

INFORMATION ASYMMETRY ON RFID SYSTEM IN THE AGRIFOOD SECTOR: A STUDY OF CONSUMER BEHAVIOUR

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Abstract

The present work aims to analyze the motivations that lead a consumer to consider RFID technology (Radio-Frequency Identification) as an efficient traceability system for agrifood products. Owing to the relevant advantages offered by radio frequency identification, RFID is deemed to be one of the most complete and reliable information tools both for companies and for consumers. Although the importance of agriculture has remained unchanged over time, technological advances have extended its functions. Indeed, the agricultural sector has been integrated into a wider one, that of Agribusiness, including not only the production, but also the processing and marketing of agrifood products. The several encoding tools that succeeded in time have originated from the companies' and consumers' growing need to access to an increasingly detailed quantity of information, which is essential to carefully check what is produced and consumed. In this way, in a general perspective, we examine traditional bar codes which have been replaced in time, firstly by bidimensional codes, and today by the radio frequency-based technology, whose peculiar features and functionalities prove the RFID system's validity and efficiency. For this reason, this system is regarded as a better traceability tool than traditional encoding systems. With the aim of investigating the consumers' degree of interest in the new identification systems, the research group has carried out an empirical survey. The administration of the questionnaire has been a unique opportunity to discover and to show the potential of these applications to consumers.

Keywords: market investigation, consumers' perceptions, agrifood supply, radio-frequency identification, agrifood traceability, consumer's information.

1. Introduction

In the XXI century, agrifood supply has to face a demand consisting of a high number of consumers who have a medium-high level of education and prove themselves to be much more attentive and responsible when purchasing, compared to the past (Migliore *et al.*, 2015a. Lanfranchi *et al.*, 2014b). In this scenario, agrifood businesses are required to provide them with increasingly complete and reliable information, by making use of certain instruments, able to optimize the agrifood products traceability systems (Aiello *et al.*, 2015. Nicolae *et al.*, 2014). In this respect, it appears appropriate to remember that the evolutionary process of technology has "replaced" traditional "barcodes", at first with bidimensional ones, and subsequently with radio frequency-based technologies (RFID) (*Radio-Frequency Identification*), which constitute a further step compared to 2D codes, particularly in regard to certain aspects related to agrifood traceability and to guarantee the authenticity of products (D'Amico *et al.*, 2014. Anica-Popa *et al.*, 2010). In an information society such as ours, where relationships between people and objects are increasingly important, the need has arisen to find, within the business logistics, universal objects identification system which, compared to traditional "barcodes" should be more efficient and capable of automatically identifying and memorizing them. This system is based on the use of the "Electronic Product Code". EPC, despite being based on the same principles as the barcode, appears to be different, as it is not printed on a paper label, but on an electronic one (RFID), and therefore, it can be read only by electronic devices (Yang and Zhao, 2014). RFID technology makes use of radio frequency which guarantees, apart from a remote reading, even

the opportunity to store much more information and to possibly modify them, providing a greater data accuracy and speed (Ariff *et al.*, 2014. Floyd, 2015. Schimmenti *et al.*, 2013). We must think that the data flow resulting from the reading of RFID can be 100 times superior to the one coming from the reading of barcodes (Zhao *et al.*, 2014. Bernardi *et al.*, 2007).

2. RFID in the agrifood sector

RFID can operate in different environmental conditions, as it offers a significant labour saving and the database can lead to the achievement of good results in terms of control and operational visibility of the distribution chain (Galati *et al.*, 2015. Băbeanu and Tamaş, 2010). Thanks to its specific characteristics, RFID technology can be applied in different fields: it can create new activities and improve those which already exist (Gandino *et al.*, 2007). Above all, it can contribute to the development of the "Internet of things", that is a global and dynamic network in which "physical and virtual objects have an identity, physical attributes, virtual personalities and use intelligent interfaces, as well as being perfectly integrated in the info-telematic network" (Rapisarda *et al.*, 2015. Lanfranchi *et al.*, 2014c. Liu *et al.*, 2012). This means that the objects (RFID tag, sensors, mobile phones, etc.) will interact and cooperate among them to achieve a specific goal (Costa *et al.*, 2013). In particular, RFID technology enables us to improve and to monitor production and logistic processes, allows products and documents to be tracked, as well as production data collection, process control, assistance and maintenance (Kumari *et al.*, 2015). The RFID system consists of: a RFID label (tag or transponder)

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applied to the object to be identified, which represents the system's real data carrier, a reader or writer of the data obtained from the tag: an information system for data processing and transfer (Nambiar, 2010). In particular, the Transponder consists of a microchip equipped with memory, linked to an antenna which sends signals; it is contained in housing, or incorporated in a paper label, in a Smart Card, in a key, or integrated in electronic devices (watches, mobile phones, etc.). The tag allows communicating information by radio frequency without any physical contact (Vlachos, 2013). RFID standards are still evolving and some limitations linked to radio frequency, such as interference, may reduce their performances. It should not even be overlooked that, if not put to profitable use by the applications, the volume of data originating from RFID rather than bar codes may result in difficulties on the network and on information systems. Moreover, even though a RFID system is an inherently trusted one, it can be subjected to threats related to the safety of the handled information. This vulnerability can generate other security breaches through concurrent access to the data reception facility, thus leading to the unavailability of the service to which the tag system is intended. Therefore, the attack on information integrity and the use of tags as an instrument of intrusion in systems are some of the most relevant manifestations of the vulnerabilities that can be blocked with a correct approach to the device development and a proper knowledge of the system to realize. However, the development of these security mechanisms implies a considerable increase in the costs of the involved components.

3. RFID benefits

The potentials of RFID technology are enormous and can be exploited for a wide range of applications. The use of tags may indeed allow the marketing sector to discover within a fraction of a second the position of promotional exhibitors during a campaign, or the advantages for a *Chief information officer* to know in real time where to find the network structures scattered all over the world (Gulisano and Privitera, 2000). It is a useful tool for the monitoring of perishable products along the whole process. It also ensures a safer management of inspection records, thus avoiding problems related to a possible falsification and the identification of the specific place where the inspection has been carried out. It could even allow to monitor the routes of all the means of transports equipped with RFID tags, with a real time communication of eventual delays and thus forever preventing possible accidents due to mistakes along the route (this is important for the shelf life of agrifood products) (Casini et al., 2015. Di Vita et al., 2014). In this way considerable fuel savings may also be achieved, since routes would be constantly monitored and optimized, and it could be possible to control the different factors leading to fuel wastage, such as a minor inflation pressure of the wheels, an excessively high speed, or a load superior to the normal one (thus respecting the principle of sustainability). It would be useful to lead tourists to specific places of interest providing them with accurate information, even in areas where the GPS signal is absent (it is particularly useful for some forms of rural tourism such as food and wine tourism). More specifically, in the agrifood sector, the process throughout the supply chain can be simplified by the RFID system. This instrument allows to identify and to monitor products along every single step of the supply chain, thus having a complete management of its entire traceability, from the producer to retail outlets (Chrysochou et al. 2009). Consider, for example, the livestock sector, where it is possible to trace all the evolution stages of farming, during the whole life-cycle (Chinnici, 2014). This may be achieved by applying RFID tags, which are capable of memorizing the animal's data, not only in registry-office terms, but especially as regards transit companies, veterinary checks and the treatments it is undergoing. RFID may also be applied in the meat processing and packing phases. In this regard, in 2010, a European RFID experiment called "*From Farm to Fork*" was launched, with the aim of assessing the

efficiency and sustainability of RFID technology for small and medium-sized enterprises in the food sector. The project was co-financed by the European Commission and coordinated by the University of Wolverhampton (UK) involving several research institutes and companies located in the United Kingdom, Spain, Slovenia, Belgium and Italy. The project aims at making RFID technology accessible to small and medium-sized enterprises, in order to enable product traceability all along the agrifood supply chain, from farmer to consumer (Migliore, et al., 2015b. Tudisca et al., 2015). The application of RFID has some advantages even in domestic consumption. In fact, the fridge will be able to decipher the information by signalling when the stocks of a particular product are running out and when the product's expiration date is approaching.

4. Research objectives

On the basis of the *Radio-Frequency Identification* system's potentials that have just been described, a market investigation able to outline the average consumers' perceptions regarding the use of these "innovations" was carried out, even though the empirical analysis was focused on a regional reference context: Sicily (Lanfranchi and Giannetto, 2014). The research objective was to analyze if consumers pay attention to the information provided on the agrifood products' label and if they show a propensity to purchase agrifood products, which are traced with radio frequency identification systems.

5. Materials and methods

This study was carried out through the creation of a questionnaire which was administered to consumers of all ages, genders, occupations and academic titles. It was necessary to accurately define the research topics, in order to allow for a careful and specific analysis, also aimed at increasing the respondent's information. The questionnaire was realized in an easily comprehensible form, in order to encourage the respondent to participate in the survey and to obtain as much information as possible in the easiest and fastest way (Borsellino et al., 2012). The questionnaire prepared by the research group consists of 17 questions, structured in four sections: the first section includes the respondent's personal data; the second one deals with the information on products; the third one refers to QR and RFID information systems, and the fourth and last section is aimed at acquiring information concerning the consumer's knowledge of the smart label. Let us examine in detail the contents of each single section. In the first introductory section, some information on the respondent's personal details as well as on his current job and on the qualification he obtained is detected. In the second section we try to examine the criteria according to which consumers relate to the agrifood products that they purchase or intend to purchase. The respondents are asked to express their interest in the origin and provenance of agrifood products as well as their confidence in these products' labelling information. Moreover, we try to understand if the current agrifood products' labels adequately satisfy the consumers' information needs, and, if they do not, we try to realize on which issues the respondent asks for further information. In the third and fourth section we try to investigate on the respondent's knowledge of the new means of identification provided by technological innovations in the last few years (Lanfranchi et al., 2015; Sgroi et al., 2014).

6. Analysis and interpretation of results

In the conducted analysis it was important to verify the consumer's willingness to use a smartphone, which enables to integrate the typical functionalities of the mobile phone with those related to personal data management, thus allowing a quick and easy access to the Internet. This information, together

with the other data, was useful to obtain important results on the level of technology, applied to mobile devices, which was supported by the sampled consumers. Subsequently, the respondent was asked about his degree of knowledge of the two specific technologies (QR and RFID), as well as his propensity to use this technology to obtain further information on the product he intends to purchase (Ruiz-Garcia et al., 2009).

6.1. Information gathering

The examined sample consists of 1000 subjects resident in Sicily. The target appears to be varied since the research involves people of every age-group and with heterogeneous characteristics. The survey is carried out through personal, telephone and web interviews. Information is quickly gathered thanks to the simple structure of the questionnaire which only consists of multiple choice questions. Therefore, the 1000 questionnaires which were gathered represent the reference target for the subsequent reworkings and analysis. By analyzing each single answer we try to identify the most relevant case and preferences which were encountered during the market research. The sample interviewed appears to be balanced as regards gender. Indeed, it is possible to assert that the study was equally conducted between men and women. As far as age is concerned, more than 50% of the sample interviewed is aged between 18 and 30 (figure 1).

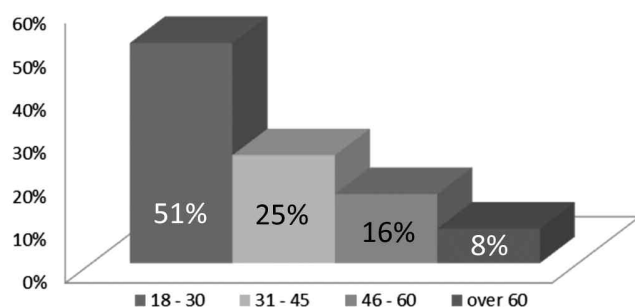


Figure 1. Target of respondents in relation to age group
Source: our elaborations

Therefore, a relevant pool of consumers belonging to this age group has to be highlighted, while in the age groups superior to 45 a low percentage of the interviewed sample was recorded. As regards the respondents' specific features, their academic title was examined as well. According to the analyzed data, a majority of subjects who have obtained a school diploma (47%) or a university degree (42%) was outlined. Therefore, through an overall analysis of the sample, it is possible to assert that it is a panel with a medium-high education. Indeed, those who have claimed to have a primary school certificate represent around 11% of the analyzed sample. The interviewed people were asked to specify their job, in order to try to understand if there were any differences of opinion, concerning the contents dealt with in the questionnaire, among those who could use these technologies as simple consumers. A high proportion of students (equal to one third of the total number) stand out and this appears to be very important to understand the opinion of the future generations on an extremely topical subject and to try to observe how their preferences are evolving as compared to past generations. It is found that the second most represented category is that of employed workers (20%), which has a difference of only 3% from the unemployed category (17%).

6.2. Results analysis

From the question related to the importance of the geographical origin of products, it emerges an active interest of the respondents in the geographical provenance of agrifood products (a significant 88%), while only 8% claim to give no importance to this element. Most of the respondents (86%) state

that they purchase food of Italian origin, while a small part of the sample (14%) occasionally buy them and none purchase them from abroad. It emerges from the survey that 60% of the respondents do not trust the information provided on the agrifood products' label, while only 27% totally trust it and 13% do not trust it at all. The respondents were asked if, according to them, food product's label lacks some kind of information. Through this question we enter the central phase of the questionnaire, certainly the most interesting one as regards the discussed topics. Firstly, the interviewed subjects were asked if, according to them, the current agrifood products' labels fully satisfy their information needs. 56% of the respondents believe that the information contained in the packages is not sufficient. It is evident that the consumer does not settle with compulsory information (expiration date, ingredients, etc.), but requires a more complete information, which takes account of collateral notions that are not directly linked to the product's organoleptic and nutritional properties. Those who have answered positively to the previous question, were asked to subsequently choose a maximum of three categories of information – on the basis of a previously selected list – for which the consumer thought he needed more information or, more simply, the ones in which the respondent was more interested as compared to others. In this way, we tried to identify the notions which were mostly requested by consumers, with the idea of using, in the next future, the smart labels technology in order to give the opportunity of taking advantage of this kind of information to those who request it (figure 2).

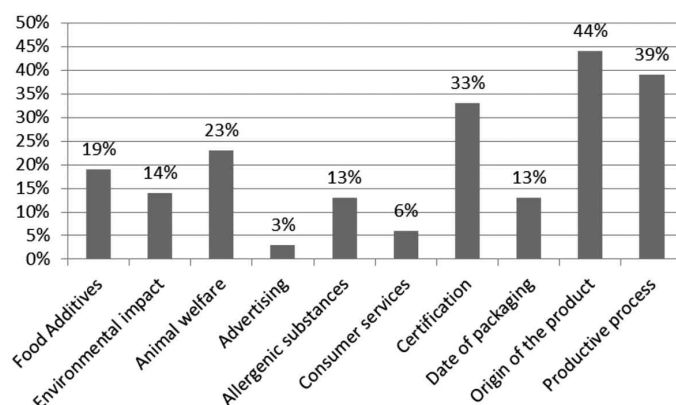


Figure 2. Categories of information preferred by the respondents in relation to smart labels
Source: our elaborations

The gathered data show that there is a quite varied distribution of the respondent's preference, so that there is no prevalent category of information among the proposed ones. However, the most selected categories were the origin of the product (44%) and the information related to traceability (39%), but both this information refers to the product's path before the purchasing phase. Therefore, we can notice a substantial interest of the interviewed target in the working and manufacturing processes that enable the consumer to purchase the finished product, at the end of the production chain. It is evident, therefore, that consumers are increasingly attentive to knowledge, especially as regards their diet. Consequently, in the next future, the companies operating in the sector will have to deal with this curiosity and it will be important to give definite answers to those who express some perplexities. Among the categories proposed in the questionnaire, a relevant interest in the guarantee of authenticity of the product can be highlighted. Even in this sense, the consumer does not appear to be quite serene and reassured, and he evidently thinks that certifying the authenticity of certain products is an important thing. Subsequently, the respondent's interest shifts to animal welfare (23%) and to additional information on food additives (19%), while environmental protection, information on allergenes, on the packing date, on the service content and on promotions still represent

secondary information. In order to understand the relationship between consumer and technology, the respondents were asked if they own a smartphone or another device (for example, a tablet). This particular question refers to QR codes, and it was asked in order to understand how much the respondents are interested in the technology supported by mobile devices, which represent an ideal support for reading and receiving information, through bidimensional codes. From the answers given, it is evident that much more than two thirds of the respondents have a latest generation mobile phone (82%). This may be also due to the fact that most of the respondents are young people and, therefore, much more willing to use latest generation devices. Subsequently, the respondent was asked if he had ever heard of *bidimensional bar codes* and *RFID*. With this question, we intended to investigate, superficially, if the respondents had previously come across at least one of the two analyzed technologies. Although both identification systems are still in a stage of approach to the market (as we could explain before, these technologies have been used for some time now, especially in some specific sectors, but the consumers' possibility to benefit from them is a phenomenon only experienced in the last few years), consumers seem to be aware of the existence of these technologies. Indeed, only 36% of the respondents have never had the opportunity to know RFID technology and bidimensional codes, while the fact that more than 60% of the target is already aware of these innovations is encouraging. On the contrary, those who have heard of smart labels slightly exceed 50%. This means that many consumers do not know this information tool, not even in generic terms. 32% of consumers have shown optimism and interest in these information tools and believe that, in the future, there will be the possibility of using them and of making them available in order to clarify any fear or uncertainty regarding what is going to be purchased. Only 2% believe that the currently existing systems and controls on the goods offered for sale are appropriate to the task of guaranteeing the authenticity of agrifood products. The respondent was also asked if the smart labelling system could have any negative effects (Lanfranchi et al., 2014a). Only 14% perceive some concerns regarding the use of this technology in the food sector, and these people were further asked what sort of risk they saw behind this future label. The analysis of the results of this second question shows that the greatest concern is related to the protection of privacy (7%). A possible interpretation of this result may be that the consumer thinks that the possibility of being "traced" through his purchases at the supermarket is a threat for himself. The second perceived risk is related to the problems linked to food safety. Consumers believe that smart labels are not able to guarantee either hygienic, health, nutritional and organoleptic quality to the foods, or quality of food production, processing, preparation and consumption (figure 3).

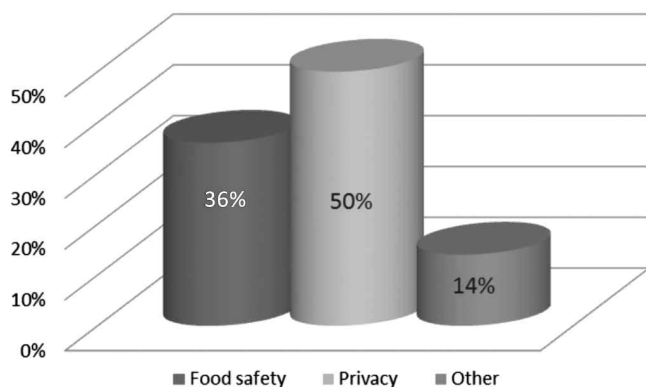


Figure 3. Types of risks perceived by the consumer on RFID systems

Source: our elaborations

In order to contrast with these convictions, it is good that research and innovation continue to study increasingly develo-

ped systems capable of minimizing the impact of these innovative devices on the product (MacAskill, 2013). The last question is related to the "weight" of smart label as a determining factor in the purchasing process. The results show that almost two-thirds of the sample would not take into consideration a product with the smart label, while the remaining 60% would choose the "labelled" product. This means that more than half of the respondents would not be willing to purchase a product provided with electronic traceability for its higher cost. A possible explanation to this result may be that the sampled subjects, mostly young people, do not have a job or a salary yet and so they believe they will not be able to afford such a service at a higher price in the future. The only possible solution to the problem consists in reducing the cost of RFID tags so that consumers may purchase a product provided with smart labelling and thus benefiting from its advantages.

7. Conclusions and discussions

From the carried out investigation it appears evident that the sampled respondents, despite not knowing specifically RFID systems, are curious and interested in this innovative agrifood information tool. Besides, they consider this technology not as a threat but as an opportunity to be seized to protect their health and food safety. The sensitivity shown by the interviewed subjects towards more developed agrifood traceability can encourage the companies in this sector, which, in this context, may be willing to adopt RFID systems within their production processes, thus guaranteeing more transparent and safe food systems to consumers (Stanciuc and Moga, 2014). However, since RFID is a technology with strong potentials and capable of improving the consumer's information in the agrifood sector, it is necessary that companies carry out a considerable initial investment in order to intensify efforts and to offer an increasingly reliable and least invasive instrument. Certainly, the huge potentials of RFID technology allow us to identify it as one of the few innovations capable of modifying the consumers' habits, of simplifying the production process and of certifying in a more efficient way food quality, providing more accurate and reliable information on the traceability of products. Indeed, through tags it is possible to directly access not only to information related to packaging, but even to the content's components, without the need to open it. Therefore, it would be necessary to make an initial economic effort requested by companies to continue to reduce the production costs of RFID labels, making them increasingly smaller and cheaper (Lanfranchi et al., 2014d). Only by doing so, it would be possible to witness an increasing participation of the companies willing to trust these communication tools and to develop new solutions through them. In order to enable radio-frequency technology to be implemented within agrifood chains it is essential that all the actors involved in it consult each other with the aim of defining the application's objectives and of sharing both technological choices and the methods of allocation of costs, risks and benefits.

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References

- [1] Aiello, G., Enea, M., Muriana, C. (2015), *The expected value of the traceability information*, European Journal of Operational Research, Vol. 244, Issue 1, pp. 176-186.
- [2] Anica-Popa, L., Anica-Popa, I., Stoian, M. (2010), *Informational systems for monitoring traceability and the pig meat quality in Romania and Denmark. Comparative analysis,*

- Quality - Access to Success, Vol. 11, No. 7-8, pp. 74-80.
- [3] **Ariff, M.H., Ismarani, I., Shamsuddin, N.** (2014), *RFID based systematic livestock health management system*, Proceedings - 2014 IEEE Conference on System, Process and Control, ICSPC 2014, pp. 111-116.
 - [4] **Băbeanu, D., Tamaş, I.** (2010), Modern instruments in on-line business environment, Quality-Access to Success, Vol. 11, No. 9, pp. 52-58.
 - [5] **Bernardi, P., Demartini, C., Gandino, F., Montrucchio, B., Rebaudengo, M., Sanchez, E.R.** (2007), *Agri-food traceability management using a RFID system with privacy protection*, Proceedings - International Conference on Advanced Information Networking and Applications, AINA 2007, Article number 4220878, pp. 68-75.
 - [6] **Borsellino, V., Galati, A., Schimmenti, E.** (2012), *Survey on the innovation in the Sicilian grapevine nurseries*, Journal of Wine Research, Vol. 23, Issue 1, pp. 1-13.
 - [7] **Casini, L., Contini, C., Romano, C., Scozzafava, G.** (2015), *Trends in food consumptions: What is happening to generation X?*, British Food Journal, Vol. 117, Issue 2, pp. 705-718.
 - [8] **Chinnici, G., Pappalardo, G., Pecorino, B.** (2014), *Economic evaluation of innovative solutions for food safety in cereal sector in Sicily*, Quality - Access to Success, Vol. 15, S1, pp. 41-47.
 - [9] **Chrysochou, P., Chrysochoidis, G.b, Kehagia, O.** (2009), *Traceability information carriers. The technology backgrounds and consumers' perceptions of the technological solutions*, Appetite, Vol. 53, Issue 3, pp. 322-331.
 - [10] **Costa, C., Antonucci, F., Pallottino, F., Aguzzi, J., Sarriá, D., Menesatti, P.** (2013), *A Review on Agri-food Supply Chain Traceability by Means of RFID Technology*, Food and Bioprocess Technology, Vol. 6, Issue 2, pp. 353-366.
 - [11] **D'Amico, M., Di Vita, G., Chinnici, G., Pappalardo, G., Pecorino, B.** (2014), *Short food supply chain and locally produced wines: Factors affecting consumer behavior*, Italian Journal of Food Science, Vol. 26, Issue 3, pp. 329-334.
 - [12] **Di Vita, G., Chinnici, G., D'Amico, M.** (2014), *Clustering attitudes and behaviours of Italian wine consumers*, Quality - Access to Success, Vol. 15, S1, pp. 54-61.
 - [13] **Floyd, R.E.** (2015), *RFID in Animal-Tracking Applications*, IEEE Potentials, Vol. 34, Issue 5, pp. 32-33.
 - [14] **Galati, A., Gristina, L., Crescimanno, M., Barone, E., Novara, A.** (2015), *Towards More Efficient Incentives for Agri-environment Measures in Degraded and Eroded Vineyards*, Land Degradation and Development, Vol. 26, Issue 6, pp. 557-564.
 - [15] **Gandino, F., Montrucchio, B., Rebaudengo, M., Sanchez, E.R.** (2007), *Analysis of an RFID-based information system for tracking and tracing in an agri-food chain*, 2007 1st Annual RFID Eurasia 2007, Pp. 1-6, 2007 1st Annual RFID Eurasia; Istanbul, Turkey.
 - [16] **Gandino, F., Montrucchio, B., Rebaudengo, M., Sanchez, E.R.** (2009), *On improving automation by integrating RFID in the traceability management of the agri-food sector*, IEEE Transactions on Industrial Electronics, Vol. 56, Issue 7, pp. 2357-2365.
 - [17] **Gulisano, G., Privitera, D.** (2000), *Strategies of marketing of a traditional vegetable product: The red onion in Tropea*, Acta Horticulturae, Vol. 536, pp. 577-585.
 - [18] **Kumari, L., Narsaiah, K., Grewal, M.K., Anurag, R.K.** (2015), *Application of RFID in agri-food sector*, Trends in Food Science and Technology, Vol. 43, Issue 2, pp. 144-161.
 - [19] **Lanfranchi M., Giannetto C., De Pascale, A.** (2014a), *The role of nature-based tourism in generating multiplying effects for socio economic development of rural areas*, Quality - Access to Success, Vol. 15, No. 140, pp. 96-100.
 - [20] **Lanfranchi M., Giannetto C., D'Amico, M., Di Vita, G.** (2014b), *Analysis of demand determinants of fish products in Messina: An economic survey on the fish consumption*, Quality - Access to Success, Vol. 15, No. 142, pp. 106-108.
 - [21] **Lanfranchi M., Giannetto C.** (2014), *Analysis of producers' knowledge about farmers' markets*, Italian Journal of Food Science, Vol. 26, Issue 3, pp. 335-340.
 - [22] **Lanfranchi M., Giannetto C., De Pascale, A.** (2014c), *Analysis and models for the reduction of food waste in organized large-scale retail distribution in eastern Sicily*, American Journal of Applied Sciences, Vol. 11, Issue 10, pp. 1860-1874.
 - [23] **Lanfranchi M., Giannetto C., De Pascale, A.** (2014d), *Economic implications of climate change for agricultural productivity*, WSEAS Transactions on Environment and Development, Vol. 10, pp. 233-241.
 - [24] **Lanfranchi, M., Giannetto, C., Alibrandi, A., Zirilli, A.** (2015), *Analysis of the propensity to fruit consumption among young people through the cumulative proportional odds model*, American Journal of Applied Sciences, Vol. 12, Issue 8, pp. 542-548.
 - [25] **Liu, D., Zhou, J., Mo, L.** (2012), *Applications of internet of things in food and agri-food areas*, Nongye Jixie Xuebao/Transactions of the Chinese Society of Agricultural Machinery, Vol. 43, Issue 1, pp. 146-152.
 - [26] **MacAskill, J.** (2013), *Innovative approaches of business greening*, Quality - Access to Success, Vol. 14, S3, pp. 84-92.
 - [27] **Migliore, G., Di Gesaro, M., Borsellino, V., Ascianto, A., Schimmenti, E.** (2015a), *Understanding consumer demand for sustainable beef production in rural communities*, Quality - Access to Success, Vol. 16, No. 147, pp. 75-79.
 - [28] **Migliore, G., Crescimanno, M., Schifani, G., Romeo, P., Galati, A.** (2015b), *Quality perception and consumer choice of cactus pear: Results of direct survey in Italy*, Acta Horticulturae, Vol. 1067, pp. 275-281.
 - [29] **Nambiar, A.N.** (2010), *Traceability in agri-food sector using RFID*, Proceedings 2010 International Symposium on Information Technology - Engineering Technology, ITSIM'10 Vol. 2, pp. 874-879.
 - [30] **Nicolae, C.G., Neculita, M., Cristea, D.S.** (2014), *Trends in the development of traceability systems for fish products*, Quality - Access to Success, Vol. 15, No. 143, pp. 95-97.
 - [31] **Rapisarda, P., Rizzo, M., Scuderi, A.** (2015), *Analysis of a direct selling network for agrifood products*, Italian Journal of Food Science, Vol. 27, Issue 1, pp. 109-117.
 - [32] **Ruiz-Garcia, L., Lunadei, L., Barreiro, P., Robla, J.I.** (2009), *A review of wireless sensor technologies and applications in agriculture and food industry: State of the art and current trends*, Sensors (Switzerland), Vol. 9, Issue 6, pp. 4728-4750.
 - [33] **Schimmenti, E., Ascianto, A., Borsellino, V., Galati, A.** (2013), *The role of information and communication technologies and logistics organisation in the economic performance of Sicilian fruit and vegetable enterprises*, International Journal of Business and Globalisation, Vol. 10, Issue 2, pp. 185-193.
 - [34] **Sgroi, F., Di Trapani, A.M., Testa, R., Tudisca, S.** (2014), *Strategy to increase the farm competitiveness*, American Journal of Agricultural and Biological Science, Vol. 9, Issue 3, pp. 394-400.
 - [35] **Stanciuc, N., Moga, L.M.** (2014), *General framework of the traceability systems in food chain*, Quality - Access to Success, Vol. 15, No. 143, pp. 92-94.
 - [36] **Tudisca, S., Di Trapani, A.M., Sgroi, F., Testa, R.** (2015), *Socio-economic assessment of direct sales in Sicilian farms*, Italian Journal of Food Science, Vol. 27, Issue 1, 2015, pp. 101-108.
 - [37] **Vlachos, I.P.** (2013), *Key performance indicators of the impact of radio frequency identification technologies on supply chain management*, International Journal of RF Technologies: Research and Applications, Vol. 4, Issue 2, pp. 127-146.
 - [38] **Yang, Y., Zhao, X.P.** (2014), *Research of organic vegetables safety traceability system in agricultural enterprise based on RFID technology*, Applied Mechanics and Materials, Vol. 469, pp. 473-476.
 - [39] **Zhao, G., Yu, H., Wang, G., Sui, Y., Zhang, L.** (2014), *Applied research of IOT and RFID technology in agricultural product traceability system*, IFIP Advances in Information and Communication Technology, Vol. 452, pp. 506-514.