



# Traceability as a strategic tool to improve inventory management: A case study in the food industry

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## ARTICLE INFO

Available online 22 August 2008

### Keywords:

Traceability  
Supply chain  
Innovation

## ABSTRACT

Our aim in this research is to show that traceability can become much more than just a way to guarantee food safety. To illustrate this idea, we have developed a longitudinal case study of one firm in the Spanish vegetable industry. We show the reasons why this firm decided to implement a computerised traceability system, and we describe how the use of its traceability system has provided them with many qualitative and quantitative advantages along the different stages of their supply chain, their manufacturing operations and their inventory and logistics activities.

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## 1. Introduction

Traceability is defined by the American Production and Inventory Control Society (APICS) as “the registering and tracking of parts, processes, and materials used in production, by lot or serial number”. This definition is quite broad, although in the food industry is a concept that has been basically related to as a mechanism to assure food safety. In fact, in the ISO 9000/BS 5750 traceability is defined as a quality procedure referred to as the ability to retrace steps and verify that certain events have taken place. Traceability is nowadays a requisite in the food industry. In fact, as of January 2005, the European Union requires that all food firms must trace their products, in all stages, beginning with suppliers until the arrival of the end products to the final consumers.

Our aim in this paper is to show that traceability may become much more than just a mechanism to assure food safety. In order to do this, we have developed a longitudinal case study of one firm in the vegetable industry. We have analysed the impact of their computerised traceability system on inventory management, and on

the rest of the organisation. We have found among other outcomes that the firm has improved the management of their inventories through a better use of warehousing space; reduced handling costs; decreased inventory level; and minimised errors related to the whole production and logistics processes.

This paper consists of six more sections: first, a review of literature related to traceability (Section 2); then, we describe the firm (Section 3), and then the methodology (Section 4) we have used; in Section 5, we study the reasons why and the way in which the firm implemented their computerised traceability system; then, in Section 6, we show the qualitative and quantitative benefits obtained; and finally, we summarise conclusions and present some venues for future research (Section 7).

## 2. Traceability in the literature

With the purpose of finding how traceability has been studied in the academic literature, we have made an examination of published articles related to this concept. We have identified three main areas: firstly, the one that describes traceability as a mechanism for food safety; secondly, the set of articles that deals basically with the problems organisations must cope with when implementing traceability; and finally, the area in the literature that portrays traceability as a source for firm differentiation.

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With regards to the first viewpoint, *traceability as a guarantee of food safety*, traceability is a concept whose relevance for media and consumers is given by its relationship to food safety. In this sense, many firms use their traceability systems as a promotional device in order to show the reliability of their food safety procedures. Gellynck et al. (2006) focus on the effect of information about meat safety procedures on consumer trust using data collected in Belgium. A similar study was carried out in France by Latouche et al. (1998). They find that consumers demand a greater transparency on food safety and that they are willing to pay for it. In the UK, Northern (2001) shows empirical evidence that supports the hypothesis that industry-led farm assurance schemes, such as traceability systems, are indeed used by large multiple food retailers as a credible signal of food safety. Dimara and Skuras (2003) define traceability as an extrinsic quality evidence. The authors demonstrate that traceability and the use of certificates of origin influence consumer evaluation.

Regarding the second issue, *mechanisms to implement a traceability system*, Cheng and Simmons (1994) analyse traceability in manufacturing systems. They conclude that a good traceability design sets out to provide the right amount and form of information for the appropriate level at an acceptable cost. Tracing functions include detecting and measuring, two key activities in any manufacturing system. In this sense, Jansen-Vullers et al. (2003) propose an approach to the design of information systems for traceability based on graph modelling. Using traceability of products cultivated by farmers as an example, Dióspatonyi et al. (2000) stress that one of the problems associated with an accurate traceability of raw materials is the recollection of exact documentation. To solve this problem, they design a number of simple tools and create several test applications running on different database systems. Sohal (1997) carry out a case study in which he describes a number of factors critical to the development and implementation of a traceability system in an automotive parts manufacturer. Those are, basically, the need of top managers to have a clear understanding of Computer Integrated Manufacturing (CIM); a multidisciplinary team approach to problems; a smooth relationship between software vendors and users; and the appropriate training of the personnel-related implementing and running such a system. Finally, we have also found papers, such as the one written by Pinto et al. (2006), which analyses the use of specific TIC's as mechanisms for traceability in the food industry.

Concerning *traceability as a tool for differentiation*, Fisk and Chandran (1975), for example, give five reasons why a company can use traceability as a source of competitive advantages: firstly, as a mechanism to solve possible product safety problems, something that can be used to demonstrate that quality control systems work to protect customers before and after products are sold; secondly, as a way to provide a good-faith legal defence in many product liability cases for a company; thirdly, traceability may improve manufacture's understanding of its distribution systems; fourthly, a traceability system can enable the manufacturer to keep in touch with their consumers;

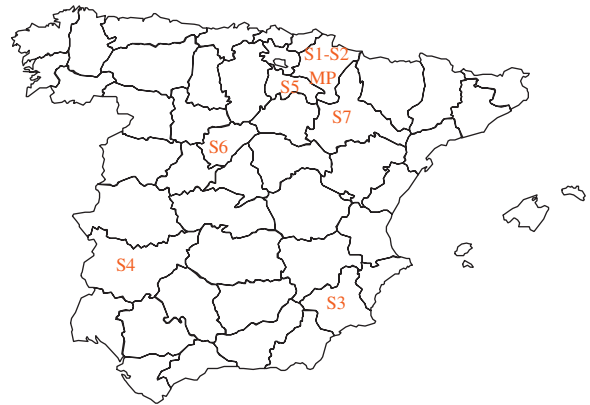


Fig. 1. Supply plants (S) and main plant (MP) of FF.

and, finally, the traceability systems may supplement quality controls made in laboratories because the findings of test programs, in conjunction with field usage studies, can be valuable in developing better products in the long run. For the authors, undoubtedly, there are costs involved in establishing and maintaining a traceability system, but those ones can be a bargain compared with the overhead of, for example, bringing back default products previously distributed in the market. In a recent article, Rábade and Alfaro (2006) analyse buyer–supplier relationship's influence on traceability implementation in the vegetable industry, and show the way traceability helps to reinforce the degree of coordination in the supply chain.

After this review, two obvious questions arise: where does our research fit and what does our paper add to the existing literature on traceability? Answering both questions, we must say, first, that our paper builds on those articles aimed to show the way traceability can be used as a source of competitive advantages; and, second, that we analyse an industry, vegetable products, and a country, Spain, which, to the best of our knowledge, have not been studied before in the traceability literature.

### 3. Description of the firm

FF<sup>1</sup> began its activities in 1984 as a small family firm dedicated to the production of canned vegetables. Presently, the company's business includes the manufacturing, packaging and commercialisation of products consisting of a wide assortment of frozen vegetables. The variety of finished products is extremely extensive, as well as the packaging, which varies from 50 grams plastic bags to containers of more than 1000 kg, depending on customer specifications. The most important raw materials used by the company are green beans, peas, peppers, broccoli, potatoes and carrots. The volume of sales rose from 18 million Euros in 1995, to 151.25 million Euros in 2006, year in which the firm processed 180,000 tons of vegetables, and employed 326 people.

<sup>1</sup> FF is not the true name. The firm whose activities we describe has asked us to remain anonymous.

FF has eight manufacturing facilities located throughout Spain, as shown in Fig. 1. Of them, seven factories are located near by the regions where the vegetables are harvested, selected, cut and frozen. Each of these factories specialises in a number of crops, something that minimises the supply time, thereby avoiding spoilage as well as low-quality problems in the raw materials. Besides, the geographical dispersion of these production centres allows an extension of the harvesting epochs for the different vegetables they work with. FF has a plant located in Northern Spain where the company has its headquarters; this industrial unit operates as a packaging and distribution centre, manages all quality procedures, and executes all the marketing activities for the firm.

The whole manufacturing process, in which FF is involved, begins with the scheduling of production needs and ends with the delivery of final products to the customer (retailers or food firms). This entire process is shown in Fig. 2.

This process denotes the complexity of implementing the tracing system in a firm like FF. In the stages A1–A3, FF estimates and schedules the needs for the incoming year. After this, in A4, the firm chooses each of the suppliers. The set of decisions that must be taken from A4 to A8 encompass suppliers' (farmers') activities. FF works, together with farmers, to determine where to cultivate and what kind of vegetables must be grown. The firm gives great importance to the choice of seeds, looking for varieties that mature earlier, taking into account all the pertinent factors for adequate sowing and harvesting. These first stages of the manufacturing process show the high level of integration that exists between FF and their suppliers, something that was crucial to ease the implementation of the traceability system. A9–A12 are activities that are the responsibilities of each of FF's seven supply plants. A13–A16 are activities that are carried out

by the main factory (MF in Fig. 1): this plant receives the work-in-progress (WIP) from the supply plants, and then mixes the frozen vegetables to obtain the final product, which is stored until its delivery to the customers (A17).

The deep-freezing of the vegetables is completed as soon as vegetables are delivered to the supply plants, something that assures the high quality of the raw materials employed. Because deep-freezing is a critical procedure for the firm's manufacturing procedures, the firm owns 285,000 m<sup>3</sup> of cold storage chambers. Depending on specific needs, FF may lease extra cold storage chambers in order to increase their storage capacity.

#### 4. Methodology

For this project, we have performed a longitudinal case study research. In order to do so, we have adopted case study methodology considerations (Yin, 2003; Miles and Huberman, 1994; Voss et al., 2002), as well as particular recommendations for a longitudinal case like this one (Leonard-Barton, 1995; Pettigrew, 1995; McPhee, 1995). Case study is a research methodology widely used and basically recommended to study phenomena that take place in rich contexts where there are always many variables to consider in comparison to the number of observations made. For this case study research, we have followed a multi-stage process. First, we chose the firm to be analysed. We took advantage of previous research done by the authors about traceability and food safety in the Spanish vegetable industry (Alfaro et al., 2004; Rábade and Alfaro, 2006). From these studies, we soon realised that FF was one of the most interesting firms in the industry. Knowing the owner as well as some of the top managers granted us access to different informants and a way in to internal documents and materials.

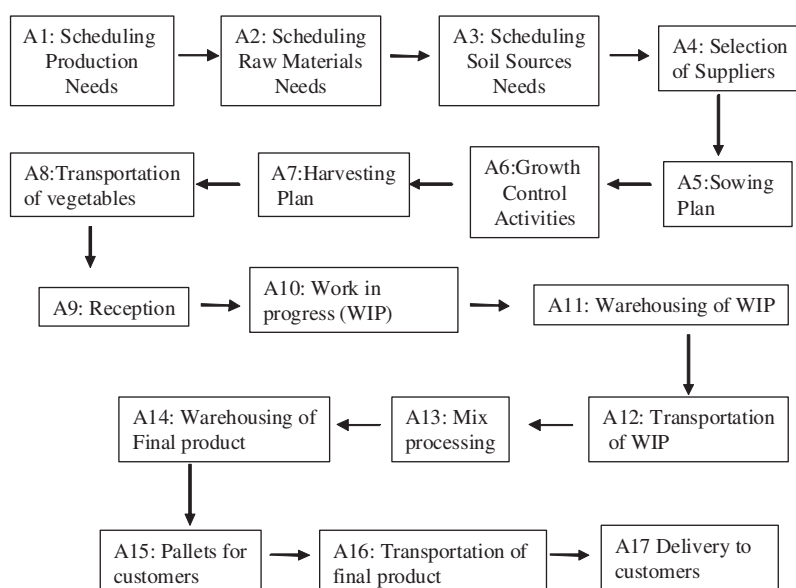


Fig. 2. Manufacturing process at FF.

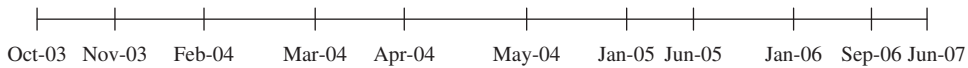


Fig. 3. Chronology of interviews with FF managers.

Data collection began in October 2003 and concluded in September 2006. Fig. 3 shows the chronology. Along this period of time, we interviewed multiple employees of the firm. All the conversations were recorded. The in-depth interviews were done using a semi-structured questionnaire and were always performed by two members of the team in order to make possible the comparison of notes and interpretations. The interviews lasted an average of 2 h.

With the purpose of enhancing the internal validity of the case study, we used different informants (triangulation), took our tentative interpretations back to the people from whom they were derived asking them if the results were plausible, and requested colleagues to comment on our findings. The fact that we did a long-term observation of the same phenomenon made possible the gathering of data over a period of time, something that, in our opinion, served to increase the internal validity of the investigation.

Since the term reliability in the traditional sense seems an oddity when applied to qualitative research, to increase reliability, Lincoln and Guba (1985) suggest thinking about the dependability or consistency of the results obtained from the data. In this sense, rather than demanding someone else to obtain the same results as ours, (the definition of reliability), we tried to make the outcomes of this research as consistent and dependable as possible. For this reason, much like an audit trail, we made a final presentation of our findings to the top managers of the firms. From this meeting, some clarifications were made, and included in this article.

## 5. Implementing the traceability system

FF began the implementations of its traceability system in January 2002. Nowadays, FF traces both the auxiliary components (plastics, for example) and the vegetables used in the production process. The firm tracks the entire production schedule, and controls the inventory of final product as well as the logistics in charge of sending the product to the end consumer. Fig. 4 shows the chronology of the traceability project at FF.

With the computerised system, traceability information is attained on a real-time basis: finished products can be traced backwards; from the arrival of all kinds of raw materials to the supply plants, until its delivery to the end customers. The total investment was approximately 1.8 million Euros: of this amount, approximately 50% of the money was spent on equipment (i.e. each forklift operator has a PC with a scanner), and the rest on software. Although, the firm had estimated a payback time of 2 years, the investment was recovered in around 18 months.

There were five main factors that triggered FF to implement a computerised traceability system. Firstly, we

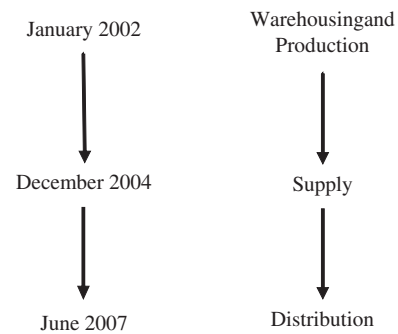


Fig. 4. Stages in traceability implementation.

have found that the firm has a top management team that is strongly committed toward any kind of activity that implies a source of competitive advantages, something that obviously facilitated the implementation of the traceability system. Secondly, the fact that FF had the required human capabilities and financial resources, of which are both needed to set up such a costly and complex system. Thirdly, FF has been exporting products to Great Britain, Germany and the Scandinavian countries since the mid 1990s. These markets have strong requirements for food safety. This experience was very useful to ease the implementation of the computerised traceability system. Fourthly, the European incoming food safety regulations were, evidently, a strong incentive. And finally, early on, people at FF realised that a system like this would be qualitative and quantitative beneficial in terms of control, flexibility and differentiation. All the above reasons explain why not only has FF developed a traceability system but also why this firm can be considered as an example of innovation in implementing procedures for managing their manufacturing operations with advanced information technologies.

## 6. Advantages obtained from traceability in FF

Since the very beginning, FF used the traceability system as an intra-firm level intranet to constantly monitor their whole production processes: today, if something goes wrong, the firm can determine exactly at what stage and in which moment the error has occurred. In this sense, the philosophy of the company is to use traceability as a tool for continuing improvement.

The benefits of the traceability system for FF have been ample and diverse, and have touched all the activities that encompass the whole FF supply chain: from suppliers, through warehousing and production, to distribution. FF has upgraded all their operations both from a qualitative and a quantitative perspective.

On the supply side, the upgrading has affected suppliers and FF's supply plants in the same way. The Table 1 summarises these improvements.

For vegetable companies, a common practice is to choose their suppliers based only on price considerations. With FF's traceability system, each supplier can be audited in such a way that a price–quality ratio can be calculated. With the tracing system, the firm has found that lots from different farmers have different productivity levels due to impurities, residues, shrinking during the blanching process, as well as because different calibres, colours and other quality characteristics of the crops. In this sense, the traceability system has helped FF suppliers to reduce their costs. For the firm, there has been an increase in flexibility that has given them advantages in the number of kilos processed per hour, in the reduction of spoilages, and returns. All these improvements have reinforced the relationships between FF and its suppliers.

On manufacturing, warehousing and inventory management, the possibilities achieved by the computerised tracking have given FF the possibility of analysing individual production lots. Table 2 shows the improvements reached in these areas.

Nowadays, inefficiencies and problems in manufacturing have been drastically reduced. In this sense, FF has better operational procedures and utilises their resources in a more efficient way. For example, now the firm contracts less warehousing space and has decreased their stock outs.

Finally, in the distribution aspects, with the on-line time traceability tool like this one, costs have been significantly reduced. Today, in FF there are less delivery errors, the transportation times have been reduced, the firm has less refunds and breakage costs. Currently, FF keeps a record of every procedure; tracks all the incoming raw materials from each one of its different facilities; controls its manufacturing process from beginning to end, and knows exactly how and when each final product was delivered to each one of its customers. As it can be seen in Table 3, the traceability system has allowed FF to increase their chances for acquiring larger and more demanding clients.

In summary, traceability gives FF a total control of their operations. The firm has improved the rotation of their stocks and optimised the warehousing space; it has reduced the workforce employed per shift and decreased the inventory level. When processing the vegetables, the chemicals used, the blanching and cooling temperatures, as well the conditions in the deep-freeze tunnel are strictly controlled. All these data help to identify flawed lots; with only the label printed on the bag, any customer may obtain detailed information on the manufacturing date, the processing line, the name of all the operators and the shifts in which this item was manufactured. With this, the productivity of the labour force can be examined. After all, FF can acknowledge when the production lot was first manipulated, the foreman of the line, and the number of

**Table 1**  
Benefits of traceability on the supply side

|                  | Qualitative benefits  | Quantitative benefits  | Indicators  |
|------------------|---|--|---|
| Suppliers        | <ul style="list-style-type: none"> <li>• Food safety</li> <li>• Trust in FF helps establishing long term relationships</li> </ul>   | <ul style="list-style-type: none"> <li>• Choose varieties</li> <li>• Improve watering techniques</li> <li>• Better use of pesticides</li> <li>• Reduction of harvesting costs</li> </ul> | Average reduction of farmers' costs in about 10–15%   |
| FF supply plants | <ul style="list-style-type: none"> <li>• Greater flexibility in product variety</li> <li>• Better criteria to choose suppliers</li> <li>• Integration of suppliers in the strategy of FF</li> </ul> | <ul style="list-style-type: none"> <li>• Productivity of raw material (vegetables)</li> <li>• Less raw material returns</li> </ul>   | <ul style="list-style-type: none"> <li>• Number of kilos processed per hour: increase of 5–10%</li> <li>• Reduction of spoilage: 3–5%</li> <li>• Decrease of raw material returns: 10%</li> </ul> |

**Table 2**  
Benefits of traceability in production and warehousing

|                                      | Qualitative benefits  | Quantitative benefits   | Indicators   |
|--------------------------------------|---|---|--|
| Production                           | <ul style="list-style-type: none"> <li>• Improvement in operational procedures</li> <li>• Better use of resources</li> </ul>                                  | <ul style="list-style-type: none"> <li>• Increased production</li> <li>• Productivity of employees</li> <li>• Efficiency of productive process</li> <li>• Give up subcontracting warehousing space</li> </ul> | <ul style="list-style-type: none"> <li>• FF has doubled production with the same number of employees</li> <li>• Reduction of disruptions in productive process: 90%</li> <li>• Reduction of indirect costs: 20%</li> </ul> |
| Warehousing and inventory management | <ul style="list-style-type: none"> <li>• Packaging fits to warehousing requirements</li> <li>• Working with frozen products is specially expensive</li> </ul> | <ul style="list-style-type: none"> <li>• Less risk of stock outs</li> </ul>   | <ul style="list-style-type: none"> <li>• Increase in warehousing capacity: 10–15%</li> <li>• Obsolescence costs: 0%</li> <li>• Reduction of safety stock: 20–30%</li> </ul>  |

**Table 3**  
Benefits of traceability in distribution

|              | Qualitative benefits  | Quantitative benefits  | Indicators   |
|--------------|---|--|--|
| Distribution | <ul style="list-style-type: none"> <li>Traceability system increases the trust of customers in FF</li> <li>Increase the portfolio of customers</li> </ul> | <ul style="list-style-type: none"> <li>Less compensation fees</li> </ul> | <ul style="list-style-type: none"> <li>Reduction in devolution of lots: 80%</li> </ul> |

pallets that contained the different raw materials used. FF has also optimised the way the products are delivered to their customers and has reached a more efficient use of their transportation system.

For FF, the traceability system has brought significant benefits, but, at the same time, the firm had to cope with two major problems. First of all, part of FF's top management team was reluctant to accept the investment proposal. Some time had to be used to convince them that the investment was perfectly sound. This happened because, for these managers, traceability only meant something related to food safety. Secondly, there was a noteworthy resistance from some of the intermediate managers of the company. Before the implementation took place, some of those intermediate managers controlled information and had more room for making certain decisions. With the new system, the top management team has accurate and unfiltered information on each aspect of the supply chain. Some of those intermediate managers felt that, with the new system, their work would be less decisive as they would have less influence on decisions. To overcome this resistance, top managers made a great effort to explain the intended objectives and the expected advantages.

## 7. Conclusions

FF traceability system truly demonstrates that tracking systems must not be seen short-sightedly: a computerised traceability system represents an optimal way of knowing at all times what is happening along the whole supply chain. As a matter of fact, for this firm, traceability constitutes a blood circulation system. FF has been able to extract decisive information for the enormous amount of data provided by their tracing system. In spite of some initial unwillingness, the implementation of the traceability system has been a major success: the initial investment was recovered in less than 2 years; and the firm has had significant qualitative and quantitative improvements in supply, warehousing, inventory and production.

As of today, FF's system is 100% operational and works perfectly well and certainly has become a source of competitive advantages. As a way to illustrate this, not long ago, a potential customer who visited the plant was delighted to check the way in which FF could provide all the pertinent information from a product in just a few seconds after introducing the bar code into the computer system.

Finally, we must say that a firm like this one offers many opportunities for further research. Just to mention a couple ideas; we think that certain aspects of the implementation should be studied, specifically the way in which top management dealt with resistance to change. Another aspect that, in our opinion, deserves more attention is the way FF exploits its traceability system as a marketing tool. Obviously, we are now interested in finding more firms that use traceability as a way to improve their general operations. After all, a more general framework may help practitioners from other firms and other industries to take advantage of a system like the one we have analysed at FF.

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