is not more than 2-3% of the total (reaching 6% in terms of economic value).

In the international context, Italy is the first importer (with 33%, followed by USA, Spain, France and Portugal), the second exporter (20% against 60% of Spain, third is Greece, in turn followed by Tunisia and Turkey) and the second producer (15% against more than 50% of Spain) in the world. Global demand has increased until 2012 with an average of +1%/year. Until 2017 it remains constant with about 3 millions of tons per year.

TOTAL VARIABLE COSTS	71.6%	TOTAL FIXED COSTS	28.4%
FUEL	5.9%	DEPRECIATION	19.4%
INDEPENDENT WORKFORCE	27.6%	MAINTENANCE	3.5%
DEPENDENT WORKFORCE	25.1%	INSURANCE	1.6%
FERTILISERS	5.9%	TAX ASSISTANCE	1.8%
PHYTOSANITARY TREATMENTS	1.8%	CERTIFICATION	0.3%
CHEMICAL WEEDING	0.4%	MEMBERSHIP FEES	0.5%
OTHER DIRECT COSTS (IRRIGATION)	4.0%	OTHER INDIRECT COSTS (WASTE DISPOSAL, TECHNICAL ADVICE)	1.3%
THIRD PARTY (HARVESTING)	0.9%		

Figure 53: Costs allocation of olive farms (source: Ismea)

Workforce costs, in general, have the highest impact on the overall costs to be incurred by olive farms.

INTERMEDIATE CONSUMPTION	10.8%
WATER CONSUMPTION	0.4%
ENERGETIC CONSUMPTION	2.8%
BY-PRODUCT DISPOSAL	0.6%
CONSUMPTION MATERIALS	7.0%
PROCESS COSTS	33.1%
OVERALL WORKFORCE	9.2%
SALARIED WORKFORCE	6.9%
FAMILIAR WORKFORCE	2.3%
DEPRECIATION	9.0%
RENT	0.2%
OTHER COSTS	5.5%
RAW MATERIAL PURCHASE	66.9%

Figure 54: Costs allocation for olive oil mills

Raw material purchase, in general, has the highest impact on the overall costs to be incurred by olive oil mills. Production costs of olive oil can vary from 3 €/kg to 8 €/kg.

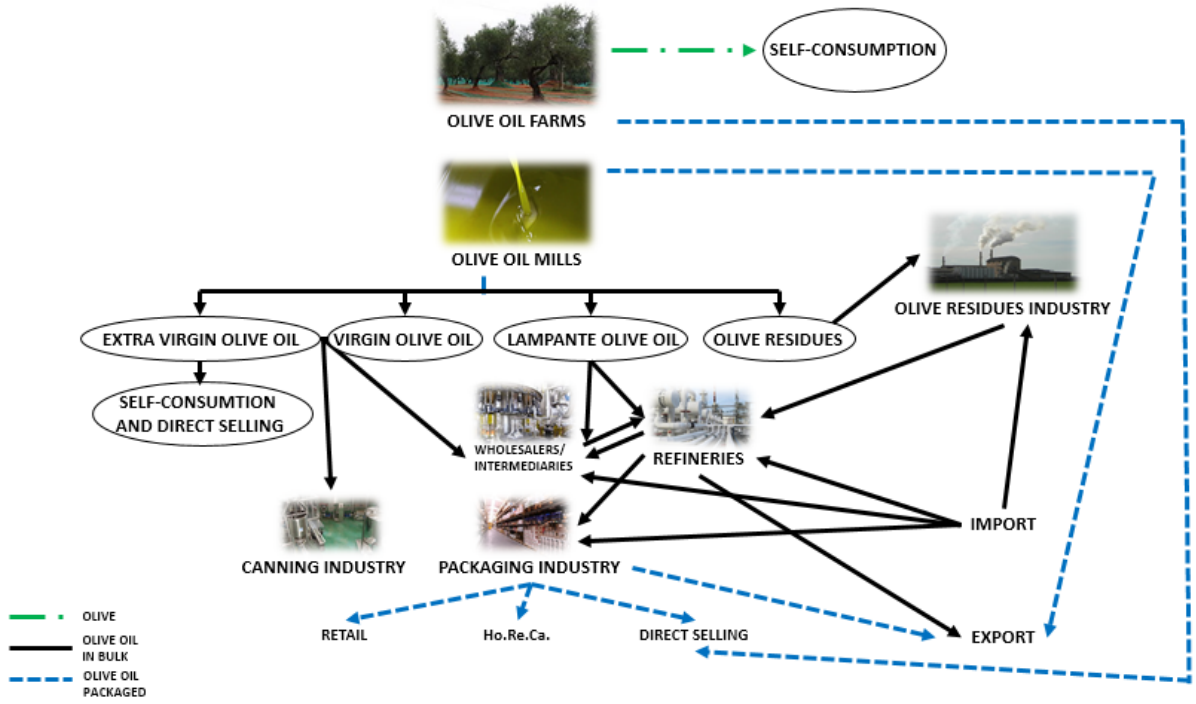


Figure 55: Main olive oil supply chain operators

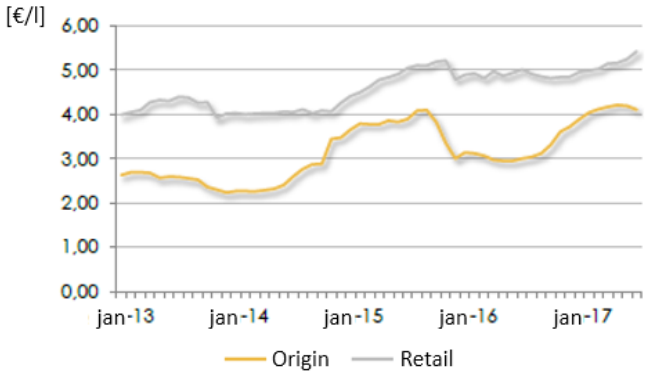


Figure 56: Comparison between origin and retail prices (source: Ismea/Nielsen)

The retail price follows a similar trend with that one of origin. While this one depends on production, retail prices depend by the strategy of the distribution chains. Generally, origin price fluctuations are absorbed in order to mitigate the variability of the final price.

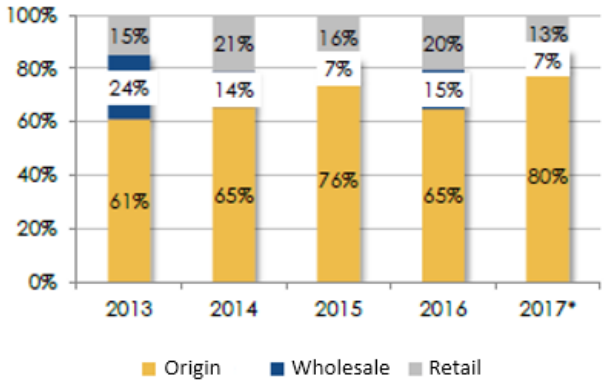


Figure 57: Price allocation along the supply chain (source: Ismea/Nielsen)

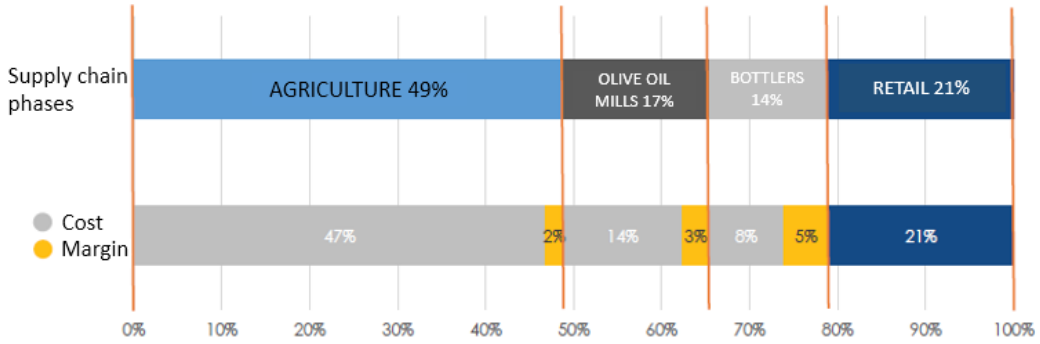


Figure 58: Costs and margins along the supply chain (source: Ismea)

The main problem of olive grower in Italy is the low profitability, especially during agriculture phase. In fact, for each 100 € spent by the consumer, 49 € are allocated to the agriculture phase, that however uses 47 € to cover its costs. Also olive oil mills and bottlers phases show low margins. The objective is trying to increase the value to be distributed along the supply chain. A limit that hinder this intent is, for example, the constant promotion policies.

Italy benefits from the presence of territories that guarantee a good level of quantity of olive and, especially, high quality. Thanks to the presence of several types of cultivar, it can differentiate production in significant way, both for typology and taste. Ancient olive trees represent for our country an important environmental, cultural and historical value. Italian know-how in olive oil sector is high, this is a great strenght for maintaining an excellent level of products quality (DOP/IGP, BIO…). There are about 400 traced supply chain, with more than 8,000 olive farms involved. However, on the other side there is a big fragmentation of the production structure, most part of olive farms have small dimensions. The unit value of grounds is very high. Automation level is limited because of a prevalent presence of traditional plants. Generational turnover is almost absent, for this reason the willingness to innovate is often overshadowed, also because of the limited capability to invest. The role of scientific research is perceived as fundamental for spreading in time the awareness about the benefits of new solutions. This is a list of the manoeuvres the national olive-growing sector is taking into account:

- **Increasing internal production of extra virgin olive oil**: through the rationalization of cultivation and the renewal of the actual production plants. This goal has to be pursued in a sustainable way, respecting environment and minimizing resources consumption, especially water. The willingness of improving the procedures should be complemented by the respect and the preservation of territory and social-historical values. Economical, social and environmental sustainability is the pillar to which refer.

- **Supporting and promoting research activities**: in order to increase efficiency.

- **Supporting initiatives to valorize "made in Italy"**: through, for example, the use of certification to highlight product quality thanks to Italian know-how.

- **Stimulating the varietal recovery of the national cultivar of table olives**: through new olive-growing plants that can be mechanized.

- **Incentivizing and supporting aggregation and economical organization**: in terms of supply chain operators.

4.2.2 International scenario

- **North America**: olive oil consumption, especially in USA, is increasing. Also production, olive oil from California is considered the best in internal market. Moreover, in the last years import of olive oil in bulk has increased.

- **South America**: both import and production are strongly increasing. In few years, Argentine has increased production from 13,000 t/year to 20,000 t/year, also thanks to the growing demand from USA. In Chile, olive oil sector is rising and its products quality is highlighted by several international prizes won.

- **Africa**: Maghreb is one of the main centres of production. Tunisia is the second country in the world for surface designated for olive trees agriculture. It is also the main supplier for Europe, also thanks to its good price performance.

- **Asia**: it is considered an emerging market. For this reason, European producers have a lot of expectations towards the evolution of Asian demand (especially as concern Japan, China and India), despite the big gap in culinary traditions between the two continents.

- **Oceania**: Australia has increased production in five years from 5,000 t/year to 13,000 t/year.

5. OLEIFICIO ZUCCHI

Now we have all the elements for introducing the business case on which this thesis project aims to focus attention: Oleificio Zucchi S.p.a.

5.1 HISTORY

Oleificio Zucchi was founded in 1810, in the province of Lodi. It started as family-run artisanal activity, specifically for the extraction of oil from seeds for food use. In 1922 the refining process is implemented and in the end of 50's the company enter in the market of retail industry, both with seed oil and olive oil. The company grown more and more and its plant was moved to Cremona in 90's, with a surface that covers 80,000 m². The production capacity has grown until 1,500,000 l packaged/day, with 9 highly automated production lines and a cutting-edge technology. As concern distribution, actually the company has three main channels: GDO, Ho.Re.Ca and food processing industry. In the last years a laboratory of Research& Development has been developed, in which an internal team of qualified blendmasters is working for the execution of panel test and the realization of better blends. This group is specifically dedicated to extra virgin olive oil that is at the moment a product on which the company is paying large attention in terms of business development (the market of seed oil is not so profitable as before). In order to maintain quality of the oil, the biggest conditional structure of storing in Italy has been created. In conditions of constant temperature of 16 degrees, it is able to store about 4,800 t of extra virgin oil, maintaining unaltered the organoleptic characteristics.

Figure 59: Cantina dell'olio in Oleificio Zucchi's plant, the biggest conditional structure of storing in Italy

In line with technological progress and with the interest of an always better economical and environmental sustainability, Oleificio Zucchi pursues a policy of constant investments, updating its tangible assets to the most recent technical expertise. The values on which the philosophy of the company is based are environment, quality and safety. Actually it produces sunflower seed oil, high oleic sunflower seed oil, soy bean oil, "friggimi" (80% sunflower seed

oil, 20% high oleic sunflower seed oil), extra virgin oil. The subject under investigation of our study is precisely this last one, because it is the protagonist of the project that the company has started to implement.

This project began in 2015. It did not arise out with the intention of creating a sustainable and traceable supply chain. In 2013, Oleificio Zucchi decided to make a partnership with Legambiente, that involved extra virgin olive oil. In order to ensure that this product was suggested by Legambiente, a voluntary disciplinary has been set (different from the actual one but similar in different points). This formalized the effort by Oleificio Zucchi, under the supervision of the association, to produce olive oil with very stringent qualitative parameters. It consisted in a process of constant improvement in a time horizon. Quality requirements were not only related to the product itself, but also to packaging (i.e. reduction of package, choice of more sustainable recyclable materials). This partnership allowed Oleificio Zucchi to enter the market with a differential product. Legambiente is not a certification body, nevertheless it put efforts in making laboratory tests to verify that the disciplinary was respected. For the company it was necessary to have suppliers that satisfied the defined parameters.

Successively the strategy moved to the idea of certifying the suppliers, passing from a voluntary disciplinary to an official one, and creating a new product category (different from DOP/IGP products, that actually have a value on the market of 1%; BIO, whose value is about 5%; extra virgin, with 94%). An important message to spread to consumers was that extra virgin oil is made by a blend, that is a mixture of different types of olive oil, coming from different places. For Oleificio Zucchi "100% Italian" is not a synonym of quality. In fact, it is not important that its suppliers are from Italy, but that they respect the quality standards from the agreements predefined. Spreading the concept that "good" only means "100% Italian" could crash the market, because the production in Italy is not enough to satisfy the overall demand. The company had nothing to lose when the project has been launched, because it started as a startup (despite the name "Zucchi" was already known since 1810). It hopes that the new category of "sustainable and traced extra virgin oil" will not represent a niche on the market but, on the contrary, will grow and be taken into account even from the competitors. In this way, the client will be able to make purchase evaluations on the basis of quality parameters shown on product labels. Furthermore, Oleficio Zucchi could represent the leader because it started first to implement the project, so having an advantage in terms of timing and resourced involved. In fact, the company needed at least one year to build a sustainable supply chain. In the eyes of consumers it was necessary to build a new brand image, since these used to devise Zucchi as a seed oil seller. In order to do it, Oleificio Zucchi is exploiting all of its know how gained over the time, thanks an experience of more than 2 hundred years. It is not a coincidence that its trademark was modified in the end of 2015 and new human resources were recruited.

Figure 60: Oleificio Zucchi's new brand

5.1.1 Before the project

By law, together with olive oil supply, it was necessary to collect a series of documents (paper and/or scanned via e-mail) to be manually put on the website online. This one was connected to QR code on the bottle, that just reported supplier origin (i.e. olive oil mill province), and not that one of farm (still not required by law). Oleificio Zucchi followed EU regulation. It used an internal information system (W-Track) that allowed the management of incoming materials, starting from olive oil that arrived inside a tanker, to which is assigned a barcode, called travel code, that is registered by the system through a scanner. All the movements of travel codes were followed along the production process (from their registration to finished product), packaging included, and could be also observed in reverse.

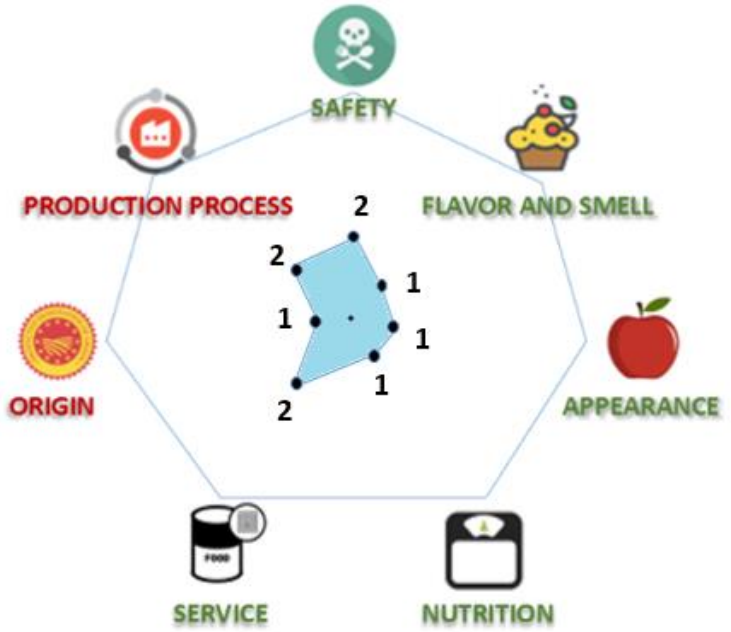


Figure 61: Quality septagon of Oleificio Zucchi's extra virgin oil (before the project)

5.2 THE PROJECT

The project started in 2015, with a duration of 5 years, and it consisted in the implementation of a traceability system able to cover all the supply chain, "from farm to fork". In a first phase the objective was the involvement of all the operators that are already certified with ISO 22005:2208.

This standard is the reference document, with international validity, for certifying agri-food traceability systems. It is part of the series of standard ISO as a voluntary certification, based on the overcoming of the basic legislative requirements, aimed at a continuous improvement. ISO 22005 points out the pillars of traceability (supply chain, flows, documentation, system management) and allow a wide flexibility in terms of business objectives, leaving the company the possibility to define the object (product, ingredients) and the system dimension in terms of organizations and flows of materials involved (width and depth of supply chain). It is fundamental that communication aspects, through which a company makes public what it is carrying out, respect three principles:

1. Coherence between the elements of the system and the information sent.

2. Depth with the maximum extension possible (starting from the farm).

3. Implementation of a system coherent with quality and food safety policies.

The design of a traceability system have necessarily to define the following aspects:

- Supporting food safety
- Satisfying client
- Defining history and origin of a product
- Facilitating recall
- Identifying responsibility
- Facilitating the verification of specific information concerning the product
- Communicating the information to the interested parts
- Improving the competitiveness of the organization

More in details:

- Definition of the specific goals, according to the standard principles. These should be verifiable and compliant with mandatory legislation and with a defined accuracy
- Legislative requirements and related to policies concerning traceability
- Products and/or ingredients
- Position in the supply chain
- Materials flow
- Necessity to specify which information have to be obtained by suppliers, collected (as concern history and process of the product), provided to clients and/or suppliers.
- Documentation requirements (which documents are required to guarantee the respect of the goals)

- Coordination of agri-food supply chain, intended as system structure (which actors are involved, interactions and responsibilities of each one).
- Procedures implemented (concerning the documentation of materials flow and relative information, also considering archiving and verification of documents). In particular, elaboration of functional procedures concerning: product definition, batch identification, flow of materials and information, assets to storage information, data management and protocols registration

During the implementation phase it is necessary to define the following aspects:

- Traceability plan in which, for each phase, are described: system management, critical points, monitoring and preventive actions aimed to control, responsibilities, registration documents both of activities of control and actions undertaken
- Employees training plan that can have an impact on traceability
- System effectiveness verification plan, through planned internal audits and tests (e.g. simulations, traceability test and mass balance, that consists in identifying the quantity of product processed in a given period)
- Revision of the traceability system, in order to improve it considering: results of traceability tests, results from internal audits, variations in terms of product and/or process, information provided by other operators of the supply chain, corrective actions implemented, feedback information from clients, legislation updates.

Here a scheme that summarises, in general, difficulties and advantages related to the implementation of a traceability system that overcomes the basic legislative requirements:

difficulties	advantages
objective impossibility to deduce some traceability paremeters inherited along the process through analytical tests on product (e.g. origin); costs related to system management; operational and professional adaptations necessary for the implementation; demonstration of the capability to manage the process	higher guarantee of products safety; increase of reportable product/process requirements and consequent higher opportunities of penetrating the market; higher technical effectiveness due to the awareness of critical points; higher economical effectiveness in managing the processes

Figure 62: Difficulties and advantages concerning traceability system implementation

Therefore, ISO 22005 is a standard that brings with it a series of requirements that are stricter than those one required in Regulation 178/2002. This last has been set by the European authority for food safety and it represents a mandatory standard that consolidates the rules about safety for food and feedingstuffs. It requires that has to be maintained the documentation of who has supplied raw materials and packaging, so only the information about the adjacent upstream operator.

In the specific, as regard extra virgin olive oil sector, the only mandatory request concerns product origin at segregation level of raw materials:

- EU: if the product has been obtained with extra virgin oils from the European Community
- Italian: if the product has been obtained with extra virgin oils from Italy

For privacy issues, hardly an oil-miller discloses, to the company that has bought olive oil from him, information about the farmers who supplied him. Oleificio Zucchi is able, through QR Code on its products labels, to indicate the province from which olive come from and that one where the olive oil mill is located. Potentially, thanks to a portal of data collection, the Portal 4.0, the company can trace back to the land parcel, that is the smallest unit of a plot of land. We have to consider a farm like a puzzle: each piece of it, cultivated with the same production unit, is called plot. Every part of this one is divided, at cadastral level, in map sheets, whose sub-units are the land parcels. The land registry recognizes the type of cultivation and the extension can imply different levels of precision of data. The unit of measurement that Oleificio Zucchi considers is the square meter, whose the level of precision is useful for calculating carbon footprint. In addition, the company started in October 2016 the implementation of a project of sustainability, that is actually strongly intertwined with that one of traceability. Because of that, in order not to make confusion, from here on out it will be used the term “project” to indicate both traceability and sustainability projects together, as the result of a macro work that the company is pursuing in the same time for its extra virgin olive oil.

Before going in details with the project, let's introduce some considerations that are at the bottom of its implementation. First of all, a market survey has been done, in order to understand what consumers are looking for. It emerged that the average consumer is increasingly sensitive to the issues concerning sustainability. However, in his/her mind, this concept is very vague, circling around environment, economy and society. The project is born "putting the hearth over the obstacle" because it was a question of a mammoth and challenging work. Oleificio Zucchi aimed to:

1. Extend the concept of sustainability through the introduction of a fourth pillar: nutrition. This is an unedited issue for consumer.

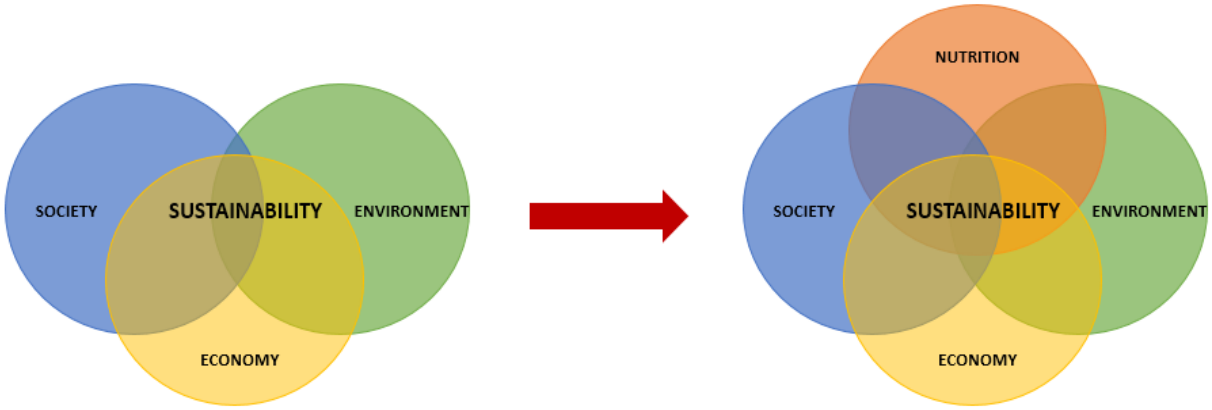


Figure 63: Sustainability pillars for Oleificio Zucchi

2. Explain to consumer that to obtain high quality product it is necessary the collaboration of all the supply chain.

5.2.1 Blend

Nevertheless, it seems that for consumer "sustainability" is a prerequisite from which starting. For this reason, it is necessary to add other concepts. In fact, Oleificio Zucchi aims to communicate the clients more aspects. For example, through a TV advertising campaign, broadcasted on Rai in September 2017 (through a format called "lezioni di etichetta"), in addition to sustainability the concept "blending" was mentioned. This is an innovative issue in the Italian context of olive oil. Today this concept is becoming a trend, even in wine sector, considering for example the commercial of Tavernello. In the past blend has been seen as something of negative, because the product was considered as "not pure anymore". Today this idea is changed with a new one, in which the product is perceived as something of elaborate, that adds value. Still today a large part of Italian consumers have a concept of olive oil as something of "pure and primordial", while abroad, instead, blending has already been conceived as a positive aspect (this is due to cultural and nutrition issues). The job of blendmaster is that one of trying to find a taste balance, at organoleptic level, among the different cultivar, in order to involve the largest number of consumers. Oleificio Zucchi is aiming to give value to the Italian know how, through blending and quality on raw material.

Italian value does not come from the fact that there are Italian olive in the product, but that behind its there is Italian know how. Spain, for example, that produces a volume of olive oil that is 5-6 times higher than that one produced in Italy, recognizes the higher level of Italian know how as concerns blending. Blend can change from one batch to another one. About olive oil, for regulations, it is not possible to give descriptions that are not proved by an accredited panel test (through a certification). This issue strongly limits the communication, both on the label and website, that can be done on the product, because every communication toward clients should be verified with panel test. For this reason, the names that are given to the olive oil, to identify the taste profile, are more creative. These names try to suggest the consumer something to better be helped (e.g. "the strong", "the delicate"…). What Oleificio Zucchi does, to at least partially remedy this issue, is communicating (for the sustainable and traced product) with which cultivar, whose blend is composed, the product has been made. For example, the presence of Coratina gives to the olive oil a spicy taste. The idea is to settle in the future the range of products (at the moment too much confused) to simplify the communication towards consumers.

The need relating the project comes from the willingness to differentiate from the market, providing something of extremely new. It is difficult to innovate in the context of extra virgin olive oil, because it is a "poor" product, very regulated, restrictive from a legislation point of view. Until 2015/2016 a project like this has been always conceived as something of unachievable. Extra virgin oil supply chain in Italy is extremely fragmented. For this reason, being able to build it and acting as leader it was considered a very innovative idea: connecting all the operators (from farm to consumer), through the realization of a sustainable product, has been always thought as impossible. Oleificio Zucchi started this challenge, trying to obtain additional information, that otherwise would remain unused inside a farm notebook, to provide them to final consumers and to achieve an added value recognition.

5.2.2 Certifications

Let's now come back to the core of the project. By law, agri-food products must be traced, not necessarily certified. Oleificio Zucchi follows ISO 22005 and so all the subjects of its supply chain. The company not only undertakes to require the origin of olive, but to reach a higher level of detail, until land parcels (despite ISO 22005 does not require it). It is possible to obtain a certification only through certification bodies. Each of these is accredited by a superior body of the Italian government, that allows to it to certify some regulations. For example, CSQA (certification body at national level) is accredited by Accredia to certify ISO 22005 in Italy. As concern sustainability, Oleificio Zucchi follows a disciplinary: **DTP 125** (Disciplinare Tecnico di Prodotto). This is a protocol from CSQA too, that is composed by 150 evidences, i.e. a list of points that all the subjects of the supply chain have to respect. The objective is to characterize the olive oil supply chain, giving value to the products from a sustainability point of view. The last objective is to allow the supply chain operators to increase the level of awareness as concern sustainability and so to start a path of continuous improvement in the widest definition of economic, environmental, social and nutritional sustainability recognized at international level:

- **Economic**: capability to generate income and job. The company defines the "fair price" and the criteria for its determination. This one has to consider both the evaluation of the

possible positioning on the market and the effective production and transformation costs incurred by all the supply chain operators. “Fair price” shall be agreed among them on a proposal from the company.

- **Environmental**: capability to maintain quality and reproducibility of natural resources. The company computes the environmental performance of the product by using PEF indicators (Product Environmental Footprint), as described in the Recommendation 2013/179/UE of CE. In this computation, it follows the indications included in PEFCR of olive oil issued by Technical Secretariat of CE. The methodology applied is LCA (Life Cycle Assessment), considering 1 liter of extra virgin oil, with its packaging included, as functional unit. The system boundaries include all the steps, from the production of olive to the end of life cycle of the product. Furthermore, the company measures annually the level of biodiversity in water, air and soil, by using a methodology patented in 2014 by WBA Onlus (World Biodiversity Association)
- **Social**: capability to guarantee conditions of human wellbeing (human rights, job practices, fair operative practices, consumer protection, involvement and development of the community)
- **Nutritional**: through which the company aims to give a qualitative connotation of the product itself, and not only of the production process. The objective is to assure the consumer a high quality product, with nutritional/health parameters that are stricter compared to those imposed by legislation

Parameter	Limit to be respected from the beginning of certification phase	Limit to be respected within five years	Legislation parameter (Reg. 2568/91 smi)
Acidity (%)	0.4	0.3	< = 0.8
Median defect	0	0	0
Median fruitiness	> 0	> 0	> 0
Peroxides	12	10	< = 20

Figure 64: examples of nutritional parameters reported

<table>
<tr><td rowspan="11">FROM FARM TO FORK</td><td rowspan="4">CROSS REQUIREMENTS</td><td colspan="5">FOOD SAFETY</td></tr>
<tr><td colspan="5">QUALITY ASSURANCE</td></tr>
<tr><td colspan="5">SUSTAINABLE PRODUCT IDENTIFICATION</td></tr>
<tr><td colspan="5">SUSTAINABLE PRODUCT TRACING</td></tr>
<tr><td colspan="3">ENVIRONMENTAL PILLAR</td><td>SOCIAL PILLAR</td><td colspan="2">ECONOMIC PILLAR</td><td>NUTRITIONAL PILLAR</td></tr>
<tr><td colspan="2">INDICATORS</td><td colspan="3">GOOD PRACTICES</td><td rowspan="2">PRODUCT REQUISITES</td></tr>
<tr><td rowspan="5">BIODIVERSITY</td><td rowspan="5">PEF</td><td colspan="2">Working practices</td><td>Social practices</td><td colspan="2">Economic practices</td></tr>
<tr><td>Production</td><td>Transformation</td><td>TRAINING</td><td colspan="2">EMPLOYEES</td><td>NUTRITIONAL REQUISITES</td></tr>
<tr><td colspan="2">ENERGY</td><td>SAFETY ON WORKING PLACES</td><td colspan="2">SUPPLY CHAIN OPERATORS</td><td rowspan="2">HEALTH REQUISITES</td></tr>
<tr><td colspan="2">FUEL</td><td>WORKING CONTRACTS</td><td colspan="2">SUPPLIERS</td></tr>
<tr><td colspan="2">WASTE</td><td>RELATIONSHIPS WITH COMMUNITY</td><td>Fair price</td><td>Value Chain</td><td>HYGIENE AND HEALTH REQUISITES</td></tr>
</table>

Figure 65: Structure of standard DTP 125 (Source: CSQA, 2017)

In particular, DTP 125 includes:

- Major requirements (M), to be mandatorily satisfied
- Minor requirements (m), to be satisfied in increasing percentages in the course of years
- Recommendations (R), suggestions for a continuous improvement

One of the requirements of DTP 125 is that all farms have to be at least in integrated production. Through this system, it is possible to use only a limited number of active substances (coherently with environmental sustainability). The treatments towards the plants are not arbitrary but have indications on the disciplinary. In fact, they can be done only in specific phenological phases. For example, during olive harvesting it is not allowed to intervene with active substances, to avoid that olive oil becomes contaminated. These have to be used before, to guarantee that the plant has time for absorbing them.

It is really important not to make confusion between the two certifications mentioned:

1. ISO 22005: it is related to traceability. As concerns it, Oleificio Zucchi is not the supply chain leader, because all of the operators involved in the project already answer this certification autonomously (through certification body). It is the first certification that involves all the supply chain. Also other companies (e.g. Bertolli) tried in the past to realize it, but without success, because it required flexibility, patience in long period and also a lean structure.

2. DTP 125: it is related to sustainability. None of the micro-supply chains is autonomously certified with it. For this reason, Oleificio Zucchi is the leader of these chains involved in the project. The company has to ensure that the operators respect the requirements indicated in the disciplinary.

For the company, traceability is a prerequisite of sustainability: a product can be traced but not necessarily of high quality. Through traceability we are able to follow step by step the flow along the supply chain, in this context we do not assume necessarily a high quality product. Adding sustainability, that requires the monitoring of all the agronomic practices, it is possible to achieve it.

While in some cases the link between traceability and quality is rather evident, in that one of quality related to organoleptic parameters the tools of traceability do not seem to have any evidence: this is not true, because if we have tools that allow to trace and punctually verify what happens during the different steps, the monitoring becomes easier (e.g. control of pesticide use during working on field). In order to guarantee quality of finished product, traceability and control of all processes are fundamental.

5.2.3 Project's operators

Which are the upstream operators involved in the project?

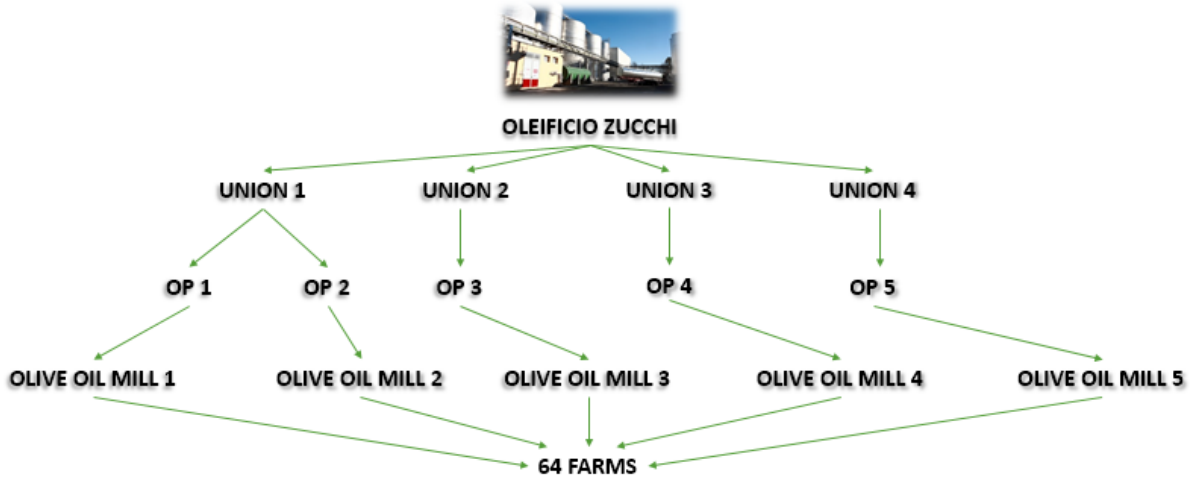


Figure 66: The operators actually included in the project

1. **Oleificio Zucchi**: the sustainable supply chain leader. It checks that all the actors are compliant with the agreement. It purchases sustainable extra virgin olive oil from Unions or OPs in relation to the contract signed. It mixes the product with others of the same category (traced/sustainable/Community…) and packages it, though bottling and canning. Successively it delivers final products to clients (e.g. GDO).

2. **Union** (or AOP, Associations of Organization of Producers): at national level, it is the administrative part of the supply chain and the supplier of Oleificio Zucchi. It has responsibility for itself and the operators below the pyramid. It can access the Portal 4.0 for checking the information. An union can supervise more than one OP, that in turn can supervise more than one olive oil mill, the same as concerns this last one towards farms. For example, Unasco includes 1 union, 26 OPs, 120 olive oil mills and 500 farms (whose 26 have been selected because traced).

3. **OP** (Organization of Producers): at regional or provincial level, it is the administrative part of the supply chain (but more at local level, as an "eye on the territory") and the supplier of Oleificio Zucchi. It is a territorial authority that controls, tipically through agronomists, the information from the operators below the pyramid. It has responsibility for them and itself. It uploads information, concerning olive oil mills and farms, on the Portal 4.0 or sends them directly to the company. There is an agronomist for each group of farmers, he/she gives them the indications about what and how to do, in terms of quantity and quality of product. Its technicians also interact with the portal of his related Union, but this does not concern Oleificio Zucchi.

4. **Olive oil mill**: it has production function. Here the olive are collected and transformed in extra virgin olive oil, that is stocked in silos (storing can be done directly inside olive oil mill or through outsourced stock). It has responsibility for itself and the actors below the pyramid. It is not a technical organization, for this reason there is an OP to supervise it.

5. **Farm**: it has production function and responsibility for itself. It is the place where olive grow and are harvested. The farmer works on the field and is committed to collected data, with of reference technicians (e.g. agronomists). Furthermore, the farmer is the first subject to decide if signing the agreement. His/her job is monitored through bubbles (invoices). In particular, the farmer has to go to consortium, show his/her license and a bubble that reports name, quantity and date. This invoice is related to the documentation that Oleificio Zucchi requires. The farm has the full responsibility as concerns the truth of the information provided, the agreement does not oblige it to confer all the harvesting, this means that the farm is free to sell non-sustainable goods to clients outside the agreement. By accepting to deal with Oleificio Zucchi, the farm accepts to share its cadastral data, treatments register (farm notebook) and consumptions. All of these information are managed by its OP, Union and Oleificio Zucchi.

Creating a link among these operators means being sure that data is correct and real.

5.2.3 The supply chain

Here a scheme of the sustainable supply chain:

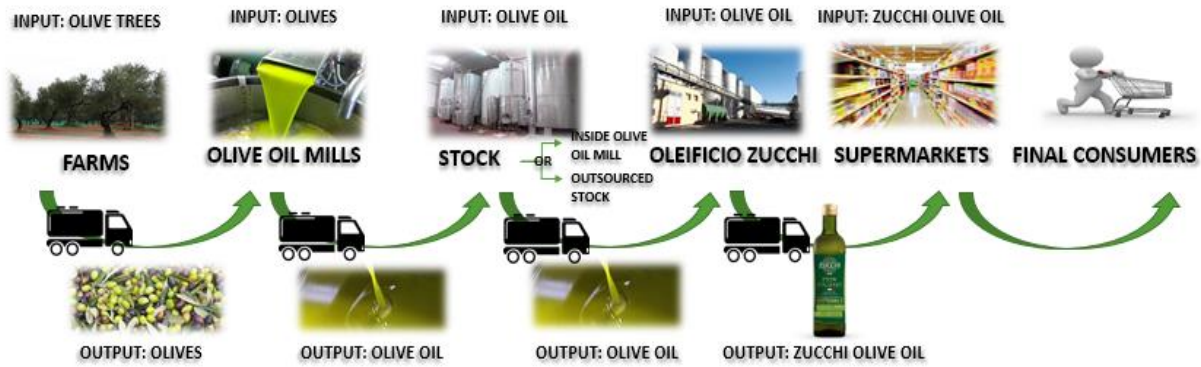


Figure 67: Oleificio Zucchi's sustainable supply chain

As we can see from the image, Unions and OPs are not included in the physical flow, because they work as bureaucratic offices (they don't have silos and the products do not transit here). During the implementation phase of the project, Oleificio Zucchi contacted the Unions, asking them to select their micro-supply chains that are already traced and certified with ISO 22005 (that is the prerequisite) through an accredited body recognized by Accredia. Once the first selection has been taken, the company asked to the Unions if the operators involved are potentially sustainable. This means if they are ready or not for respecting what is indicated in

DTP 125. After this second selection, Oleificio Zucchi asked to the downstream operators to sign voluntary agreements, specific for each of the four levels (Union, OP, olive oil mill and farm), that require the control of everything concerning the downstream subject, as a pyramid system (see figure 66). Every operator performs an internal pre-verification according to its competence (internal audit) and, if there are no conflicts with which is required by the agreements, successively a report that declares a condition of regularity is drafted. Oleificio Zucchi uses external audits for controls. Once verified that all is as reported, the certification body is called for checking again that all is in order. If this condition is verified, the certification can be assigned. Everything must be compliant with what has been declared, otherwise the certification release is not possible and has to be postponed waiting for any encountered problems are solved. On the basis of audits, Oleificio Zucchi can evaluate to interrupt the agreement with a supplier, removing it from the sustainable supply chain. The certification specifics that the micro-supply chain in consideration is sustainable, with a duration of 1 year, for renewal it is necessary to repeat controls. At the beginning, Oleificio Zucchi offered 5 Unions the possibility to adhere to the project. The main motivation for which one did not take part was due to the absence of adequate instrumentation to guarantee the desired level of sustainability. An union can not adhere if it includes farms and/or olive oil mills that are not in conditions to respect the agreement.

Oleificio Zucchi organizes free expert advices for farms and olive oil mills, in order to help them to calculate some indicators as carbon and water footprint, biodiversity index. This is because they might not have the adequate instrumentations and/or knowledge for doing it. The results of the analysis are then shared, through a report, with the actor involved, giving it some suggestions to improve them. In fact, on DTP 125 it is written that Oleificio Zucchi has to guarantee for the actors below the hierarchy, but it also has to monitor them. For example, if an actor is "crippled" in a certain aspect, the company tries to help it, for this reason a consultant is paid for doing this activity. Otherwise, the consequence would be the exit from the supply chain, situation that no operator wants. The company worries that every point of the agreement is respected, that is not obvious.

Oleificio Zucchi archives all the bills from farms and olive oil mills about annual consumptions and related production. It is not possible to have a daily precise data about the resources consumption of 1 kg of extra virgin olive, for this reason an average on a yearly basis is done. On the other hand, the data concerning production on field (its processing) is more accurate.

Each farmer bring its olive to the olive oil mill, according to vesting date, the yield (the ratio between kg of olive oil produced and kg of olive milled for producing that quantity of olive oil) is different. It can vary from 8% to 25% and affects the calculation of carbon footprint. The less is the yield, the higher the quality of the product. Therefore, it is necessary to find a balance between this trade-off between vesting date, yield (that affects farmer's profit) and quality (that is the constraint to respect, because the disciplinary implies specific parameters to follow).

5.2.4 Interaction with consumer

For consulting the information related to a specific bottle, the consumer can:

1. **Using QR Code**: in this way, it will be provided the link to directly access to traceability section of Oleificio Zucchi website

Figure 68: The link provided with QR Code

2. **Accessing to the company website**: in this way, it is possible to access to traceability section on a pull-down menu in the homepage

Once reached traceability section, it is required to specify the type of oil, if from olive oil or seeds. By selecting the first one we need to enter the number of batch and the verification code, both reported on the label of the product.

Let's see an example:

- Number of batch: L800182
- Verification code: N16

There are 5 five sections: one related to traceability, the others to each sustainability pillar.

1. **Traceability**: from here it is possible to see the origin and cultivar's description.

Figure 69: The origin (source: Zucchi.com)

Figure 70: Cultivar (source: Zucchi.com)

2. **Economic sustainability**: in which there is the company's mission concerning this aspect.

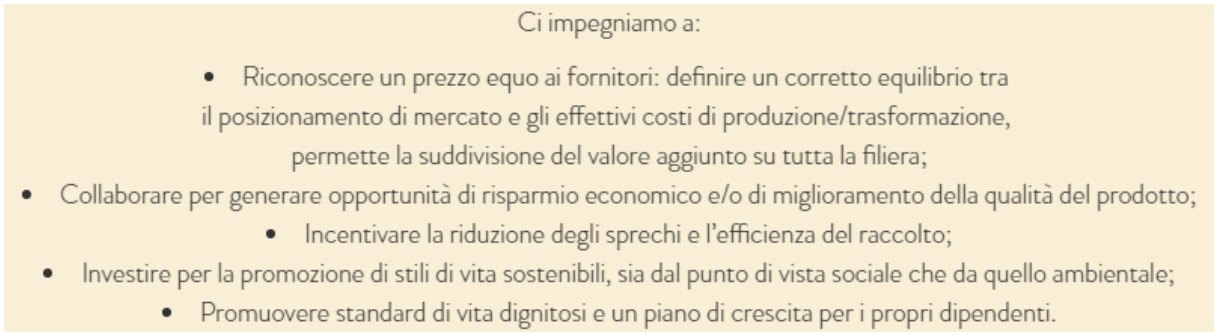


Figure 71: Brief description of economic pillar (source: Zucchi.com)

3. **Social sustainability**: in which there is the company's mission concerning this aspect.

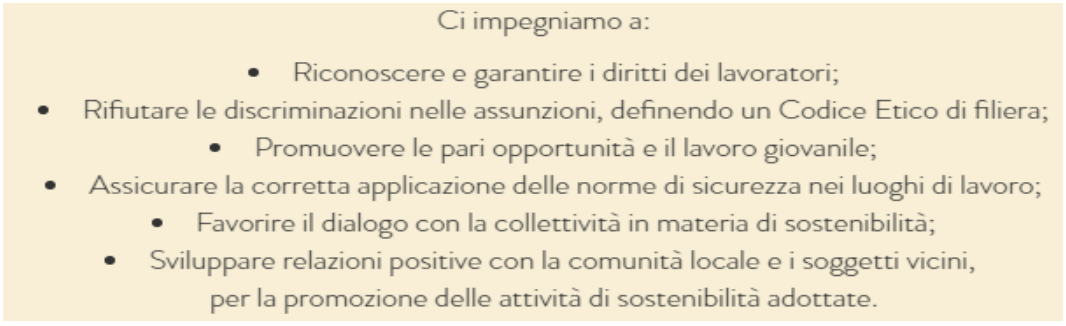
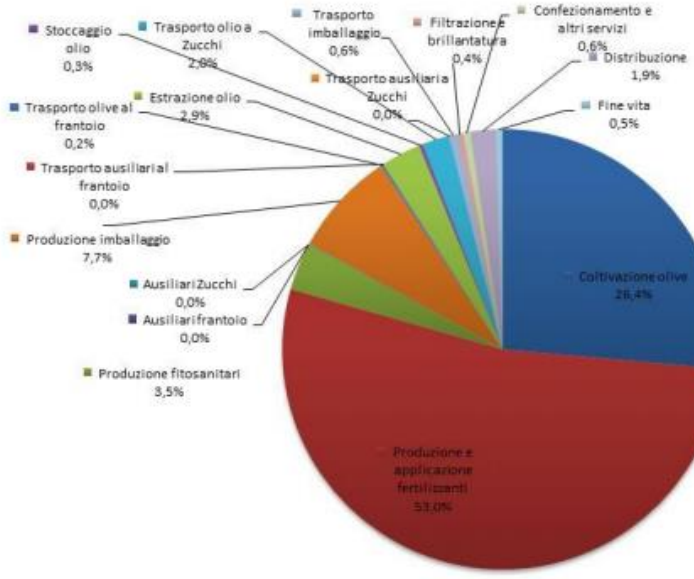


Figure 72: Brief description of social pillar (source: Zucchi.com)

4. **Environmental sustainability**: in which there are two reports, one about carbon footprint and the other one about biodiversity.

OLIO EVO SOSTENIBILE	kg CO_2 eq	%
CICLO DI VITA	4,37	100%
UPSTREAM	3,97	90,7%
CORE	0,30	7,0%
DOWNSTREAM	0,10	2,3%

CFP dell'olio extravergine di oliva sostenibile



Contributi alla CFP per unità di processo

Figure 73: Some data from carbon footprint report (source: Zucchi.com)

5. **Nutritional sustainability**: in which nutritional parameters are reported, in particular the gold one are referred to the product, the black ones to the current legislation. There is also a report with further quantitative data from the analysis.

MEDIANA DEL FRUTTATO
Indica i valori legati alla misurazione del fruttato, aroma che richiama l'aroma delle olive fresche e sane, e viene percepito attraverso l'olfatto.
0
> 0*

MEDIANA DIFETTO
Indica i valori legati alla misurazione dei difetti, attributi negativi che indicano imperfezioni.
0
0*

ACIDITÀ %
Indica la percentuale di acidi grassi liberi. Espressa in % di acido oleico (g/100 g) è inversamente proporzionale alla qualità.
≤ 0,40%
≤ 0,8%*

PEROSSIDI (meq02/kg)
Composti chimici che indicano il livello di ossidazione dell'olio e quindi il suo stato di conservazione.
≤ 12
≤ 20*

K232
Valore che definisce se l'olio ha subito processi di ossidazione primaria.
max 2,20
≤ 2,50*

DELTA K
Valore che definisce se l'olio ha subito processi di ossidazione secondaria.
max 0,01
≤ 0,01*

PESTICIDI (ppm)
Prodotti di sintesi o naturali utilizzati in agricoltura per combattere le principali avversità delle piante.
< limite di rilevabilità
Regolamento (ce) n. 396/2005

ETILESTERI DEGLI ACIDI GRASSI (ppm)
Composti che si formano a causa della combinazione tra
≤ 15
≤ 35*

Figure 74: Some data from nutritional pillar (source: Zucchi.com)

5.2.5 The role of technology

SIAN (Sistema Informativo Agricolo Nazionale) is portal in which supply chain operators have to access for entering data required by law. It is a public registry in which all farms, oil mills and oil manufactures are involved at national level. It contains all the movements of oil and raw material, but not information on cadastral parcels. Through it, olive oil manufacture can access olive oil mill data, this one in turn can access farm data. Oleificio Zucchi can not access these one. Therefore, in order to obtain them, it should ask to olive oil mill. Nevertheless, this one does not care about the information of notebook farm, it just needs olive quantity, cultivar and cadastral parcel. For this reason, Oleificio Zucchi has implemented its private portal, in order to have the overall control and monitoring of the data it needs:

5.2.5.1 Portal 4.0

Exactly as concerns the part of traceability, Oleificio Zucchi also uses the Portal 4.0 for that one of sustainability. Through this platform, property of the company, it is possible to manually enter data. It takes care of training the employees in order to let them learn the utilization. The goal is making more independent all the operators of the supply chain in the management of data. Each of them that accesses and manages the portal has a dedicated access and limited functions. All the activities (compiling or reading) are recorder and traced, in order to identify the author. Training activity is fundamental bot for the single subject and the company's project, because it is necessary that everyone is able to use the platform and answer the evidences of disciplinary. The entry or exit of an operator have to be communicated both to the company and the certification body. Portal 4.0 was implemented in 2016 with the launch of the project, and it is used for collecting data from subjects that:

- Are only traced
- Are traced and sustainable
- Produce seed oil

The sections to which it is possible to access depend on if the operator is only traced or even sustainable. In fact, the portal concerns also the operators that are not included in the sustainability part. In relation to the type of agreement the level of detail of information is different. For example, as regards traceability, the company needs to know suppliers, land parcels, cultivar, yeld of olive trees…; as regards sustainability, it needs to know consumptions, machinery used, processing, treatments…Each operator of the supply chain that has signed the agreement can access the portal through password and username (once defined the identity of the person who is going to interact with it), that have been directly generated and provided by Oleificio Zucchi. The Unions can have sight, OPs can enter data and modifying them in case of data-entering mistake, the company can enter, modify and delete data. Portal 4.0 contains two types of data:

1. Static: that should not vary (e.g. plots, parcels, surfaces, cultivar…)

2. Dynamic: that regard annual production (e.g. quantity)

It is also divided in different sections, here some of these:

- Registry (per each operator): it includes information as name, place, VAT registration number, OP membership.
- Quality data (per each operator): in which the certifications are uploaded
- Management data (per each operator): in which there is a list of questions. from Oleificio Zucchi, addressed to the single operator (to have more information about its situation)
- Sustainability (per each farm and olive oil mills): related to plots, consumptions…
- Social part + attached (per each farm and olive oil mill): it contains information about the subjects involved (e.g. number of employees)
- Shipments (per each olive oil mill)
- Silos + transfers (per each olive oil mill): it contains information about the quantity and the type of olive oil included in a silos, date of its creation and identification name, transfers of olive oil from a silos to another one (to maintain traceability).

Who has the task to compile Portal 4.0? Not the farmer (because the farms are generally managed by old age people, that have not familiarity with the portal), not the olive oil mill owner, but for sure the OP technician. For this reason, training activity is directed to this figure. Hardly the Union gives help during compilation, because it is a subject that has already a superstructure concerning traceability information (from OPs). For this reason there are no interfaces in common with Oleificio Zucchi, that has to comply with the Union's management system. Each Union has its own management system, that is different from those of the others.

	NUMBER	REGISTRY	QUALITY DATA	MANAGEMENT DATA	SUSTAINABILITY	SOCIAL PART	ATTACHED	SHIPMENTS	WORKING	SILOS + TRANSFERS	BATCH PRODUCED CHECK = 15
UNION	4	20	10	15							
OP	5	20	10	15							
OLIVE OIL MILL	5	20	10	15	15	15	1	10	240*TANKER	10*SILOS (2 SILOS IN AVERAGE)	
FARM	64	20	10	15	30*PLOT (2 PLOTS IN AVERAGE)	15	1				

VALUES IN MINUTES PER SINGLE ACTOR

Figure 75: Timing to compile Portal 4.0

There is no uniformity. Therefore the Unions send to Oleificio Zucchi the documentations concerning traceability in variable formats.

The compilation of portal, as regard registry part, both for sustainability and traceability, started from December 2016 until February 2017.

At decisional level, Portal 4.0 does not point out the moment in which olive have to be harvested, this is a competence of OP technician. Him/her, together with farmers and olive oil mill workers, is the responsible for quality. Oleificio Zucchi does not have competences about it, the company only requires the respect of the parameters established by the agreement.

Portal 4.0 represents the digitalization of all the information. At the basis they are necessarily generated through paper format, also because the sources are different (e.g. phytopharmacy, national energy management body…). A bill, for example, can be arrive to OP in paper or digital format. The file received does not extrapolate in a direct way the data concerning consumption, OP technician has to do it and upload the result on the portal. Therefore, at the basis the operator work on paper, the digitalization takes place at the next step with Oleificio Zucchi.

5.2.5.2 W-Track

Portal 4.0 is also connected to production part, that is managed between a software: W-Track. This one sends to the portal all the information concerning batch and codification (related to item code), the operation is done manually. Through it, it is possible to define all the movements of olive oil (from a silos to another one), the suppliers, the province of farms. Each batch produced corresponds to one blend. As regards traced olive oil, we can know, in addition to the suppliers of olive oils, in which percentages they are included in a blend created (e.g. in a batch of 500 liters). Knowing the percentages is useful to understand how much impact can have, on the overall quantity produced, an olive oil from a supplier compared to that one from another (e.g. if there are problems of contamination, the inspections can start from the suppliers with high impacts in terms of percentage), and to have a check as concern the balance of masses distribution. Each batch produced brings with it the information related to: day and hour of packaging, silos of transfer, line of packaging.

Oleificio Zucchi does not only record the first packaging (the bottle) but also the secondary one (boxes), through Barcode. In this way it is possible to trace everything that has been used and contemporarily monitor the warehouse.

5.2.5.3 SAP

Production planning is managed with another software: SAP. This one sends to W-Track the orders, that works as intermediary between SAP and the production system. When an operator sends a production order, W-Track transfers it to another system (hierarchically lower) that manages directly the production. This one in turn sends back information to W-Track, that elaborates them. For each order we have an unique order code, date of packaging and expiration of the products, batch code. On W-Track it is not entered anything manually, in fact it has just function of monitoring, giving a picture of the production. Therefore, the input of data occurs automatically from the production system. Here a scheme to summarise:

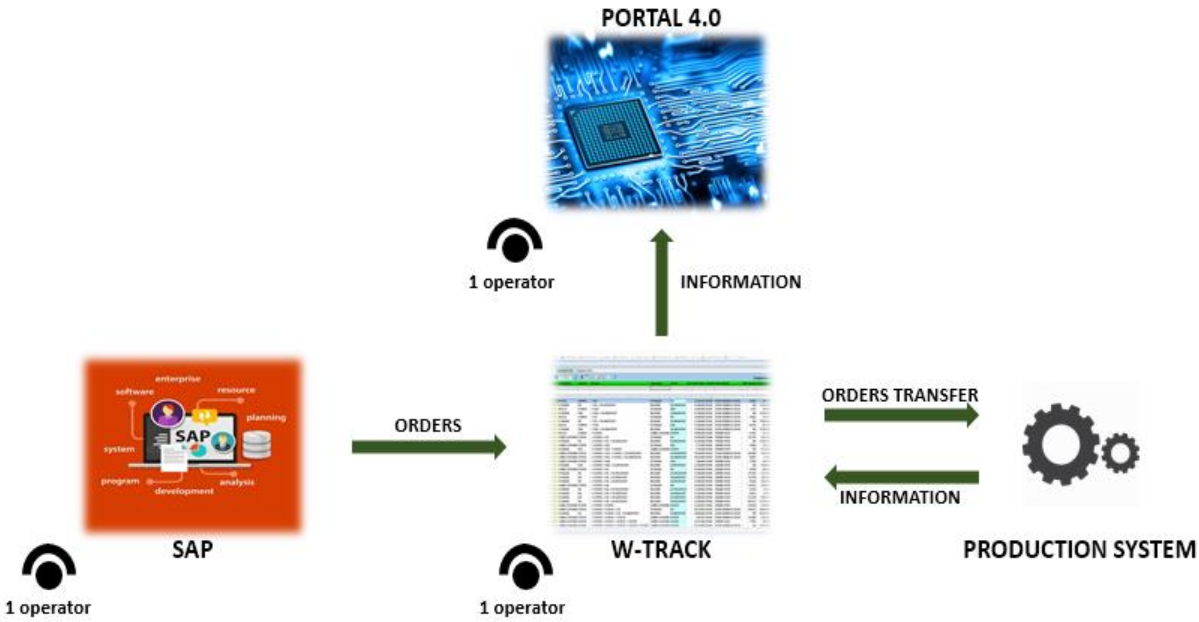


Figure 76: Systems scheme communication

Among these systems, the only element of novelty is Portal 4.0. The others were already present also before the project implementation.

5.2.6 Flow of information among operators

Figure 77: Flow of information

OP technician collects data from farms and olive oil mills, uploading these on Portal 4.0 or sending them directly to Oleificio Zucchi, generally via e-mail through scanner, that will do this activity instead of him/her (these alternatives often depend on how busy is the technician

in that period). Union technician provides static data and certified analysis. Oleificio Zucchi, through its portal, stores and elaborates all the data and links some of them to its products. Final consumer will be able to check the information by scanning QR code with his/her own smart phone or consult them directly on Oleificio Zucchi's website.

5.2.7 Supply phase

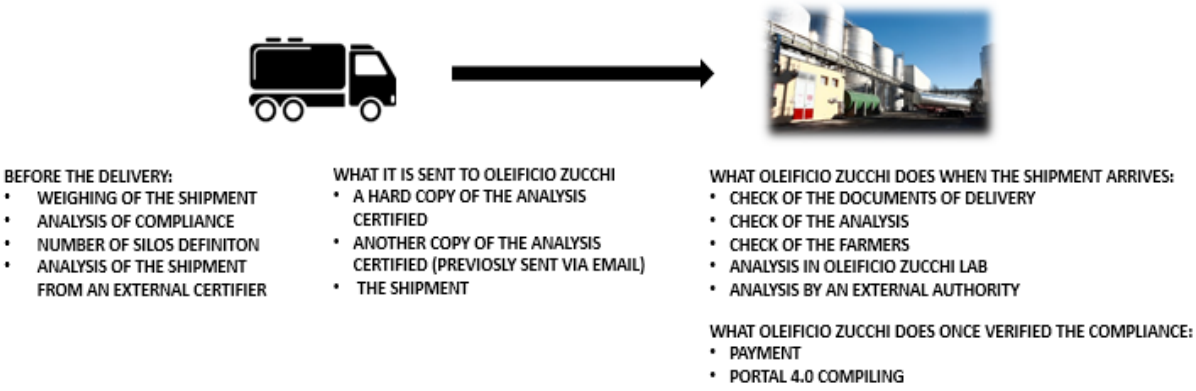
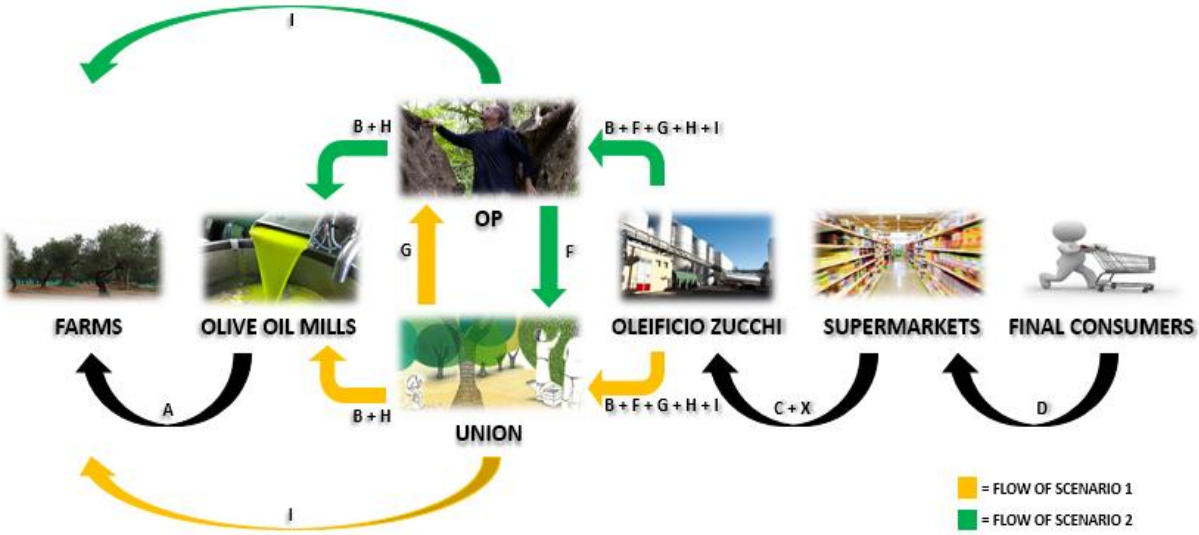


Figure 78: Supply phase scheme

When an Union or OP sends goods to Oleificio Zucchi (generally one shipment weighs about 27,000 kg), it has also to attach a series of certified information from laboratory analysis. They are related to a sample (generally 0.5 liters) of the whole batch delivered. Oleificio Zucchi analyzes this one again and, contemporarily, lets also this task to an accredited external laboratory. This control is done because the product could be sustained modifies of parameters during the transportation. For this reason, the company, before paying the batch and taking responsibility for it, shall ensure that another sample is compliant. Controls are a must because the goods accepted have to be within the limits fixed by DTP 125. It is a safety issue, not only concerning food but also the disciplinary and the correctness towards consumers. During the weighing of shipment, a series of information has to be reported, for traceability issue: compliance of the product with sustainable standard DTP 125 of CSQA, silos number, contract number. When the certifier comes, he analyses all the iter of goods, from the cadastral parcel. For example, considering a document we have: silos n. 44, contract n. 332. The olive oil in this silos can result from the union of olive oil from more silos, whose related number are reported too, with quantities and date of the operation.

5.2.8 Flow of cash



A = PURCHASE PRICE OF OLIVES SET BY THE FARMS (FOR EACH FARM WE HAVE A1, A2, A3…)
B = PURCHASE PRICE OF OLIVE OIL SET BY THE OLIVE OIL MILLS (FOR EACH OLIVE OIL MILL WE HAVE B1, B2, B3…)
C = PURCHASE PRICE OF ONE BOTTLE OF OLIVE OIL SET BY OLEIFICIO ZUCCHI
D = PURCHASE PRICE OF ONE BOTTLE OF OLIVE OIL SET BY THE SUPERMARKET (FOR EACH SUPERMARKET WE HAVE D1, D2, D3…)

X = PREMIUM PRICE = E + F + G + H + I

E = PREMIUM FOR OLEIFICIO ZUCCHI
F = PREMIUM FOR THE UNION
G = PREMIUM FOR OP
H = PREMIUM FOR THE OLIVE OIL MILLS (FOR EACH OLIVE OIL MILL WE HAVE H1, H2, H3…)
I = PREMIUM FOR THE FARMS (FOR EACH FARM WE HAVE I1, I2, I3…)

Figure 79: Flow of cash scheme

Who does Oleificio Zucchi have to pay? It depends with who it has the commercial contract:

- Scenario 1: the Union is the supplier. This one keeps a part of the selling price, that has to be divided among OPs, olive oil mills and farms that contributed to the realization of the goods in consideration.
- Scenario 2: OP is the supplier. This one keeps a part of the selling price, that has to be divided among Unions, olive oil mills and farms that contributed to the realization of the goods in consideration.

Both Unions and OPs are responsible of the economic pillar for equitable price definition.

5.2.9 Farm notebook

It is a paper document that is given to Oleificio Zucchi from the supplier (OP or Union) during supply phase. It is compiled by an agronomist or an OP technician (that are seen as consultants for a farm), and contains information related to farms, in particular:

- Planting distances: important information that provides, knowing the average distance (in metres) between plants, the number of these for each hectare of land, from which it is also possible to make an estimation about the kilos of olive produced.
- Land surface: field extension in square metres
- Geolocation: it includes cadastral paper and parcels (marked by numbers). This data are also available on the related municipality website.
- Expected production
- Trees' age: the older is a tree, the bigger it could be, the higher the quantity of olive we can expect
- Ripening: phase related to olive's ripening

On farm notebook it is also reported the type of fertilizer with title annex, that is the proportion of nitrogen, phosphorous and potassium included in the fertilizer. The higher is the percentage of nitrogen, the higher the attention towards vegetation aspect; the higher the percentage of phosphorous, the higher the attention towards flowering (more flowers means more pollination and so more olive); the higher the percentage of potassium, the higher the comprehensive attention towards the tree. There are different formats of farm notebook, that vary according to the subject who compile them (the information reported are the same but the layout is variable at its discretion). Oleificio Zucchi can not impose an unique standard but has to adapt itself to this variability. The activity of data transcription from farm notebook to Portal 4.0 can unintentionally imply mistakes. All the data uploaded can not be lost, also those that have been deleted can be recovered. As concerns training activity, Oleificio Zucchi also upload on the portal scientific papers and news that can be freely downloadable. As concerns how to use Portal 4.0, training is done through phone calls, online guides and, especially at the beginning, directly in the place where users work.

5.2.10 Oleificio Zucchi and the quality septagon

According to what emerged during the interviews at the company, here the new quality septagon concerning sustainable extra virgin olive oil:

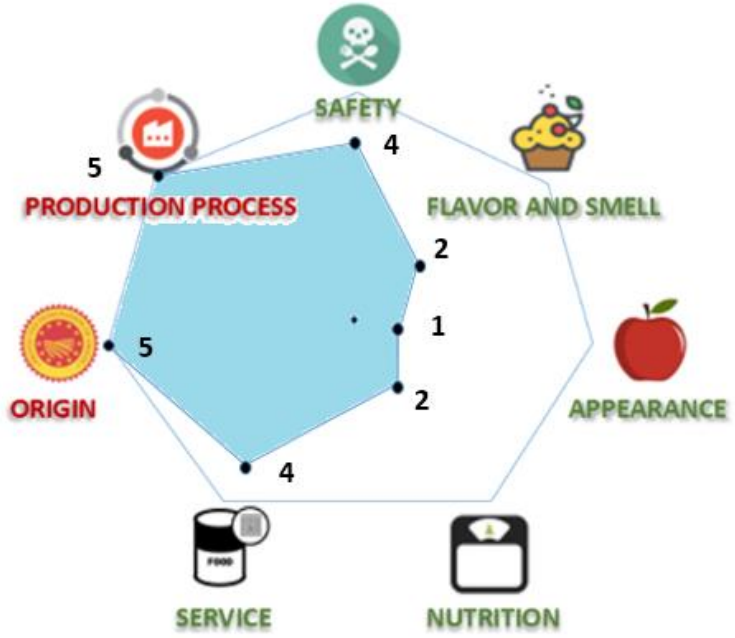


Figure 80: Quality septagon designed by Oleificio Zucchi for its sustainable extra virgin oil

5.2.11 Communication

On Oleificio Zucchi website, the information addressed to consumer have been limited for two reasons:

1. "Not to wash over" the consumer with too many information that maybe he/she can not encode

2. "Politically speaking", there is not the need to share too many information

We can consider, for example, the case of extra virgin oil Garofalo, that has adopted a similar communication strategy with Oleificio Zucchi. By entering the batch code on Garofalo website it is possible to consult: origin of the olive (province), cultivar, harvest period, olive oil mill, olive grower through which the olive have been collected. For Oleificio Zucchi, some information, as for example the identity of the olive grower, are not so relevant for consumer. This one can be interested in the date in which the product has been packaged. Nevertheless, consumers psychology is sometimes full of contradictions: for example, they declare their concern in sustainability but in practice they tend to purchase a more recent product (in this way those packaged earlier risk to remain unsold and thrown away). For this reason, Oleificio Zucchi does not put this kind of information because it could be misleading for consumer and

it could not bring advantages both for the company and sustainability. If the company closely listened the market survey, probably would not call its product "sustainable extra virgin olive oil", however it considered fundamental stopping the competition, asserting itself as the first seller of it. The research has been useful to understand the approach towards sustainability. The company has incorporated inputs from consumers. It is aware that "sustainable" is not a positioning that can hold the business, because also many other companies are aiming to this aspect. Before Oleificio Zucchi had a label for its traced olive oil with a small appendix behind packaging. Now, with the new label of sustainable extra virgin olive oil, it starts from the front of the bottle and continues on its back, in order to inspire consumer to rotate it for reading and understanding what it really wants to tell. We can imagine that this action could be already done during the phase of choice at the supermarket. In the future revisions, the company will try to make the label even more usable, reducing the description (probably actually too excessive, because of the enthusiasm of wanting to tell the product and the project).

Figure 81: The label

It has been done a relevant investment in communication because the company really believes in the project. Several meeting have been taken with different buyers of supermarket chains (e.g. Coop, Esselunga…) to show both product and project related. The means of marketing communication are television, radio (especially "Radio 2" channel), internet and cinema (the same advertisement on television was broadcasted before the movie started).

5.2.12 Market and foreign relations

Today the consumer understands more and more the importance and the value that traceability and sustainability effectively have. In fact, there is a higher attention to environmental and social aspects; quality is perceived in a different way from the past. Entering a supermarket there are on the shelf a lot of extra virgin olive oil brands. Most part of Italian consumers is already loyal to some of these. Therefore, trying to gain market share with a non-differentiated product is very hard for a company of relatively small dimension. Introducing an unique and innovative product, it could be a solution to gain a market share, especially involving that part of consumers in line with the values the company is communicating. Generally, for the average Italian consumer, what is immediately perceived in an olive oil is its organoleptic profile. This is a characteristic that, together with price, tends to gain his loyalty towards a brand. Consumers do not know the chemical composition of the product, so they make confusion about optimal targets. In this scenario, the goal of Oleificio Zucchi is to choose blends they appreciate, and try to let them know that there is a series of merely chemical aspects that are strictly related to olive oil quality, like the level of acidity, peroxides, polyphenol, glycerides, absence of pesticide.

Actually Oleificio Zucchi distributes in 40 countries. USA represents a strategic market, because there are several Italian-American from several generations, that have already familiarity with the concept of olive oil. Furthermore, traceability is a very important concept for them. DTP 125 has been translated in other languages to facilitate the involvement with European countries. Portal 4.0 is actually can be reviewed in Italian, English and Spanish. Oleificio Zucchi has planned to do audits in Spain and it is committed to make local suppliers, already traced with ISO 22005, sustainable by 2018. In Spain did not exist ISO 22005, because there is not a certification body for it. Suppliers were already traced by law, but without certification because not considered necessary. The company has brought the certification body to Spain in order to collaborate in line with the project. The same situation and procedure in Greece.

5.2.13 Price

In general, the olive oil price in the market is almost all given by the purchase price of raw material, so the margin is very low (see also figure 58). For this reason, the price fixed by Oleificio Zucchi is the result of what has been remunerated along the supply chain. The larger part of consumers usually buy promoted olive oil. This sector is constantly involved in heavy promotional manouvres, about 80% of the market. The company wants to communicate that also at the supermarket it is possible to find a high quality product. Quality can be undervalued through a policy only based on discounted price. For this reason, Oleificio Zucchi aims to maintain a well-defined price positioning, and to apply very focused promotions in which its olive oil is not vilified. For example, it will never happen to find the product below cost or discounted of 50%. Between list and suggested price there is a gap that is at the discretion of point of sale. Promotions are granted through a contract with it. At perception level, and also as concern selling price, sustainable extra virgin olive oil might be positioned in the middle between BIO (it is not BIO because it does not have the biological certification) and conventional (because it has more specificities). For this reason it is a new product category,

because it answers other needs not covered by the other categories. For example, BIO deals with production process but not with the relations management among supply chain operators. Italian olive oil price has for reference Bari Stock Exchange. Oleificio Zucchi calculates an average between the prices from fluctuations and adds to it a premium value, to justify its project efforts.

5.2.14 Costs

As we can see from the image, here a representation of how the costs have been allocated to launch the project. Budgeting data did not show relevant gap compared to final outcomes, for this reason a comparison is not necessary. Cost categories have been divided for processes:

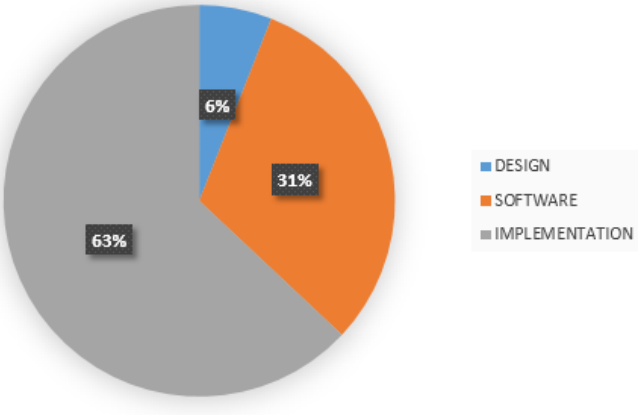


Figure 82: Costs allocation in the last three months of 2016

- **Design**: it includes cost items related to project planning
- **Software**: it includes the development of Portal 4.0
- **Implementation**: it includes elements as indicators computation, certification assistance, training, audits and biodiversity.

The overall investment have an order of magnitude that is around one hundred thousand euros.

Why does the implementation phase have the highest impact? Because the company has to spend especially in audits and biodiversity. External consultants need to be paid every time they are called for an inspection. In the first period (Oct-Dec 2016), according to the disciplinary, there was the necessity to visit the 100% of olive oil mills and the square root of the number farms; during 2017, the square root of olive mills and the 60% of the square root of farms, and decreasing so on. For this reason, the costs related to audits do not increase proportionally to the supply chain enlargement. In this way Oleificio Zucchi avoids to increase every year the inspections, that otherwise could lead the company to an unsustainable situation in terms of costs and efforts.

In terms of technologies and human resources, the only changes concern the introduction of Portal 4.0 and an enlargement in terms of know how. To make laboratory analysis the technological assets remained the same, only the limits concerning parameters changed.

5.2.15 Critical points and difficulties emerged

- Data availability not always immediate
- Data management not always accurate, especially during carbon footprint computation (e.g while electric consumption is easy to know, just checking the bills, water consumption is estimated, because it concerns several agricultural procedures that are harder to be monitored with precision)
- The most critical phases along the supply chain are olive's harvesting and pressing, not so much those one of transportation and storage (that are however very important for ensuring product quality). In particular, among those mentioned, transportations can be considered as the least critical ones, because they are not so long to compromise olive oil properties. Trucks are not thermostated, nevertheless they are constantly kept in controlled conditions (e.g. not exposed for long time to sunlight)
- Difficulties, at the beginning, in recruiting subjects that are willing to share their information with the others. Through this system, the company aims to give value to data, especially those included in farm notebook, that previously were "hidden" from consumers' eyes. At each transfer of information, from one operator to the next, an increasing value is generated. This fundamental concept had to to be explained to every subject
- It is required, from Oleificio Zucchi, a continuous monitoring and control of the operators, to ensure that the good intention with which the project started will be kept over time
- Higher effort from each operator, because of more information to collect

Most of the work, concerning the upload of data on Portal 4.0, has already been done.

5.2.16 Benefits

Since sustainable extra virgin oil started to be distributed on the market in September 2017, we do not have significant data on revenues to draw reliable conclusions and make objective considerations through also numerical results. However, we can make a list to outline the benefits that the company is experiencing and/or hopes to achieve:

1. **Benefits for Oleificio Zucchi**:

    - Higher visibility concerning agricultural and transformation practices
    - Higher stability of supply chain relationships. In fact, the operators have an incentive to maintain them, because of the higher economic return and general increase of value at supply chain level. This means that the message that Oleificio Zucchi wanted to convey among the operators has been got.
    - Better positioning on the market and new brand image
    - Opportunity to create new B2B collaborations , in particular as concern retailers and private labels that believed in the project and in its issues
    - Creation of a close connection with consumer in terms of trust through the information shared

2. **Benefits for consumer**:

    - Possibility to obtain more information on product, in particular as concern origin; environmental, economic, social impact and nutritional aspects

3. **Benefits for the other operators**:

    - Economic value distribution along supply chain, being achieved by premium allocation among all the operators
    - Higher efficiency and creation of improvement opportunities, thanks to data collection. In particular, as regard agricultural practices, having a clear report on consumptions is useful to understand what can be improved. Stricter requirements have not to be seen just as a duty to fulfill, but as an opportunity to increase efficiency and effectiveness. As the spiral of Juran shows (see figure 8), we are talking about a continuous improvement, in which previous experiences are collected, and analyzing deeply their input and output is the way to move closer and closer to best practices
    - Possibility to guarantee fair working conditions, contrasting illegal practices
    - Feeling of working "as a unique team", determined and united by a common scope. Willingness to help each other to grow together

"It is fundamental to trace, in sustainably economic terms, how the product is managed. This will bring a new and different support towards the consumer" (Giovanni Zucchi: Vice-president, Public Affairs & Corporate Development, Oleificio Zucchi)

5.2.17 The floor to an agronomist

During a call interview with Dr. De Palma Floriana, forest agronomist of OP Puglia Olive, related to Unaprol (Union involved in the project with Oleificio Zucchi), some questions have been asked to have another point of view about the case in consideration. In addition to the information already obtained during the interviews in Oleificio Zucchi, from which a coherence with the two supply chain operators has emerged, here some further relevant notions:

- Before accepting the agreement, it has been considered if, among thousands of partners, there was a group of operators that could satisfy the disciplinary requirements (otherwise there was not compliance).
- The commercial agreement included an increase on price, compared to the market average. Considering a highly certified product, it is possible to gain a bonus of about 0.4€/kg compared to the trend of Bari Stock Exchange. The economical gap is comparable and proportional to the operational and documentary efforts.
- The first year of project implementation (2016), the OP just selected the operators that were compliant with the requirements, without the need to take further actions.

- In 2017, after the audits, some measures of improvement were adopted (e.g. fertilizer use reduction, better water management…) and the supply was extended (at the beginning the OPs involved were only 3, now 5).
- From a managerial point of view, it has been asked the effort from all the operators, to provide data in detail (e.g. bills, water consumption information…). Before they were collected in a more limp mode.
- In agricultural context, there can not be standardization (except with a historicity of several years, at least five), because campaigns are not all the same. In fact, production is subjected every year to different external factors (e.g. climate and weather conditions).
- At measurement level, compared with the past, nothing is changed. Therefore, requirements are changed, that now are stricter.
- Until today, no relevant problems emerged. The only one occurred this year (2018), with a non-compliant batch that has been declassified by Oleificio Zucchi.
- The main "critical point" is that the requirements from the disciplinary are wide and several. For this reason, it is necessary an accurate monitoring in each step of supply chain (to avoid product declassification).
- The efforts to be put are a lot, starting from farmers, that are the basis from which start data collection.
- OP receives the data from farms and olive oil mills through paper format. It photocopies, elaborates and uploads them on Portal 4.0. This one, through an algorithm, elaborates all the data and calculates the impact that each operator has within the supply chain (e.g. carbon footprint). In this way, each operator can have an economic overview about its situation, in which, for example, it is possible to see that a production X corresponds to an economy Y because of specific technical choices.
- OP is completely autonomous as concern the compilation of Portal 4.0.
- Portal 4.0 is permanently operable online. Only during the end of 2017 there were small software dysfunctions that were promptly fixed by the company.
- Communications with Oleificio Zucchi are fluid, both via e-mail, phone, and sometimes whatsapp for fast messages.

6. ANALYSIS AND CONCLUSION

After having introduced different concepts, their relevance in the context we live, the existing connections between them, and having made direct experience with a real business case, it is time to sum up the outcome with some considerations.

6.1 ANALYSIS

First of all, let's consider now some managerial tools to analyze our study case.

6.1.1 Social Business Model Canvas

Through Business Model Canvas it is possible to describe the rationale of how an organization creates, delivers and captures value. Since the main values on which Oleificio Zucchi is based are environment, ethic, quality and safety, I found more appropriate to consider a Social Business Model Canvas for having a more complete overview.

<table>
<tr>
<td rowspan="2">KEY PARTNERS:
• 64 Farms
• 5 Olive oil mills
• 5 OPs
• 4 Unions
• Retailers
• CSQA
• Media (RAI)
• Politecnico di Milano
• Legambiente</td>
<td>KEY ACTIVITIES:
• Laboratory analysis
• Refining (Blending)
• Packaging
• Stocking
• Delivey
• Increase awareness of better agriculture practices</td>
<td rowspan="2">VALUE PROPOSITION:
Commercial Value proposition: High quality product, process and leve of transparency
Social Value proposition: Provide safety and healthy food through a traced and sustainable supply chain</td>
<td>CUSTOMER RELATIONSHIP:
• Plant visit
• Sharing information</td>
<td rowspan="2">CUSTOMER SEGMENTS:
• Supermarkets
• Final consumers (e-commerce)</td>
<td rowspan="2">BENEFICARIES:
Direct:
• Operators
• Consumers
Indirect:
• Society
• «Made in Italy» reputation
• Government
• Local communities</td>
</tr>
<tr>
<td>KEY RESOURCES:
• HR, employees
• Facilities of plant
• Portal 4.0 and other softwares
• Skills and experience
• Certification (ISO 22005)
• Disciplinary (DTP 125)
• Training activities</td>
<td>SOCIAL IMPACT AND METRICS:
• Economic sustainability for supply chain operators
• Energy and water consumption reduction
• CO2 footprint impact reduction
• Pesticides usage reduction
• Biodiversity respect</td>
<td>CHANNELS:
• Social media
• Mass media (journals, TV…)
• Website (reports and data)
• Packages with QR code</td>
</tr>
<tr>
<td colspan="3">COST STRUCTURE:
Direct: employees, energy, raw material, quality control (in laboratories), maintenance, transportation, storage, internal and external audits, training activities. Indirect: administration (taxes and marketing)</td>
<td colspan="3">REVENUE STREAM:
• B2B
• E-commerce</td>
</tr>
</table>

Figure 83: Oleificio Zucchi's Social Business Model Canvas

6.1.2 STEEP analysis

Here a STEEP analysis to describe some variables of the context that characterize the external environment in which the company is operating:

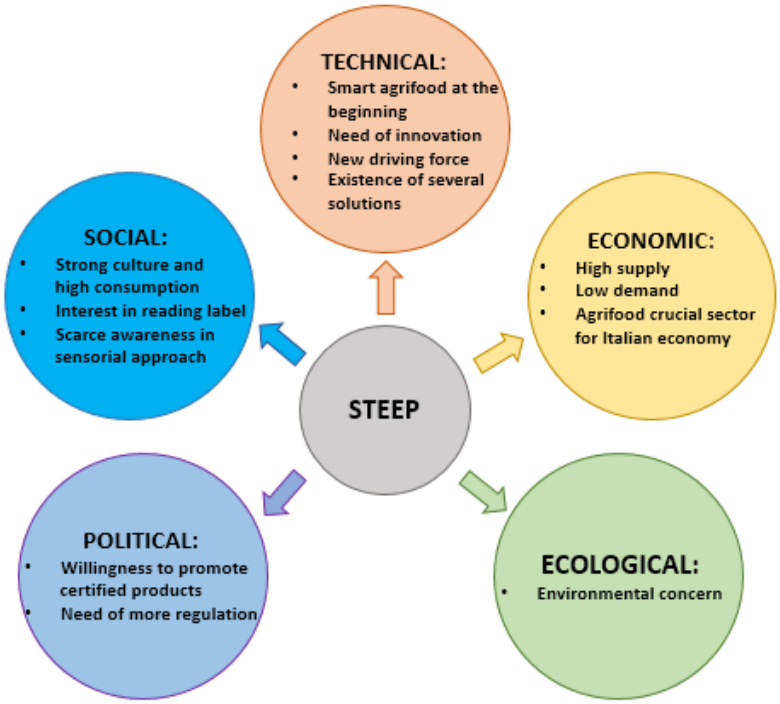


Figure 84: STEEP analysis in the Italian context

1. **Social**: historically speaking, Italians have always had in their culture the tradition of olive oil, that we can consider a must-have concerning their nutrition and cuisine. But today, how much do the consumers believe in extra virgin olive oil? And what do they are looking for? According to a survey, conducted in February 2018 by Doxa on a sample of internal consumers, it emerges that: 72% consume more than 1 liter/month; 44% have 3 bottles at home in the same time; 98% have extra virgin olive oil at home, 68% seed oil, 18% olive oil; the average expenditure is about 5.5 €/liter, while 63% declare to buy BIO oil; 54% choose on the basis of price/promotion: among these, 35% is interested in packaging aesthetic, 80% read the label to make a distinction among the different typologies of extra virgin oil. Considering oil general, 76% read the label, 68% consider very important its origin, 67% consider useful to have indications about the type of usage for cooking. It results a scarce knowledge in terms of sensorial approach and taste differences. In fact, for example, only 19% know that oil acidity is not perceived from taste, while 50% wrongly think that extra virgin oil "is more green and tastes better".

   Furthermore, climate change has already entered in common perception, spreading outside the narrow pool of scientists and climatologists.

2. **Technical**: Smart agrifood in Italy is only just beginning. In 2017 about 300 new businesses started to be run, mainly thanks to a new driving force composed of a lot of young people (under 35), passionate about agriculture world. This one, in our country, strongly needs new energies and innovation. In fact, according to the Osservatorio of Politecnico, only the 1% of the areas under cultivation is actually involved in smart agrifood, that implies about one hundred million euros of investments. More reassuring results, instead, by taking a look at the number of startups: among 481over the world, 12% are Italian.

   "Technological and digital innovation are changing the aspect of modern agriculture, in order to make it increasingly more productive and sustainable. Agriculture entrepreneurs, especially the young ones (i.e. Millennials), are already using digital applications" (Raffaele Maiorano, President of Giovani Agricoltori di Confagricoltura)

   Today, about 70% of business managed by young people is not operating following the old practices of traditional agriculture. New technologies as drones, sensors, 3D maps, Big Data and machinery without driver, allow to get and elaborate external and internal data in a faster and more precise way, optimizing processes.

3. **Economic**: Agriculture 4.0 is a very dynamic market in terms of supply, while not so enhanced if we consider demand, that today in Italy corresponds only the 2.5% of the global one (100 million euros against 3.5 billion). Despite this inertia to innovation, Agrifood is a sector that has to be taken in consideration with strong attention, since the phases of production, transformation and distribution on the whole generate a turnover of about 300 billion euros/year (11.3% of the overall Italian GDP).

4. **Ecological**: in 2015, MiPAAF begun a new plan for olive oil sector, in order to define the strategic objectives for the next five years. One of the point included in the article 4 of DL 51/2015 refers to the intention of qualifying national product with the implementation of procedures based on quality and sustainability.
   Because of climate changes, scarce precipitations put in absolute priority the issue of water saving, that is not anymore only an environmentalists' choice, but a need for farmers that are facing critical situations.

5. **Political**: another point underlined in the article 4 of DL 51/2015 reports the willingness to support the initiatives to give value to "made in Italy" and certified extra virgin oil, also through interventions for promoting the product on the internal and international market.
   According to Stefano Calderoni, President of Cia-Agricoltori Italiani Ferrara, new trade policies are needed, in order to gain the access to new markets. Strategies to give value and reward producers and virtuous supply chains are needed. Politics should have a more active role and remove the obstacles that often do not allow business to run. At national level, a single text on agriculture is needed, in order to be guided in law, simplify bureaucracy, have certainty on contributions disbursement, better protection

for BIO production and regulation on soil exploitation. On national territory, it is necessary to overcome the actual institutional fragmentation; local authorities should support businesses, helping them to grow, with more bureaucratic clarity; minimum service in rural areas are needed (e.g. internet access point).

6.1.3 SWOT analysis

In addition, through SWOT analysis, the aim is identifying both external and internal factors that can be considered relevant to influence the project's success.

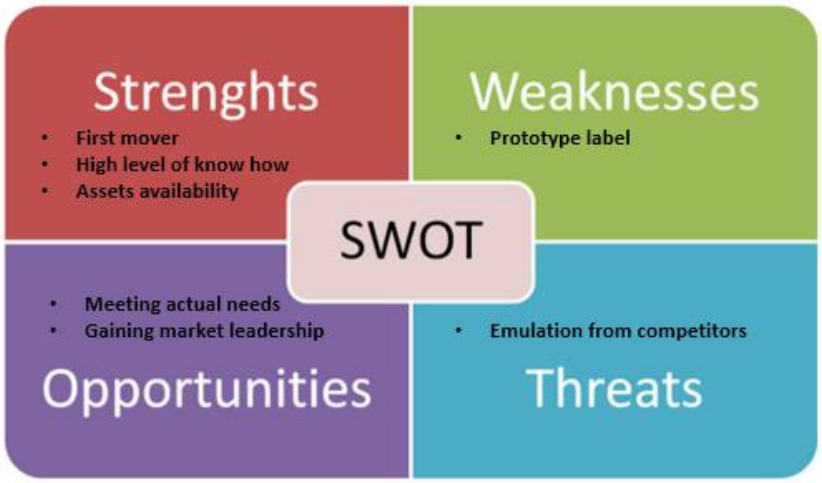


Figure 85: SWOT analysis concerning Oleificio Zucchi

- **Strenghts**: Oleificio Zucchi is the first company, in the olive oil sector in Italy, to introduce a certification that involves all the supply chain operators, paying attention to all the aspects concerning its product (production process, administration, flow of cash). Taking action as first mover, the company gained an advantage on potential competitors that are willing to follow the same strategy. Having been born as a centuries-old company, and not properly as a new startup, it had the time to develop a high level of know how, improve its capability both from a managerial and production (e.g. plant assets, blendmasters) point of view.
- **Opportunities**: actual issues, as the increasing concern about environment (e.g. climate change due to CO2 emission, biodiversity preservation, water consumption) and the need of more transparency through information sharing, are indulged by a product that is intended to defend these values.
  In case of other potential competitors will behave as follower, "imitating" the strategy, Oleificio Zucchi considers the possibility to become the market leader, thanks to the advantage accumulated in these two years**.**
- **Weaknesses**: here the role of communication is crucial. A not sufficiently accurate marketing campaign can lead to an incomprehension from the market, that can perceive the product as one of the many on the supermarkets' shelf. Actually the new label

introduced by the company is still a prototype, and could be modified in the future in relation to the feedback from the market. This is an important aspect that have to be considered with extreme attention.

- **Threats**: in the future other potential competitors (with higher dimensions, budget available, market share and reputation) could put pressure by introducing on the market products able to emulate the performances reached by Oleificio Zucchi. At the moment this is just a hypothesis that is not perceived as a threat by the company.

6.1.4 The project as Blue Ocean strategy

This case is a typical example of differentiation, through the creation of a new product category. Since the company wanted to emerge with something of innovative, avoiding the direct competition with a market already mature and well-consolidated, this can be considered a case of Blue Ocean strategy.

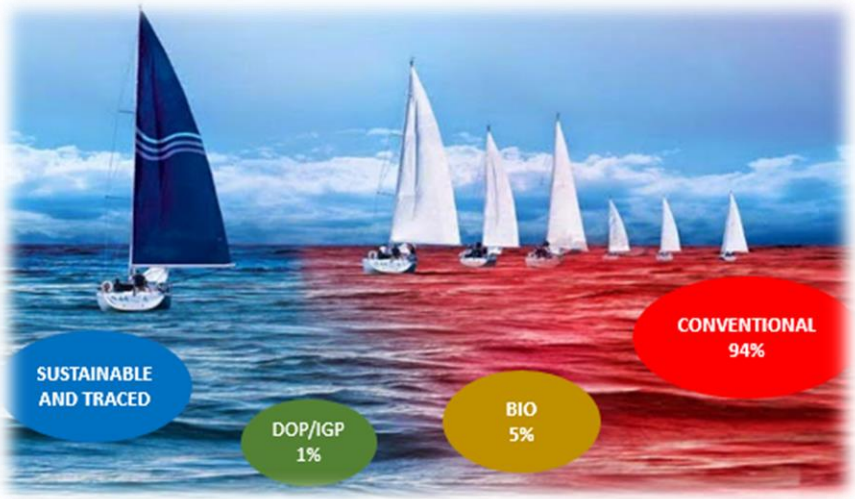


Figure 86: Qualitative positioning in terms of strategy

We can consider as Red Ocean the market characterized by an elevated percentage (94%) of conventional extra virgin olive oil, in which the boundaries are defined and accepted, and the competitive rules of the game are well understood. Moving out more and more towards clearer water, we find BIO (5%) and DOP/IGP (1%), that nowadays still remain a niche, nevertheless on the rise. Oleificio Zucchi's sustainable and traced product is born as an idea for sailing in blue water: in fact, the company has altered the boundaries of an existing market, trying to make the competition irrelevant. It is right here that there are the best opportunities for growing in a more profitable and rapid way.

As an evidence of that, this January, after a pre-selection of innovative products, Oleificio Zucchi's sustainable extra virgin olive oil was "elected product of the year 2018" from a market research carried out by IRi among about 12,000 Italian consumers. To confirm this title, it has been decided to put on packaging the red sticker, as an indicator of excellence for all the customers.

Figure 87: The red sticker "product of the year 2018"

6.1.5 Quality septagon: before and post project implementation

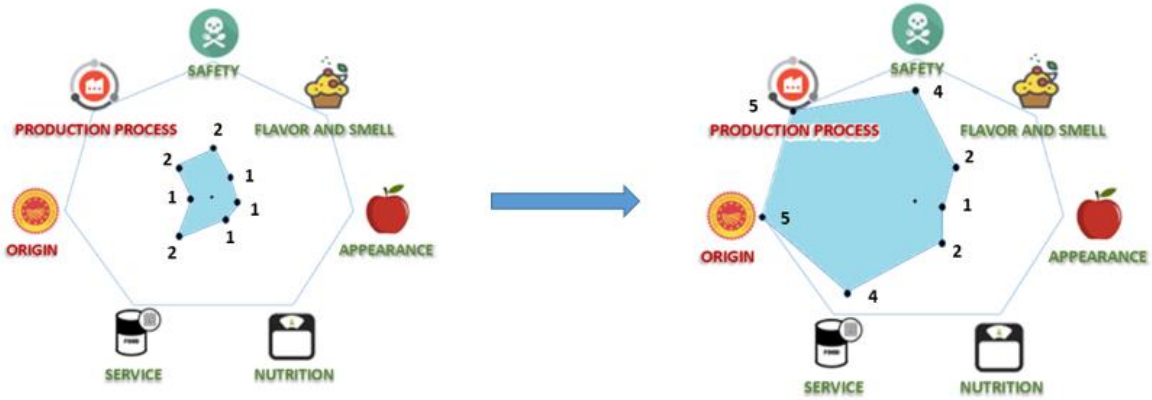


Figure 88: Comparison between the two quality septagons (before and post project implementation)

Considering now the two quality septagons already drawn (see figures 61 and 80), we can make a comparison, commenting the new positioning that the company is aiming to achieve and that leads its strategy of quality:

- **Safety (2 → 4)**: this dimension is considered at the basis of all, the product offered goes beyond the mandatory requirements by law, because of more restrictions defined by disciplinary and ISO 220005, that require to support food safety.

- **Flavor and smell (1 → 2)**: the company is promoting the spread of organoleptic profiles culture, related to its know how in blend techniques, nevertheless it has not defined yet in a rigorous way which are the organoleptic shades of its product

- **Appearance (1 → 1)**: the company does not aim to packaging aesthetic. Moreover, packaging has been voluntary reduced to embrace environmental sustainability, by reducing CO2 emissions

- **Nutrition (1 → 2)**: because DTP 125 introduces the nutritional pillar

- **Service (2 → 4)**: the level of communication towards consumers is higher. For each of the four pillars of sustainability considered by the company, there are information on the website. For example, in that one about nutrition, in addition to the parameters reported on DTP 125, there is also a downloadable report, containing the analysis carried out in laboratory on the production batch from which the product comes

- **Production process (2 → 5)**: very important because related to sustainability. Furthermore, the new traceability system allows a rigorous monitoring of all processes

- **Origin (1 → 5)**: while before traceability followed the standard by law, now the new system implemented, in addition to the identification of farms (ISO 22005 requires a depth with the maximum extension possible), enables the company to reach a very high level of detail

From the assigned values to each attribute, it becomes immediately clear the direction in which the company is moving. In particular emerged a strong willingness to be the guarantor of a product that aims to gain trust from final consumers, respect the environment and also give value to the effort behind it.

6.1.6 Traceability framework

Figure 89: The project and the pyramid of traceability objectives

Considering the pyramid of traceability objectives (see figure 24), we can state that thanks to the support of technology, it has been possible to overcome by far the level of mandatory traceability required by law, passing from a reactive approach (necessary to trace compromised

batches) to a proactive one, generating added value (see in details the benefits, paragraph 5.2.16).

Traceability objectives influence its dimensions:

<table>
<tr><th>System boundaries</th><th>Object of traceability</th><th>Tools</th><th>Data</th></tr>
<tr><td>Internal (Oleificio Zucchi)</td><td>Input and raw material (treatments, olive/semi-finished extra virgin oil)</td><td>Paper documents (farm notebook, bills)</td><td>Identification (data collection, starting from farms)</td></tr>
<tr><td rowspan="2">External (suppliers and buyers)</td><td>Product (sustainable extra virgin olive oil)</td><td rowspan="2">Digital technologies (Portal 4.0, W-Track and other softwares, digitalization of paper documents)</td><td>Management (data extrapolation and transcription)</td></tr>
<tr><td>Processes (production phases; logistic flows; laboratory analysis)</td><td>Transmission (among farmers, agronomists/OP and Union technicians, Oleificio Zucchi and consumers)</td></tr>
<tr><td rowspan="2">Supply chain (from farm to fork)</td><td>Operators (farmers, agronomists/OP and Union technicians; internal employees)</td><td>Systems interconnection (interface creation)</td><td rowspan="2">Validation (internal and external audits, data check and laboratory analysis)</td></tr>
<tr><td>Places (farms, olive oil mills, Oleificio Zucchi's plant)</td><td>Support tools (sensors, drones…)</td></tr>
</table>

Figure 90: Dimensions of traceability influenced by its objectives

6.1.7 Possible future developments

Taking into account the words in red and the arrows of connection of the above table (see figure 90), we can state that technology could impact more on traceability dimensions, improving both efficiency and effectiveness of processes. Here some issues on which it could be possible to open new discussions:

- Paper documents, as farm notebook, could be digitalized and made unique, reducing time, resources and margin of error during data transcription
- A common interface could be developed, guaranteeing the possibility to automatically transfer data to Portal 4.0. This can be taken into account especially in case the supply chain will significantly expand, because the amount of data to be managed will consequently grow.
- Audits phase could be simplified with innovative solutions, reducing the most critical point on cost items
- Introduction of support tools for automatically recording and transmitting data, as sensors and drones on farms' fields. Here some examples of concrete solutions:

1. **Elasian**, Italian startup founded by Damiano Angelici, is a service of precision agriculture aimed to protect olive trees. Every year, on average, 40% of olive oil production is lost, because of the absence of efficient tools. Thanks to a device, able to collect in real time the data on soil, climate, weather forecasts and nutritional needs of the plants, it is possible to obtain and transfer the information to a web platform, and

elaborate them through a database of agronomic researches and historical data. This solution allows to: reduce costs of 20/30%, water consumption of 14% and CO2 emission of 18.5%; increase production of 10/20%; improve the viability of plants and soils.

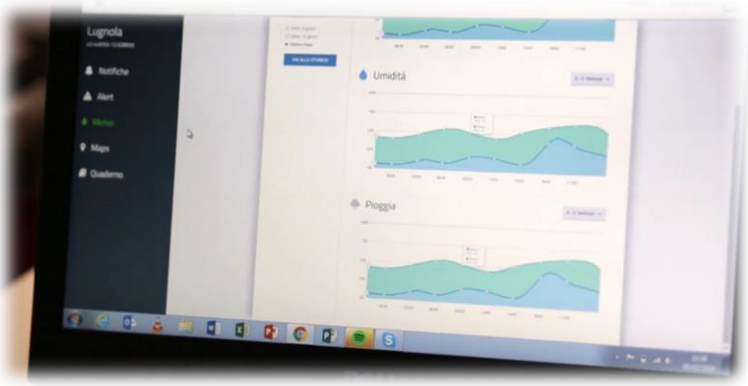


Figure 91: Elaisian platform

2. **XF-ACTORS**, a research project in Europe, has introduced a small sensor, "Tree Talker", that allows to detect and transmit in real time on web the vital parameters of plant. The project was launched in 2017, with the goal of fighting Xylella bacterium, a serious olive trees' disease (spread also in Italy, with a very recent case in Puglia).

Figure 92: The sensor "Tree Talker"

3. **Atlas Experimental Flight Center**, located in Spain, aims to promote the application of drones in the monitoring of olive groves, to improve productivity, competitiveness in agriculture and protect natural spaces.

Figure 93: Atlas drone

6.2 CONCLUSION

Based on what has been described, the context seems to be in favour of a product, just as sustainable and traced extra virgin olive oil, that is trying to answer all the needs required by the market, running into the trends of today and, at the same time, overcoming national issues (e.g. supply chain fragmentation, giving value to "made in Italy"). The analysis of results and on consumers will help the company to understand better how to manage the value given to the information provided.

The role of the digital has proven to be of extreme importance for the project's realization. It has allowed the possibility to:

- Provide online contents for training activities and support for farms
- Improve the communication with final consumers (QR code)
- Collect and elaborate a huge amount of data that, otherwise, would have remained unused.

Data potentially available are a lot, today the big challenge of companies is to understand which to use and how to create value from them.

"*Data are the new petrol"* as, Filippo Renga, Director of Osservatorio Smart Agrifood, has reiterated several times. Personally I believe in this statemement, because knowledge is, for companies, a solid basis from which start to survive in the market. Having as reference what was said, we can go deeper with the metaphor: data are petrol, this one is often "hidden somewhere", exactly as, for example, data included in a farm notebook. Petrol, once detected its position, can be potentially extracted. This operation could require a lot of time and efforts, that can discourage the willingness to take action. While in the past it could be considered an unfeasible mission, today new systems can facilitate its realization. This is exactly what is happening with the passage from old practices, mainly based on data collection on paper format, to new, innovative and constantly evolving technologies, able to simplify and accelerate the processes. Nevertheless, exactly as petrol have to be transformed in something people can use, data need to be elaborated and analyzed in order to be transformed in information that people can use and understand. It is right here, in these procedures, that digital innovations, together with human know how and experience, find a scope.

7. BIBLIOGRAPHY

Treccani (n.d.) Qualità. Retrieved from http://www.treccani.it/vocabolario/qualita/

D. Shingal, K.R. Shingal (2012) Implement ISO9001:2008 Quality Management System: A Reference Guide. Retrieved from https://books.google.it/books?id=61hcoYCx_-UC&pg=PA6&lpg#v=onepage&q&f=false

Sapienza Università di Roma - F.Rieti, A. Sferruzza (2014) Glossario della Qualità. Retrieved from https://www.uniroma1.it/sites/default/files/allegati/Glossario-Sito.pdf

Accredia (n.d.) Glossario minimo della qualità. Retrieved from https://www.uniroma1.it/sites/default/files/allegati/Glossario-Sito.pdf

Università degli Studi di Napoli Federico II – G. Ragozini (2009) Le caratteristiche della Qualità e le sue dimensioni. Retrieved from http://www.federica.unina.it/sociologia/metodi-statistici-per-la-valutazione-dei-servizi/quale-qualita/

Financial Times (n.d.) Definition of hidden needs. Retrieved from http://lexicon.ft.com/Term?term=hidden-needs

Wikipedia (2017) Eight dimensions of quality. Retrieved from https://en.wikipedia.org/wiki/Eight_dimensions_of_quality

Politecnico di Milano - Dipartimento di Elettrotecnica (n.d.) La qualità. Retrieved from http://webuser.unicas.it/misure/MAQ_270/DISPENSE/6_Disp/1_LA%20QUALITA.pdf

C. Bagnaresi – Politecnico di Torino (2007). Sistemi di qualità. Retrieved from http://corsiadistanza.polito.it/corsi/pdf/02FLMDC/capitolo7.pdf

Armand V.Cardello (1995) Food quality: Relativity, consumer and consumer expectations. Retrieved from https://www.sciencedirect.com/science/article/pii/095032939400039X

Klaus G. Grunert (1995) Food quality: a means-end perspective. Retrieved from https://ac.els-cdn.com/095032939500011W/1-s2.0-095032939500011W-main.pdf?_tid=b2660168-0c14-11e8-aa8f-00000aab0f6b&acdnat=1518014547_e616358e85d48f4e53ccec9d38fd6a77

Treccani (n.d.) Tracciabilità. Retrieved from http://www.treccani.it/vocabolario/tracciabilita/

Wikipedia (2018) Traceability. Retrieved from https://en.wikipedia.org/wiki/Traceability

Cambridge Dictionary (n.d.). Traceability. Retrieved from https://dictionary.cambridge.org/it/dizionario/inglese/traceability

P. Olsen, M. Borit (2013) How to define traceability. Retrieved from https://www.sciencedirect.com/science/article/pii/S0924224412002117

T. Moe (1998) Perspectives on traceability in food manufacture. Retrieved from https://www.sciencedirect.com/science/article/pii/S0924224498000375?via%3Dihub

IlSole24Ore (2015) Le frodi alimentari in Italia: dal vino al metanolo ai funghi cinesi i casi più famosi. Retrieved from http://www.ilsole24ore.com/articlegallery/notizie/2013/scandali-alimentari/index.shtml

Wikipedia (2018) Scandalo del vino al metanolo in Italia. Retrieved from https://it.wikipedia.org/wiki/Scandalo_del_vino_al_metanolo_in_Italia

Wikipedia (2018) Bovine spongiform encephalopathy. Retrieved from https://en.wikipedia.org/wiki/Bovine_spongiform_encephalopathy

Wikipedia (2018) Avian influenza. Retrieved from https://en.wikipedia.org/wiki/Avian_influenza

The New York Times (1997) 25 Million Pounds of Beef Is Recalled. Retrieved from http://www.nytimes.com/1997/08/22/us/25-million-pounds-of-beef-is-recalled.html

Il Fatto Alimentare (2013) Milioni di uova biologiche false: l'ennesima frode alimentare fa crollare la fiducia dei consumatori europei. Retrieved from http://www.ilfattoalimentare.it/uova-biologiche-consumatori-germani-olanda-frode.html

European Parliament Research Service (2016) Fighting food fraud. Retrieved from http://www.europarl.europa.eu/RegData/bibliotheque/briefing/2014/130679/LDM_BRI%282014%29130679_REV1_EN.pdf

A. Loi (2004) La tracciabilità degli alimenti nell'UE e negli USA. Retrieved from http://www.areteonline.net/pubblicazioni/linformatore%20agr_n_34_04_la_tracciabilita.pdf

GS1Italy (2016) Fondamenti dei sistemi di tracciabilità nell'agroalimentare. Retrieved from https://gs1it.org/content/public/30/e9/30e9440b-3db2-4ee9-89dc-90df80ccc07d/fondamenti_tracciabilita_2016_-_7.pdf

CGIL (n.d) La Sicurezza alimentare: dal diritto all'accesso al cibo al diritto alla salute e alla qualità. Retrieved from http://www.cgil.it/cgil_attachments/74302_0_040202145839017.pdf

Wikipedia (2018) Precision agriculture. Retrieved from https://en.wikipedia.org/wiki/Precision_agriculture

G. Nicelli (2017) Factory 4.0. Retrieved from the slides of the course Digital Technology (B. Pernici)

CEMA (2016) Farming 4.0 at the farm gates. Retrieved from http://www.cema-agri.org/page/%E2%80%98farming-40%E2%80%99-farm-gates

Agricoltura news (2017) Agricoltura 4.0: di cosa stiamo parlando? Retrieved from http://www.agricolturanews.it/agricoltura-4-0-di-cosa-stiamo-parlando/

A. Rizzi, R. Montanari, M. Bertolini, E. Bottani, A. Volpi (2011) Logistica e tecnologia RFID: creare valore nella filiera alimentare e nel largo consumo

Smithsonian.com (2015) The History of the Bar Code. Retrieved from https://www.smithsonianmag.com/innovation/history-bar-code-180956704/

The Economist (2017) Why QR codes are on the rise. Retrieved from https://www.economist.com/blogs/economist-explains/2017/11/economist-explains-0

RFID Journal (2005) The History of RFID Technology. Retrieved from http://www.rfidjournal.com/articles/view?1338

D.Quaglia (n.d.) Tracciabilità automatica. Retrieved from http://www.di.univr.it/documenti/OccorrenzaIns/matdid/matdid572622.pdf

RFID Soluzioni (2009) RFid o Codice a Barre? Retrieved from http://www.rfid-soluzioni.com/rfid-o-codice-a-barre/

GS1 (2016) Linee guida all'uso del GS1 DataBar. Retrieved from https://gs1it.org/content/public/f1/ea/f1ea0e3e-8c64-44f7-a12d-8dff1788e5f2/lineeguidausogs1databar.pdf

Wikipedia (2018) Blockchain. Retrieved from https://en.wikipedia.org/wiki/Blockchain

A. Chang, C. Tseng, M. Chu (2013) Value creation from a food traceability system based on a hierarchical model of consumer personality traits. Retrieved from http://www.emeraldinsight.com/doi/abs/10.1108/BFJ-11-2011-0286

N. Piciocchi (2009) La qualità degli alimenti. Retrieved from http://www.rivistadiagraria.org/articoli/anno-2009/la-qualita-degli-alimenti/

M.Mattevi, J. A Jones (2016) Food supply chain: are UK SMEs aware of concept, drivers, benefits and barriers, and frameworks of traceability? Retrieved from http://www.emeraldinsight.com/doi/full/10.1108/BFJ-07-2015-0261

FAO (2012) World agriculture towards 2030/2050: The 2012 Revision. Retrieved from http://www.fao.org/docrep/016/ap106e/ap106e.pdf

UniCredit (2017) UniCredit AgriTalk. Event at the seat of UniCredit Tower (Milan)

Osservatorio Smart Agrifood (2017) Lattiero caseario 4.0. Event fair in Cremona

Osservatorio Smart Agrifood (2017) AgriFood 4.0. Event in Politecnico di Milano

Osservatorio Smart Agrifood (2018) Coltiva dati. Raccogli valore. La trasformazione digitale dell'agroalimentare. Event in Politecnico di Milano

GS1 Italy (2016) Iper, La Grande i introduce il GS1 DataBar. Retrieved from https://gs1it.org/content/public/c4/50/c4505a89-9b0e-41b2-82a5-70a095b9fa1f/iper_gs1databar_case-study.pdf

Blockchain4innovation (2018) AgrifoodTech: la filiera del tonno si certifica con la Blockchain. Retrieved from https://www.blockchain4innovation.it/mercati/agrifoodtech-la-filiera-del-tonno-si-certifica-la-blockchain/

Internet4things (2015) Tracciabilità e rintracciabilità: Cà Lumaco usa la IoT dal maialino al salamino. Retrived from https://www.internet4things.it/smart-agrifood/tracciabilita-e-rintracciabilita-ca-lumaco-usa-la-iot-dal-maialino-al-salamino/

Agfundernews (2016) The Challenges 9 Traceability and Food Safety Technology Startups Face in Disrupting the Industry. Retrieved from https://agfundernews.com/the-challenges-9-traceability-and-food-safety-technology-startups-face.html

Ismea Mercati (2017) La scheda di settore: Olio d'oliva. Retrieved from http://www.ismeamercati.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/3523

Oleificio Zucchi (2018) Storia. Retrieved from http://www.zucchi.com/storia/

Oleificio Zucchi (2018) Marchio e valori. Retrieved from http://www.zucchi.com/marchio-e-valori/

CSQA (n.d.) ISO 22005. Retrieved from https://www.csqa.it/CSQA/Norme/Sicurezza-Alimentare/ISO-22005

CSQA (2017) Disciplinare Tecnico - DTP 125. Retrieved from a meeting in Oleificio Zucchi

D. Ferrucci (2014) I sistemi di rintracciabilità secondo la norma UNI EN ISO 22005:2008. Retrieved from http://www.rivistadiagraria.org/articoli/anno-2014/i-sistemi-di-rintracciabilita-secondo-la-norma-uni-en-iso-220052008/

EUR-Lex (2017) Autorità europea per sicurezza alimentare (EFSA) – garantire alimenti e mangimi sicuri nell'UE. Retrieved from http://eur-lex.europa.eu/legal-content/IT/TXT/?uri=LEGISSUM:f80501

Wikipedia (2018) Particella catastale. Retrieved from https://it.wikipedia.org/wiki/Particella_catastale

PastaGarofalo (2018) Olio Extra Vergine d'Oliva. Retrieved from http://www.pastagarofalo.it/it_it/i-prodotti/non-solo-pasta/olio-extra-vergine-di-oliva/olio/

AgroAlimentare News (2018) L'olio extravergine ottiene la fiducia dei consumatori italiani. Retrieved from http://www.agroalimentarenews.com/news-file/Gli-italiani-credono-nell-olio-extravergine.htm

01net (2018) Lo smart agrifood italiano è appena agli inizi. Retrieved from http://www.agroalimentarenews.com/news-file/Gli-italiani-credono-nell-olio-extravergine.htm

Tgcom24 (2017) I giovani rivoluzionano il lavoro della terra, in agricoltura ora usano i droni. Retrieved from http://www.tgcom24.mediaset.it/na/i-giovani-rivoluzionano-il-lavoro-della-terra-in-agricoltura-ora-si-usano-i-droni_3116275-201802a.shtml

La Repubblica.it (2018) Agrifood 4.0, le tecnologie ci sono ma il mercato non decolla. Retrieved from http://www.repubblica.it/economia/rapporti/osserva-italia/le-storie/2018/01/29/news/agrifood_4_0_le_tecnologie_ci_sono_ma_il_mercato_non_decolla-187548188/

Agricolae (2016) Piano di settore olivicolo-oleario 2016. Retrieved from http://www.agricolae.eu/wp-content/uploads/2016/03/pianolivicolotesto1.pdf

Italiafruit (2018) Cia Ferrara chiede il testo unico sull'agricoltura. Retrieved from http://www.italiafruit.net/DettaglioNews/42818/mercati-e-imprese/cia-ferrara-chiede-il-testo-unico-sullagricoltura

Agronotizie (2018) Agricoltura digitale e acqua: strumenti per il risparmio idrico. Retrieved from https://agronotizie.imagelinenetwork.com/agricoltura-economia-politica/2018/01/09/agricoltura-digitale-e-acqua-strumenti-per-il-risparmio-idrico/56998

Oleificio Zucchi (2018) Un riconoscimento per il nostro olio. Un premio per tutta la filiera. Retrived from http://www.zucchi.com/magazine/news/un-riconoscimento-nostro-olio-un-premio-tutta-la-filiera/

I.Bengo (2017) 2017_Business in transformation Lab_Esercitazione_final. Retrieved from the slides of the course Business in Transformation: Social and Sustainability Challenges Lab (I.Bengo)

H. de Bruijn (2017) Decision Making in Complex Systems. Retrieved from the slides of the course Business in Transformation: Social and Sustainability Challenges Lab (H.de Bruijn)

A. Rangone (2012) Strategic innovation. Retrived from the slides of the course Marketing and Strategy

L. Ramundo (2017) The food challenges. Retrieved from the slides of the course Business in Transformation: Social and Sustainability Challenges Lab (L.Ramundo)

Elaisian (2017) Chi siamo. Retrieved from https://www.elaisian.com/

Xfactorsproject.eu (2017) About the project XF-ACTORS. Retrieved from http://www.xfactorsproject.eu/

CMCC (2017) Xylella: ecco il sensore che fa parlare gli ulivi. Retrieved from https://www.cmcc.it/it/scienze-ambientali/xylella-dalla-ricerca-cmcc-ecco-il-sensore-che-salvera-gli-ulivi-del-salento-2

Ansa.it (2018) In Puglia 3100 ulivi positivi al batterio Xylella. Retrieved from http://www.ansa.it/canale_terraegusto/notizie/mondo_agricolo/2018/04/04/xylella-puglia-3100-ulivi-positivi-al-batterio_cf32d3bf-9115-4624-bbe7-7f777e0a676b.html

Olive Oil Times (2017) Drones carry Spanish producers into the Next Era of Olive Farming. Retrieved from https://www.oliveoiltimes.com/olive-oil-business/drones-olive-farms/58796

Oleificio Zucchi (2018) Tracciabilità: scopri da dove arriva il tuo olio. Retrieved from http://www.zucchi.com/tracciabilita/

RINGRAZIAMENTI

Vorrei ringraziare il professor Alessandro Perego, relatore di questa tesi di laurea, oltre che per le interessanti nozioni fornitemi durante il suo corso di Logistics Management e il suo esemplare rigore e passione nell'insegnamento, per avermi messo in contatto con l'Osservatorio Smart Agrifood del Politecnico di Milano. Ringrazio il direttore Filippo Renga e la dottoressa Chiara Corbo, che si sono mostrati sempre disponibili durante tutto il percorso intrapreso, e che mi hanno dato la possibilità di portare un piccolissimo contributo alle loro ricerche su un mondo davvero affascinante e di una complessità enorme. Ringrazio inoltre il personale di Oleificio Zucchi, a cui auguro il successo meritato.

Esprimo anche un profondo ringraziamento a: la mia splendida famiglia, per il supporto datomi in questi anni, e per aver avermi sempre lasciato inseguire i miei sogni (nonostante le mille difficoltà); Bianca, la mia ragazza, una persona più unica che rara; Matteo, Camilla, Elisa, Andrea e Nicolò, cari amici con cui sono cresciuto; Digio, Nik, Franciccio e Simo, che mi hanno fatto passare delle avventure spaziali; Michi, JJ e Ziva, miei compagni di università e partite serali; i miei compagni di business game: Luigi e Lud, del formidabile team "The Asylum"; tutti i miei amici della CDG, che sono troppi e a cui voglio molto bene; i miei maestri di thai boxe e pugilato, che mi hanno insegnato a non mollare mai; il mio team delle serate cinema, un pubblico formidabile; gli amici dell'uesm di Milano.

Un sincero ringraziamento a tutti coloro che, in un modo o nell'altro, hanno arricchito la mia vita, in particolare a te nonna Pia, che ogni giorno sei nei miei pensieri e nel mio cuore.

Luca