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Traceability system of olive oil: a case study based on the performance of a new software cloud

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Abstract. For all the European agrifood establishments from the year 2005 it became mandatory the Regulation EC 178/2002 which obliges them to implement an internal system for tracking and tracing (T&T) of the products; the Regulations that has introduced an 'obligatory route' that consists of the construction of the 'certified historic' of a food or an ingredient along the supply chain. The Regulation concerns all food companies and in particular those in which there are different actors that contribute to obtaining the final product as in the case of the supply chain of olive oil.
Informatics with modern technology allows us to provide the company with a software solution, usable as a web application, everything housed on a system cloud server. The project goal was to implement a WebApplication based on Cloud Platform and centralize all information about to the context of the production of olive oil.
The results showed that the centralization of data provided by the software in question permit the various figures of the supply chain of olive oil to collaborate in an environment where you get all the information in real time. The system implements algorithms that provide notification messages that indicate if there are any delays in production/processing in terms of quality of the olive oil sought.
The operators and final customer will be equipped with an APP free for smartphones, which allow you to detect in a simple and immediate all data (in synchronize with the cloud system) and to get the product TRACEABILITY.

Key words: Traceability, safety, quality, olive growing, oil.

INTRODUCTION

Traceability is considered today a crucial factor for the agrifood sector (Papetti et al., 2012; Costa et al., 2013). The specific definition of traceability within the agricultural framework of the agrifood domain as it can be found on the OnTrace (2007), refers to it as 'The ability to locate an animal, commodity, food product or ingredient and follow its history in the supply chain forward (from source to consumer) or backward (from consumer to source)'. Food traceability implies the control of the entire chain of food production and marketing, allowing the food to be traced through every step of its production back to its origin (Holm et al., 2007; Ampatzidis & Vougioukas, 2009). The verification of food traceability is necessary for the prevention of deliberate or accidental mislabeling, which is very important in the assurance of public health. Thus, several regulations provide the basis for the assurance of a high level of protection of human health and consumers' interest in relation to food. In the case of olive oils, the increase in the demand for high-quality olive oils has led to the appearance in the market of olive oils elaborated with specific characteristics (Zohreh & Sattar, 2012).

The present study highlighted that, in spite of the requirement to enforce the above EC regulation 178 by January 1st, 2005 (subsequently extended to January 1st, 2006), a poor attention is still attached to the issue of traceability at a community level where many gaps still remain in terms of information on such systems. The Regulation is joined by other provisions, the publication of which is optional, among which the UNI, EUREPGAP and similar, which define the tracking company and/or the supply chains in different level of detail. All this in order to guarantee the food safety, optimize and adapt the production chain in case of problems or risks. Concerns all food companies and in particular those in which there are different actors that contribute to obtaining the final product as in the case of the supply chain of olive oil.

In Italy, one of the main agricultural crops is represented by the cultivation of olive trees. Olive cultivation characterizes the Italian agricultural landscape and national agricultural economics (Proto & Zimbalatti, 2010). Italy is the world's second largest producer of olive oil. With about 3,300,000 tones, Italian production of olives is situated at the second place in Europe after Spain. Three regions in southern Italy account for 66% of Italian olive production. Puglia is the most important region with approximately 373,980 ha, followed by Calabria (approx. 185,914.68 ha) and Sicily (approx. 141,810 ha) (ISTAT, 2010–2012). The total production of olive oil in these three regions accounts for approximately 73% of national production (Proto & Zimbalatti, 2015). The high economical value assumed by such cultivation in the territories where it is spread justifies the numerous researches aimed to solve problems related to the production. The main one is represented by olives harvesting and its economical and management aspects (Abenavoli & Proto, 2015).

The objective of this work is to illustrate the Software Cloud of tracking and tracing (T&T), denominated '*TraceOil*', made by the Department AGRARIA – University Mediterranea of Reggio Calabria, in the context of a regional research project. In fact, 'S.I.F.OLI.O. – System Innovative for the quality of the OLIve growing and Oil production' is a regional project funded by PSR Calabria 2007–2013 (Calabria's Rural Development Programme) under Project Action 124: 'Cooperation for development of new products, processes and technologies in the agriculture and food sector and the forestry sector'. This project set up a partnership between farms, cooperatives, and Department AGRARIA in the Calabria region to improve the use of system of traceability in the olive growing/olive oil production and supply chain.

It has relied on a preliminary in depth territorial survey meant to select those olive growing farms considered to be a representative sample of the olive-growing reality in the area under study. The above survey has been followed by the analysis of the different processing phases which envisage one or more operations: from in-field olive harvesting operations to oil mill olive handling and processing (Abenavoli & Sciarrone, 2006; Sciarrone et al., 2006; Abenavoli & Sciarrone 2008; Giametta & Sciarrone, 2009).

MATERIALS AND METHODS

The main objective of a traceability system is therefore to accurately access the history and the location of the different products along the supply chain (Dabbene & Gay, 2011).

Informatics with modern technology allows us to provide the company with a software solution, usable as a web application, everything housed on a system cloud server. The centralization of data provided by the software in question permit the various figures, such as food technologists, primary producers, oil millers and bottlers, and laboratories, to collaborate in an environment where you get all the information in real time. The system implements algorithms that provide notification messages that indicate if there are any delays in production/processing in terms of quality of the olive oil sought. The operators will be equipped with an APP for smartphones 'Android' and 'iOS', which allow you to detect in a simple and immediate all data and synchronize with the cloud system. Similarly to the final customer will be provided, through the Store 'Android' and 'iOS', a free APP that allow you to get the information and product traceability. The project goal was to implement a WebApplication based on Cloud Platform and centralize all information about to the context of the production of olive oil, from the field to the bottle, focusing the most critical phases affecting production costs and on the quality of the final product: for instance the harvesting phase (together with the pruning) is the operation more expensive and that most affects the quality of olive oil made (Abenavoli & Marcianò, 2013; Abenavoli & Proto, 2015).

Especially are implemented the data relating to (Fig. 1):

- Olive harvest with various methods;
- Processing inside the oil mill of olives harvested;
- Data Mining on data acquired and analysis about distribution of plants and products;
- Creation of a unique code about working process and harvest process;
- Traceability of the information from the primary producer to the consumer and contrariwise.

The information gathered by the traceability system shown become strategic when, in the unfortunate case, a product batch must be recalled. Indeed, beyond the media impact of this action, the firm has to bear the costs involved in withdrawing from the destruction of all products which are, in some way, connected with the offending batch. Currently, however, most of the firms does not have reliable methods to accurately estimate the amount of product that must be eliminated in case of a recall (Dabbene & Gay, 2011).

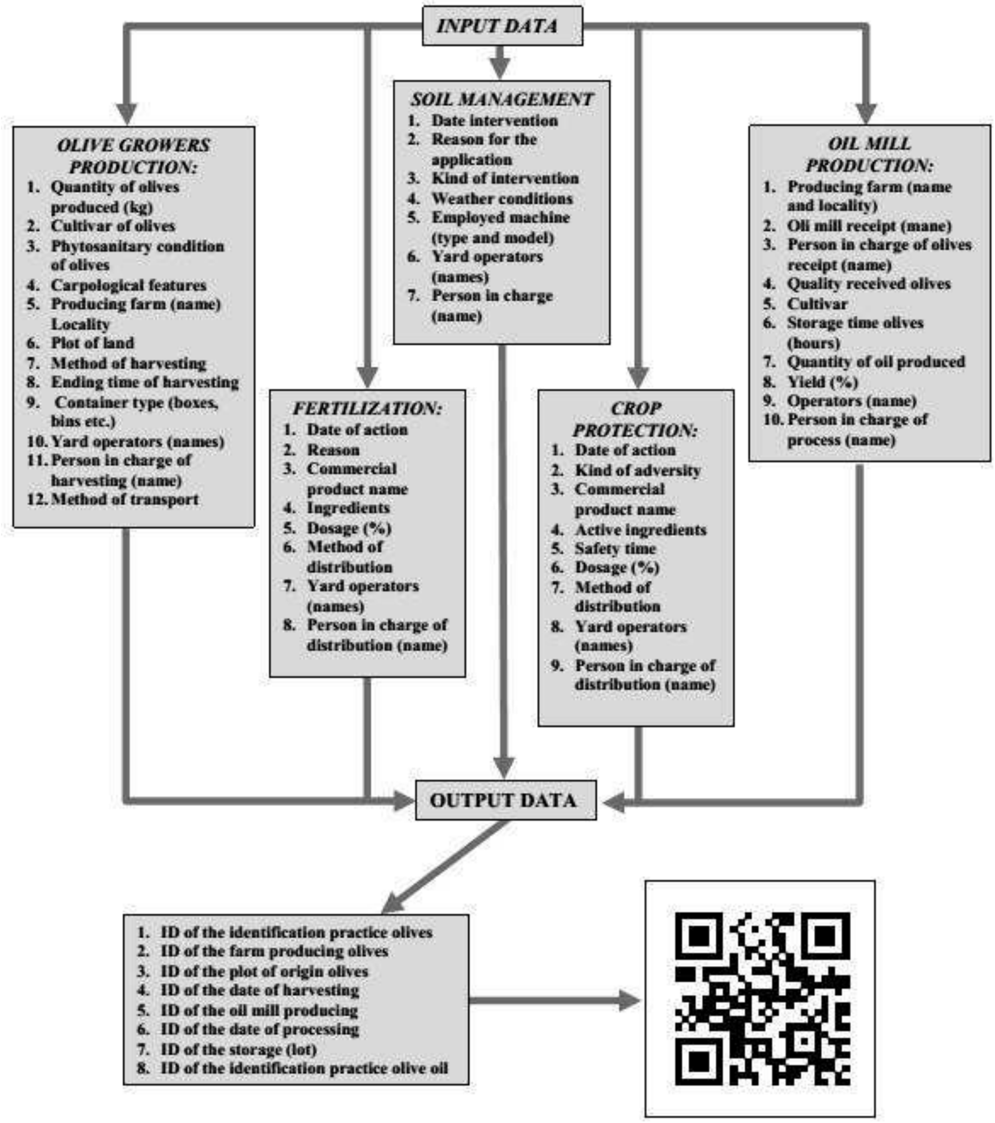

Figure 1. Model of data implementation used in the olive-oil processing chain.

RESULTS

Traceability Software

The centralization of information provided by the WebApplication allows to the actors of system (primary producer, oil mill and laboratory) to collaborate on an real time environment. The WebApplication implements a series of algorithms to provide various notification messages about the phases. The technologies/languages used to create the WebApplication are the most innovative in computing:

- The client side uses AngularJS and Material Design by Google as well as JavaScript;

- The server side uses one of the most important JavaScript framework NodeJs that has given guarantees of stability;
- While on database side, we use a NoSql database like MongoDB with high performances;
- The cloud system is very stable structure that implements a vertical scaling system.

The software '*Trace Oil*' is based on a Cloud platform that allows the scaling of the system where necessary. '*Trace Oil*' is developed for the server side with Nginx HTTP server, platform and NodeJS MongoDB; while for the client it requires the creation of a web application that is based on AngularJS (Fig. 2). It will be considered using a SSL security certificate.

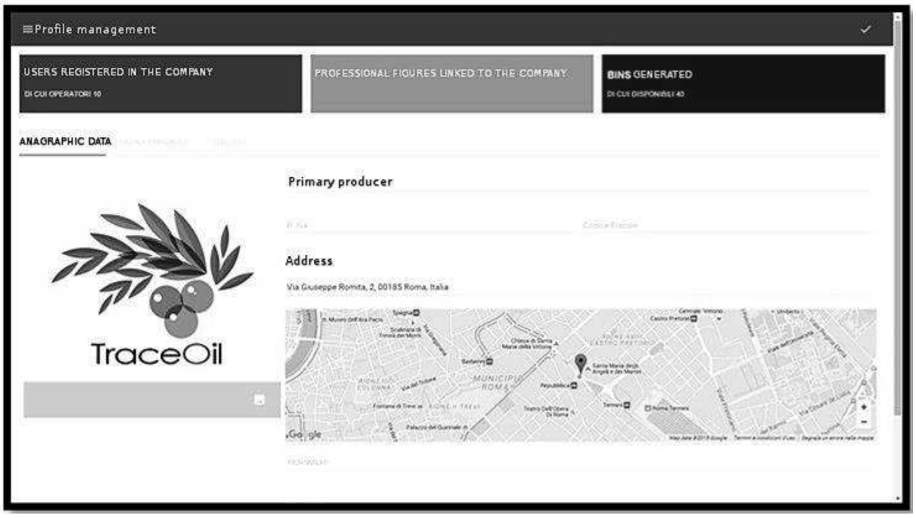

Figure 2. Farms management area of the 'TraceOil' software.

The parts of the software are subdivided in three areas:

1. Web Application.
2. Mobile Operator App and Mobile App End User.
3. Web Application (hosted on the Cloud platform).

The web application is the actual control software and interaction that allows the management of all aspects of entry and search and the implementation of operational procedures to guide subscribers. In terms of functionality and parts it is structured as follows:

- *FrontEnd*, from here you can access through login to the back office (BO) and shall provide the visitor with all the necessary information to join the system 'Trace Oil'. It will have to be present in addition to basic information, a registration form and a link to a system LOGIN;
- *BackOffice*, from here after having logged in you will have access according to the type of user to work area;
- *Login* with multi-level access that allows administrators to manage permissions of the various areas of the software. This system must include the possibility to set permissions and groups for modules and functionality of the system.

The users of the software will be divided into categories as follows:

- *Administrator*: Users can access any functionality of the system, with ability to manage permissions for all other users;
- *Oil mills*: Members who deal with stages of product processing. They can manage the system by creating access for their employees by setting the JOB or action to be followed, based on the features of the olives to be processed, and which will be available in the app operator indicated in the document;
- *Employees/Operators mills*: Members who work as employees of the oil mill;
- *Olive farms*: actors involved in the harvest phases of the product and they have access only to that stage. They can manage the system by creating access for their employees by setting the JOB to be followed, based on the features of the olives to be picked, and which will be available in the app operator;
- *Workers of olive farms*: Users who work as employees of the company mentioned above;
- *Agronomist*: Users represented by professionals who want to give advice to companies with which they have a working relationship. Such users only have access to information as a common generic data or data of the following companies with the possibility to follow the production steps in the detail of each JOB of the same companies.

For each of these categories will be possible to set the mode of access to every area of BackOffice, including ability to hide access to a module, or it visible only have full control of the same. Moreover, the various features mentioned will be managed according to the access level set to the user. The system adopted allows to describe and document organization, methodology, techniques and tools utilized to plan and monitor activities. Information on all products can be processed and transferred into barcode labels or, via the web, onto customized collective portals.

A computer system is presently being developed which is expected to:

- coordinate the flows of information on farming chains traceability;
- allow the backtracking of each individual lot of produce;
- indicate the accompanying documents (QRcodes included) required to identify the lots in question;
- SSL Certificate to the security of information exchange;
- manage the chain logistics (travel of the traced lots across the various operators);
- generate QRCode printable be affixed to the container of the final product (bottle or other) (Fig. 3);
- exporting the Job in JSON format to read and use on most platforms;
- log of operations performed on the system by the various actors and can be exported in text format.

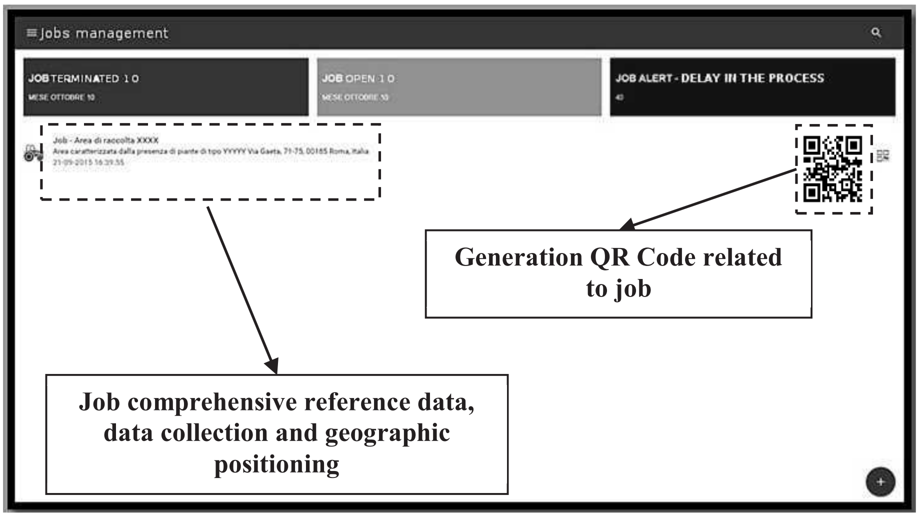

Figure 3. Jobs management area of the 'TraceOil' software.

One of the major criticalities in the model of traceability under study occurs at the time of raw material (olives) processing at the oil mill where sometimes olives can mix with other non-traced olives, i.e. drupes with different features that can happen to mix with more valuable lots. Therefore this software allows you to generate directly during harvesting phase a QRCode printable for each container (bin, crates, etc.).

Android application allows the user to perform the following tasks:

- Password access reserved to identify the operator;
- Ability to work without an internet connection and subsequent data synchronization;
- Entering the QRCode in the container in which they are harvested olives (Fig. 4);
- Geolocation of the collection point based on the GPS or through a manual insertion;
- Load up to 5/10 photos/files attached to show the detail information or details necessary.

Figure 4. Starting the 'TraceOil' software through smartphone.

After data input, the software processes a QRCode which encompasses all the data of the product, from the lot of origin to the oil mill processing operations as required by the model shown in Fig. 1. This allows for a rapid data scanning and acquisition by smartphone. After deciphering the code pass the information on the Cloud platform where it is displayed the software. The platform, which is structured in an user friendly format, can be exported to other databases containing real-time updated information to be processed, printed or published in the web. The reliability of the mathematical model used for the determination of the lot described in the previous sections has been tested on the basis of the data collected during the two-year period 2014–2015 at the olive growing farms under study. More specifically, the data collected during the above period concerned harvest operations which are considered to be crucial to the transit of information (in terms of both data implementation and transmission) from the olive growers and the oil mill.

Regarding the estimated costs of TraceOil System, these can be divided into two groups: cloud management (including maintenance and security updates) and management accounts (primary producers, analysis laboratories, oil mills, etc.). The first ones are constant up to 20,000 users, are about € 300–500 plus taxes; while the costs of accounts vary according to their numbers, and are about € 1.7 per month to around the 100 users over the 1,000 down to € 0.99.

CONCLUSIONS

This study, therefore, is focused on the analysis and the use of both tracking and tracing systems of olive and olive oil products throughout the entire territory of Calabria. The present study has been based on an in-depth analysis of the area under consideration in a view to identifying some farms typical of the territory in question. The different steps of olive processing have been analyzed, from olive harvesting to olive processing at the oil mill (Giametta & Sciarrone, 2009). The software in question has been implemented mainly to respond to the requirements of EC Regulation 178 of January 28, 2002 which set forth the principles and requirements of EU food law. Thanks to this project many farms have improved their production, starting in some cases also T&T, and they have introduced more sustainable management practices (Proto et al., 2014). Cooperation between institute of research, cooperatives, farms and the university was crucial to assess the needs for intervention. The network established among different actors along the supply chain has helped to give more safety and quality in the olive growing/olive oil production. The use of the software '*TraceOil*' enhances the typical products, accompanied by the rigorous and complete application of high quality standards, excellent presentations and various assortments (Bernardi et al., 2013). The introduction of system T&T such as that analyzed in this study, can certainly contribute for the accomplishment of cited objectives with suitable features for olive-oil supply chain.

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