


# Technological modernization and innovation of traditional agri-food companies based on ICT solutions—The Portuguese case study

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## Abstract

This paper assesses the potential for technological modernization and innovation based on Information and Communication Technologies (ICT) in traditional agri-food companies located in the central region of Portugal. A survey was applied to 50 agri-food companies of cereals, cheese, olive oil, dry sausages, honey, wine, and horticultural sectors. Results analysis show that companies use computers, have internet service, and use social networks for business purposes. However, most of them have no webpage, do not use internet for advertising/selling/buying products, and have not promoted collaborators' ICT training. Companies expect webpages to improve their productivity and/or marketing products/services. Recommendations were provided to promote the use of ICT for business purposes. Webpages, Facebook pages, and CRM systems were developed to a limited set of companies. The results of the satisfaction survey of the ICT solution confirm the company sales increase due to the web visibility gained by the company products.

## Practical applications

This paper assesses the potential for technological modernization and innovation based on ICT of Portuguese agri-food industrial companies. The ICT-based solutions developed were company webpages, Facebook pages, and customer relationship management software. The analysis and discussion of results provide an insight into the ICT solution that a specific company should follow to increase sales gains due to web visibility of company products.

## 1 | INTRODUCTION

One of the flagship initiatives of the European Commission (EC) under the Europe 2020 strategy for smart, sustainable, and inclusive growth is related to the promotion of widespread access and use of Information and Communication Technologies (ICT), as it is seen as essential vehicle for the development of advanced services on the internet, such as e-business, e-government, or e-learning. The EC designed in 2010 a strategy to encourage a pulsating digital

economy by 2020 (EC, 2010). It outlines policies and actions aimed at maximizing the benefit of the digital era to all sections of society and the economy. A top priority initiative was adopted by the EC in 2015 (EC, 2015aa) to promote a better online access to goods and services and to ensure that the European economy and industry takes full advantage of the digital economy as a potential driver for growth.

ICT and its use have been spreading at an astonishing speed. The latest figures (December 2015) for the 28 member States in

the European Union (EU28) show that 83% of households (Eurostar, 2015) (most recent data in 2015) and 93% enterprises of all dimensions (Eurostar, 2014) (most recent data in 2009) have Internet access. These values increased almost 51% and 21%, respectively, in a decade. Thirty-nine percent of EU enterprises used some type of social media (e.g., social networks, blogs, content-sharing sites, and wikis) in 2015, and compared to 2013 their use strongly increased (Eurostar, 2016a), and 79% of these businesses, most of small dimension enterprises, used such applications to build their image and to market products.

According to (Eurostar, 2016b), nearly two-thirds of EU citizens access the Internet every day (65%), but a substantial minority (22%) say that they never use the Internet or do not have access. In 2014, the share of the population that had no experience of internet use (whether at home, at work or elsewhere) was highest in Romania (39%), Bulgaria, Greece, Italy, and Portugal (30%).

As stated in (EC, 2015bb), besides accessing the Internet from a computer (92%), 61% of Internet users access it through a smartphone, and 30% use a touchscreen tablet. More than half of Internet users in the EU say they use the Internet to access their e-mail (86%), read news online (63%), access online social networks (60%), buy goods or services online (57%), or do online banking (54%), while 23% sell goods or services. Portugal is placed in tail of the EU countries, as only 48% of citizens use the Internet daily, 34% never use Internet, and 10% have no internet access. The overwhelming majority of Portuguese citizens (93%) access the Internet via the computer (EU 92%), followed by the smartphone for 38% (EU 61%) and by the tablet for 22% (EU 30%). The leading online activity is using the email (PT 82%, EU 86%), followed by the use of online social networks (PT 76%, EU 60%), reading news online (PT 67%, EU 63%), perform online banking services (PT 26%, EU 54%), and purchasing goods or services (PT 20%, EU 57%). If it is considered the use of Internet for work or business purposes, more than one in three EU citizens (38%) use the Internet, while in Portugal, this value is around 25%. As stated by Lehmann, Reiche, and Schiefer (2012), the efficiency, process control, and consumer communications are all closely related to the use of ICT. Global networks, Internet, networked devices, sensors, online social networks, and strategies and methodologies of communication are of prime relevance for the competitiveness and sustainable development of the food sector. Thus, ICT play a transversal role in productivity and competitiveness of agricultural production systems, agri-food, agro-industrial, and forestry, as well as its shaping effects on the economic structure, social organization and sustainability of rural development. ICT are the instrument basis of the knowledge economy and allowed the development of innovative solutions in the operational management of production/transformation systems that structure the global economic system by organizing the access to increasing information flows that allow integrate multidisciplinary perspectives for the optimization of its results. The agricultural system was also covered, and concepts such as precision agriculture, sensing/monitoring, traceability, automation and robotics, market and access virtualizations, have been taking increasingly the daily lives of producers and industrial sector. However, the digital gap between rural and urban areas is not only

a question of coverage. It is also related to transfer speed, quality, and cost. Operators cannot obtain an equivalent return between rural and urban customers. Boccia and Covino (2016) and Covino and Boccia (2016) state that agri-food small and medium enterprises (SMEs), usually characterized by low research and development expenditure, must innovate in sustainable food quality that will foster their competitiveness. This concept may be supported by ICT tools.

This paper aims to identify, discuss and show examples of the transversal role of ICT solutions in the value chain of agriculture and agribusiness, in particular the optimization of resource management processes, access to markets, supply chains, dissemination of knowledge and extension services, and supply of financial e-services. Additionally, it aims to show how ICT can promote the growth of value in production chains, and what their impacts on the development and sustainability of rural areas.

Given the interdisciplinary perspective, this article aims helping answer some important questions about the application of ICT in agriculture: What is the perception of producers and industrial of the agriculture sector on the usefulness of ICT in their economic activity? To what extent, the use of mobile phones and the internet has expanded/diversified the turnover in the agricultural sector? What is the degree of penetration of ICT in the daily lives of producers and industrials of the agricultural sector? Is the everyday life of producers and industrials affected by the adoption/indifference/rejection of ICT in their economic activity? Are there differences in the level of ICT adoption depending on the agriculture sector that is considered, that is, meat, fish, horticultural, and others? The systems and scales of production affect the adoption of ICT? Are the age stratum and socioeconomic level of the users, barriers/facilitators for the incorporation of ICT in the daily life of their economic activities? The yield, well-being, and quality of life of the producers and industrials of the sector has changed with the adoption of ICT? What are the effects observed in the agricultural sector in terms of employment, productivity, and competitiveness? There is evidence of greater sustainability in rural development by adopting ICT? Which are? How to promote these transformations?

This paper tries to answer these questions by discussing the assessment and application of ICT solutions in agri-food companies and businesses. The paper is divided mainly in two main parts. The first part is devoted to the study concerning the assessment of the potential of the technological modernization and innovation in strategic and traditional sectors based on ICT, specifically of the agri-food sector. This part is organized as follows. Section 2 describes the framework of the study. The state-of-the-art on the evaluation and application of ICT in the food sector and/or rural areas is described. The main objectives of the project that includes the assessment provided by this study are pointed out. Section 3 presents the materials and methods used to develop the analysis of the potential for technological modernization and innovation based on ICT in agri-food companies of the central region of Portugal. The sequential steps that compose the methodology followed are described. The procedures for the questionnaire construction and for the survey implementation are presented. Section 4 includes the results from the compilation of the questionnaire answers and its analysis and

discussion. Section 5 gathers the suggestions and recommendations that identify improvement opportunities arising from the cross analysis in all sectors.

The second part of the paper is related to the implementation of ICT solutions in selected companies and the analysis and discussion of the results. Section 6 describes the ICT solutions implemented in a set of agri-food businesses in traditional sectors, such as the creation of webpage or Facebook pages, the configuration of Customer Relationship Management (CRM) software, among others. Section 7 discusses the business improvements due to the implementation of ICT solutions and the evaluation and measurement of the influence of ICT in the competitiveness and economic growth of the companies. Lastly, Section 8 describes the main conclusions of the study.

## 2 | FRAMEWORK

One possible path to leverage the economic activity of food companies, in face of the economic recession installed, is to encourage the use of new technologies in SMEs of strategic and traditional sectors.

Lehmann et al. (2012) provide an overview on the state-of-the-art in three use cases within the application domain of the food sector. The first case deals with management support for farming and the provision of appropriate IT support. The second one with logistics that might include aspects such as customer service, transportation, storage, plant site selection, inventory control, order processing, distribution, procurement, materials handling, return goods handling, and demand forecasting. The last case focuses on the awareness, that is, on the detailed information of food products and the proper communication to present and sell these food products. It focuses on the state-of-the-art on technology (networked devices and networks for communication), information content, organization, and collection as well as data exchange and interoperability. The authors concluded that the major interest in farming is in production control. The major interests in logistics are data transfer and communication of information between stages of the chain related to tracking and tracing, monitoring of movements, product quality, and environmental impacts. In awareness, the major interest is in communication with consumers. Some studies covered these use cases, from the implementation of new ICT (Kaloxylos et al., 2013; Mayer, 2013; Schiefer, 2004), the proper determinants used to assess the ICT usage (Bayo-Moriones & Lera-López, 2007; Verdegem & De Marez, 2011), and surveys on rural areas to determine the ICT usage. Verdegem and De Marez (2011) developed a study to evaluate the ICT profile of 29 farms in the northern region of Greece using a semi-structured interview process. They were not interested in evaluating whether a computer was available with an Internet connection for the needs of rural enterprise, but whether if it was used, for what purpose and in what way. The results of the research lead to the revelation of four kinds of ICT profiles in modern rural enterprises and a way of covering the ICT skills gaps of the farmers, via social environment.

Sturiale and Scuderi (2013) provide some indications about the involvement of social networks into the agri-food system. An online survey was applied to 500 followers of a page in the Facebook social network. The results predict an increase of social commerce and that enterprises need new forms of collaboration with consumers, especially within the online environment based on tools and interaction models as well as online platforms.

Moghaddam and Khatoon-Abadi (2013) identified the factors influencing the adoption of ICT in a rural ICT center of an Iranian province. The survey was applied to 218 individuals. Based on the results, the existence of an ICT center reinforces the adoption of ICT regardless of the users' economic status. At the same time, factors such as individual, social, the households' informative & communicative, as well as the innovation-related factors were found influential on the use of ICT.

Senthilkumar, Chander, Pandian, and Kumar (2013) performed a survey on 270 respondents comprising of 180 users and 90 nonusers of village information centers (VIC). A multiple linear regression analysis was applied to assess the factors associated with the VIC usage level in the study area. The study concluded that dairy farmers with higher land-holding size and dairy herd size need good knowledge on dairy farming, so they are more likely to use VICs. Higher usage levels of VIC information contribute to knowledge gain, which in turn contributed to the effectiveness of VICs among the users.

Zhang, Wang, and Duan (2016) provide a comprehensive review and analysis of seven ICT-based information dissemination models (1: web portal, 2: voice-based service, 3: text (short message service)-based service, 4: self-support online community, 5: interactive video conferencing service, 6: mobile internet-based service, 7: unified multichannel service model). Model 1, web portal, consists in using web pages to disseminate information while Model 6, consists in the mobile Internet technology. Model 7 considers all the relevant technologies. The latter model is the current application trend in China.

Therefore, the use of ICT by incorporating innovative features with added value, improving the skills of SMEs activity, and promoting the modernization of regional business sector will foster the economy and competitiveness of agri-food traditional sectors. Thus, there is the need for an urgent intervention. The project MITTIC—*Technological modernization and innovation based on ICT in strategic and traditional sectors* was proposed to help assisting this need (InovCluster, 2013). This European project aimed to promote the economic growth and the employment by increasing competitiveness in economic, strategic, and traditional sectors in the regions of Extremadura region of Spain and Centre and Alentejo regions of Portugal. This objective was accomplished by proposing and implementing innovative models of organization and production processes based on ICT solutions. The project had the following strategic objectives:

- Increase the innovative capabilities in terms of ICT: through improved management of knowledge, based on shared structures that optimize the resources in Research, Development and Innovation (R&D&I) and which allow joint requirements and opportunities to be identified.

- Update traditional productive sectors in terms of technology based on natural and strategic resources, by applying new business models or improving existing ones based on knowledge and ICT.
- Exchange new applications, processes, or valuing methods for products with productive sectors by means of ICT, to generate new opportunities for business or to promote business innovation in those that currently exist.

The project consortium was constituted by 12 partners, 7 from Spain, and 5 from Portugal.

The methodology used to develop the activities within this project started with the assessment of the potential of technological modernization and innovation based on ICT in strategic and traditional sectors, namely in companies of the agri-food sectors of cereals, cheese, olive oil, dry sausages, honey, wine, and horticultural, located in the central region of Portugal. This assessment was supported on a survey applied to 50 agri-food companies on the use of ICT tools in manufacturing processes as well as ICT tools for support, marketing, and sales.

## 2.1 | Assessment of the potential of technological modernization and innovation in strategic and traditional sectors based on ICT

The first activity of the project was the analysis of the potential for technological modernization and innovation based on ICT. This activity aimed to develop an in-depth analysis of the use, introduction, and adoption of ICT in manufacturing and sales processes in strategic and traditional sectors in Extremadura region of Spain and Centre and Alentejo regions of Portugal. A technological research of businesses in this sector on both sides of the border was carried out. This paper presents the results of the survey on the use of ICT tools for manufacturing processes and for support, marketing, and sales in order to assess the potential for technological modernization and innovation based on ICT. The survey was applied to 50 agri-food companies belonging to cereals, cheese, olive oil, dry sausages, honey, wine, and horticultural sectors located in the central region of Portugal. This analysis of the results assessment allowed to recommend and suggest solutions to increase the introduction and use rate for ICT tools in companies of each sector in order to improve their manufacturing and marketing processes. Furthermore, it provided support, guidance, and backing for the businesses being studied to introduce and implement support, marketing, and sales tools. These recommendations and suggestions were applied to a set of companies to evaluate the influence of ICT in the competitiveness and economic growth of agri-food traditional sectors.

## 3 | MATERIALS AND METHODS

The methodology for analysis of the potential for technological modernization and innovation based on ICT in agri-food companies of the central region of Portugal followed three sequential steps:

- Step 1—Definition of the sample.
- Step 2—Script structuring and construction of the questionnaire.
- Step 3—Conducting interviews.

### 3.1 | Definition of the sample

The definition of the stratified sample required the following tasks:

- Identification of the different sub-sectors of the traditional agri-food sector with greater representation in central region of Portugal.
- Selection of the traditional agri-food companies for the sample (provided by the InovCluster—Association of Agro-Industrial Cluster of the Centre region of Portugal) (Botsiou & Dagdilelis, 2013).
- Selection of alternative companies, to ensure in proper time, any failure, or refusal response by the respondents of the preselected sample.
- Survey and validation of telephone and email contacts of the sample.

InovCluster's associates were potential companies to be part of the study. The contact list was analyzed, and after starting the survey it was verified that some contacts no longer corresponded to the initial phone numbers. Additionally, in the light of the worsening economic and financial situation, some of the companies initially contacted were extinguish.

Notwithstanding these constraints, the information provided, combined with the inquiry method adopted, allowed for an important methodological advance, namely allowing to direct the survey to all companies that fit the category and whose headquarters were in the central region of Portugal. These options increased the likelihood of obtaining more favorable response rates and ensured representativeness of the sampling process.

Table 1 shows the traditional agri-food sectors evaluated, the number of companies surveyed in each sector, as well as the range of variation of some data of these companies, such as the number of workers and turnover. The sector that contributed with most companies to the survey was the cereals sector, followed by the cheese sector. Only two companies from the horticultural sector participated in the survey, so the results for this specific sector are very limited.

As shown in Table 1, most companies have between 1 and 5 workers, so they have a small dimension. In the case of a single worker, this person is at the same time the owner, the manager, and the worker who uses ICT. Note that the turnover range is limited to the information provided by the companies.

### 3.2 | Script structuring and construction of the questionnaire

This step involved the definition of the screenplay for personal/telephone interview, supported by a number of issues directly related to

**TABLE 1** Details of the companies surveyed

Sector	No. of companies surveyed	No. of workers		Turnover [m€]	
		Min	Max	Min	Max
Cereals	15	1	5	2.5	100
Cheese	9	1	5	50	800
Olive oil	9	1	5	7	120
Dry sausages	8	2	5	50	600
Honey	7	1	3	1	50
Wine	5	1	5	1	100
Horticultural	2	1	3	50	n.a.

Abbreviation: n.a., not applicable.

readiness for the use of ICT tools. The questionnaire was composed by 50 questions about the following topics:

- Company information: In the topic were requested the following details of the company: Name, Address, Sector, Dimension, Number of workers, Business volume.
- Use of ICT and Internet access: In the topic were requested details concerning the: Use of computer systems, internet access, connected mobile devices, networks, corporate email address, enterprise management software, quality and traceability tools, cybersecurity, and automatic control.
- Use of Internet and online social networking: This topic covered questions related to web page and social networks, and its use.
- E-commerce: This topic involved questions related to marketing campaigns through the web, buy and sale online.
- ICT training: This topic evaluates the type and frequency of ICT training in companies.
- Other concepts.

After the end of the inquiry process, the database where replies were loaded was built automatically by the online application used. After loading the 50-person/telephone questionnaire results, data were exported in coma separate values format compatible with spreadsheet software.

### 3.3 | Conducting interviews

This step focused on the face and telephone interview process. In order to proceed rapidly with the face interviews, the team responsible to perform the live interviews was composed by two duly qualified elements, which received specific training for this purpose. At first, a session for presenting the study objectives was performed, simulating the interview (identifying potential constraints in getting some answers) and the procedures required for loading the surveys in the online application (ensuring a permanent monitoring of fieldwork). Subsequently, results monitoring ensured the accuracy and quality of information obtained.

The live/telephone inquiry process took place between November 1 and December 15, 2014, resulting in 50 interviews validated. The main constraints to conduct the interviews were:

- Specificities of some sectors concerning the work period (night or all day in the field) making it difficult to conduct telephone calls or arrange scheduling.
- Reduced sensitivity to the issues raised, as the business environment in these sectors, with many family farms, demonstrates a strong detachment or perception of the issues involved (low qualifications and age of responsible/workers).

## 4 | RESULTS AND DISCUSSION

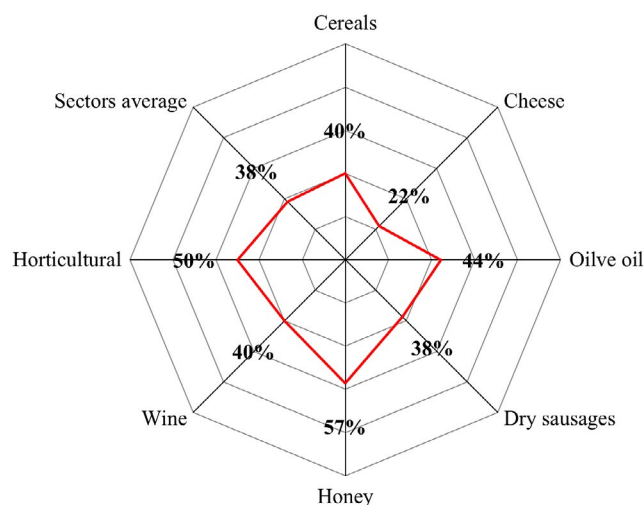
The compilation of questionnaire answers is described in this section. Only the most relevant data are presented, compared between sectors and discussed. The data is subdivided by the topics that structured the script. The results (positive answers) are presented as percentage to allow the subsequent comparative analysis of the results. It is important to highlight that the horticultural sector is characterized by the results of two questionnaires, which reduces its validity.

### 4.1 | Use of ICT and Internet access

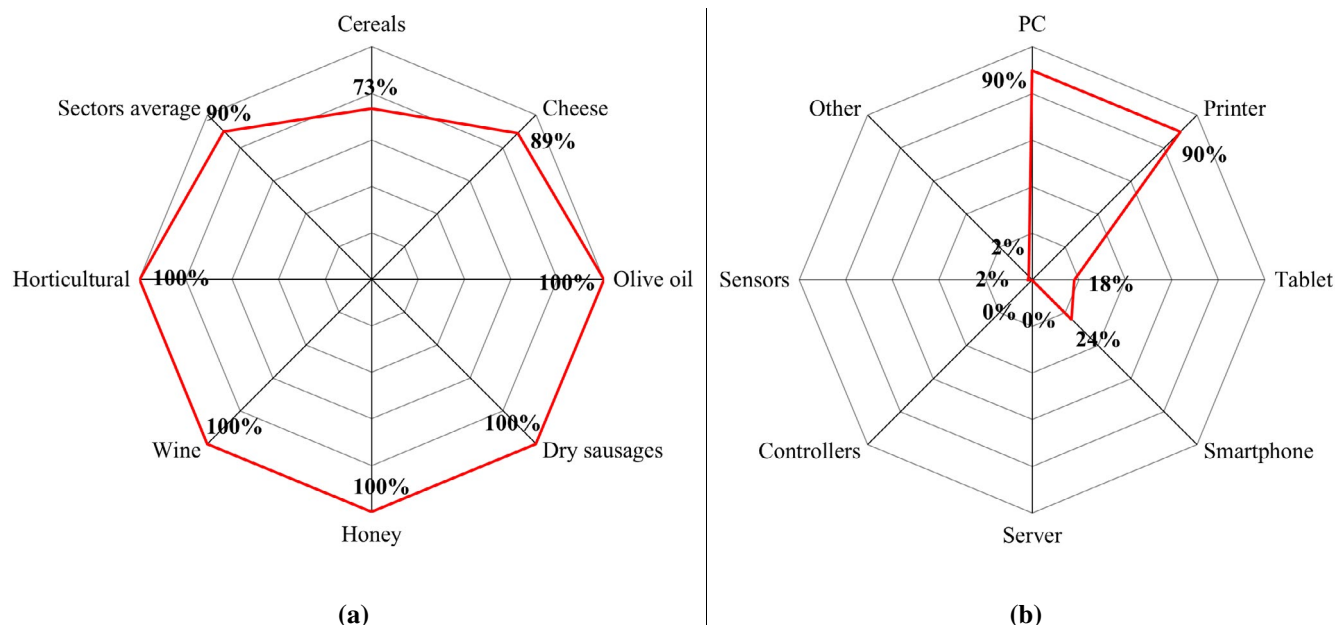
Figure 1 shows the availability of a collaborator responsible for ICT area in the traditional agri-food companies. Most of the companies have no one in charge for this area, although the large majority (90%) uses regularly ICT equipment as shown in Figure 2a.

Similar to the data obtained in the EC survey (EC, 2015bb), the computer is the usual equipment used to access Internet, although smartphone (24% in comparison with EU 61%) and touchscreen tablet (18% in comparison with EU 30%) are also used (see Figure 2b). The companies that answer negatively to this question pointed reasons such as lack of training, high cost, and no need for the business.

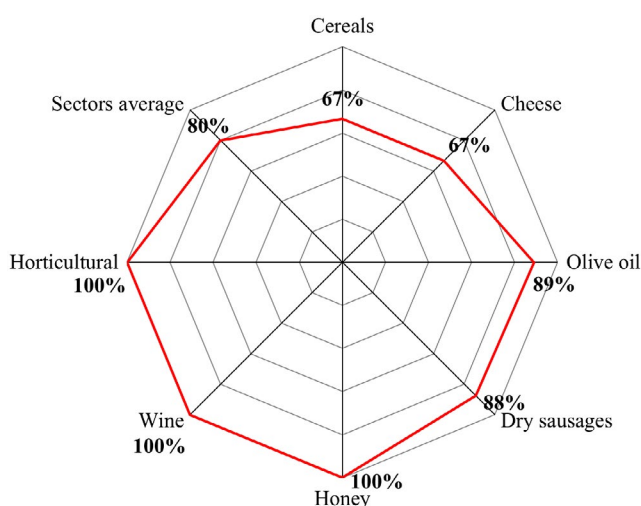
As shown in Figure 3, most of the companies have Internet service. Companies of cereals and cheese sectors show values below the average. Concerning the use mobile devices with Internet connection, fewer companies from the agri-food sector use this ICT.

**FIGURE 1** Availability of a collaborator responsible for ICT area





**FIGURE 2** Usage frequency and type of ICT equipment. (a) Regular use of ICT equipment. (b) Type of ICT equipment used



**FIGURE 3** Availability of internet service

Only 20% of the surveyed companies from the cereals use it (see Figure 4a). For the companies that use it, most of them (62%) use this feature for web navigation (62%) and access e-mail account (64%). The use of this feature for financial or industrial management applications is still reduced as shown in Figure 4b.

Most companies do not have a local area network (LAN) in their facilities (60%). However, most of companies do have a corporate email address (68%).

As shown in Figure 5a, most companies use regularly ICT tools for financial management (72%), although almost exclusively they use invoicing tools (72%). Thus, other ICT tools such as accounting tools and online banking are not usually used as shown in Figure 5b. Most of companies belonging to the honey sector do not use these ICT tools (71%).

As shown in Figure 6, less than half of companies regularly use CRM systems to support tasks of buying analysis or planning sales (45%). The majority of the companies belonging to the cheese sector do not use this type of system (89%). Additionally, only one of the companies surveyed uses Enterprise Resource Planning software. 84% of companies expressed that they have processes oriented for quality management related with:

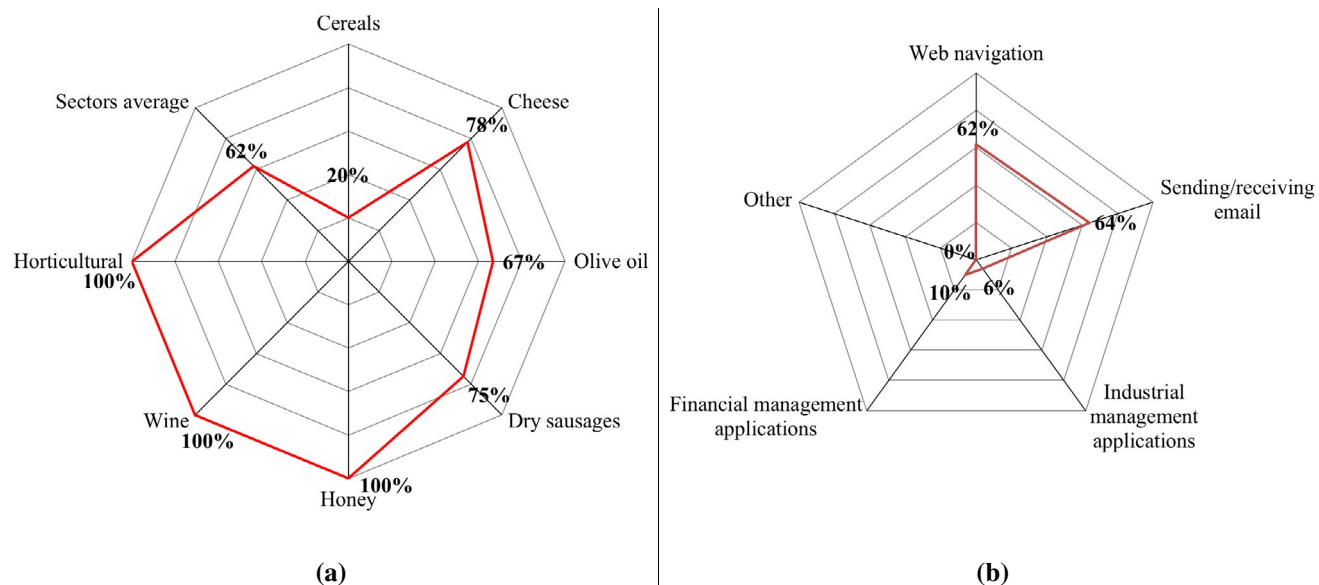
- Hazard Analysis and Critical Control Points required by Food Safety standards.
- Standard ISO 9001.
- Biological certification.

Additionally, 80% of companies stated that they use tools for products traceability. However, most of the tools used are not based in ICT.

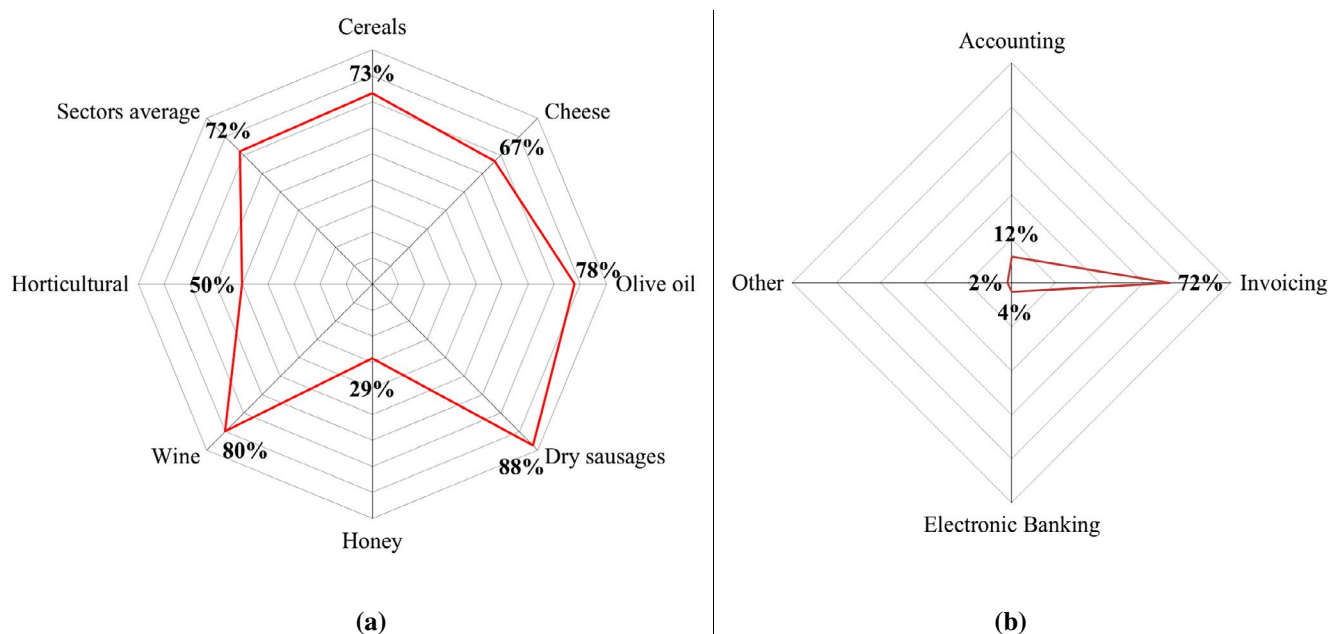
The following question focused on the use and knowledge of computer security services to protect the ICT from cybercrime. 86% of companies claimed to use of a security service such as antivirus and firewall. Safety copies, authentication mechanisms, and secure servers are not usual security services used by the companies. Nevertheless, these concerns about cybercrime are reflected in spreader use of online security tools as antivirus software when compared with the results of EU, where 61% of the Internet users changed their online behavior due to security concerns (EC, 2015bb).

## 4.2 | Use of Internet and online social networking

Figure 7a shows the percentage of companies that have a webpage. Most of the companies do not have it (24%). Only half of companies of dry sausages and horticultural sectors have webpages. For the other sectors, the availability of a webpage is even more reduced. However, most of the companies are interested in creating a webpage in the



**FIGURE 4** Use of mobile devices with Internet connection. (a) Use of mobile devices with internet connection. (b) Use objective



**FIGURE 5** Use of ICT tools for financial management. (a) Regular use of ICT tools for financial management. (b) Type of ICT tools for financial management

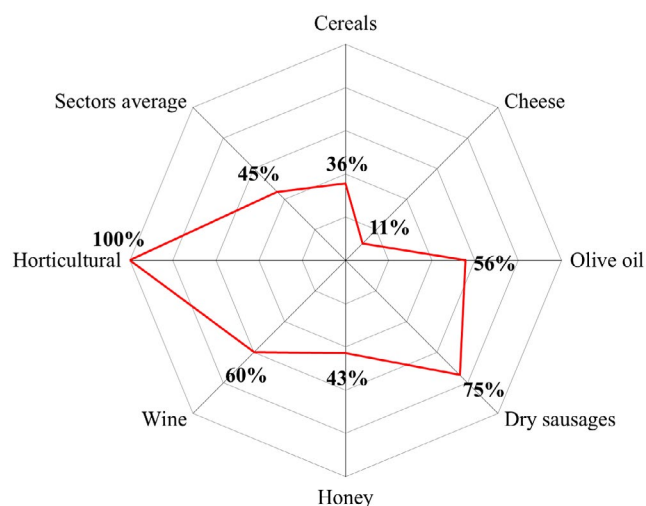
near future (44%) as shown in Figure 7b. However, there are still companies that claim not to need a company webpage (20%).

Most companies do not perform advertising campaigns through the Internet (60%). However, companies belonging to honey, wine, and horticultural sectors perform these type of campaigns (see Figure 8a). As shown in Figure 8b, half of the companies make use of social networks, mostly Facebook, for business purposes (54%). There are a reduced number of companies of the cereals sector performing this activity. The companies that provide a positive answer claim that online social networks are used as a consumer information

channel and as vehicle to promote company marketing. Additionally, half of the companies make use of social networks to search for suppliers and customers (43%).

#### 4.3 | E-commerce

Most companies do not sale products online (74%) as shown in Figure 9. The companies belonging to the cereals, olive oil, and dry sausages do not make use of this potential use of ICT. In the same sense, most companies do not purchase products for business over



**FIGURE 6** Regular use of a CRM system

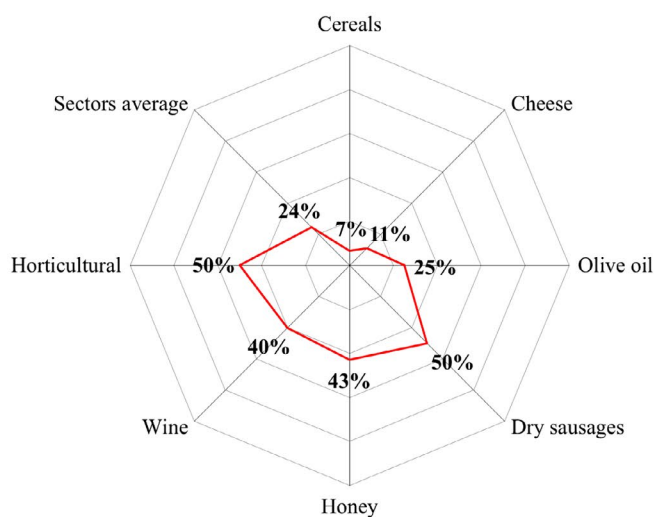
the Internet (68%) and half of the companies do not perform markets research over the Internet (52%).

#### 4.4 | ICT training

Figure 10 shows the investment of agri-food companies in ICT training during the last year. The training of company collaborators during the last year in ICT is reduced in all agri-food sectors (26%). Cereals, honey, and wine sectors did not encourage its collaborators to improve their knowledge and skills in ICT.

The ICT training performed on the companies during the last year focused the following topics:

- Office tools (text processor and spreadsheet).
- Applications for company specific systems.
- Enterprise management tools.



(a)

#### 4.5 | Other concepts

The last question of the questionnaire asked owners, managers, and workers of agri-food companies what are the equipment and/or technological solutions that may improve the company productivity and/or marketing of products and services. The overall answers are shown in Figure 11. 55% of companies think that possessing a company's webpage will improve company productivity and/or marketing of products and services. In addition, 41% of companies reveal that these objectives may also be accomplished providing ICT training to their collaborators.

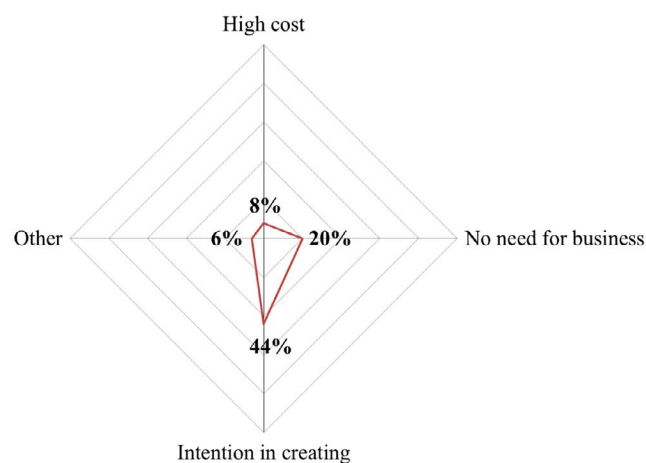
### 5 | SUGGESTIONS AND RECOMMENDATIONS

From a detailed analysis per sector, it turns out that the ICT usage is at approximately similar level. Thus, the following suggestions and recommendations that identify improvement opportunities arising from this analysis cross all sectors.

First, it is recommended to promote ICT training among company collaborators, specifically to who is in charge of management and finances in these micro and small companies. This training will promote the visibility of the company and foster e-commerce. The main objective is to make the owners/managers of these companies aware for the potential that the "virtual world" can offer to their businesses.

This objective can be accomplished pursuing the following recommendations:

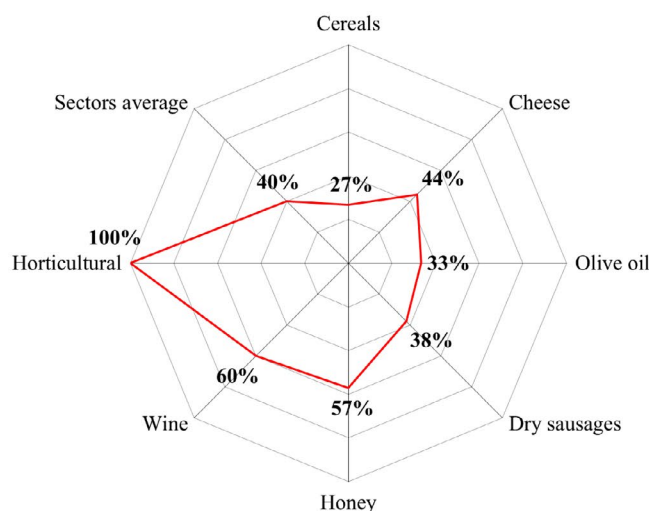
- Creating the company webpage to promote visibility of the company and to perform advertising campaigns through the Internet and online product sales.



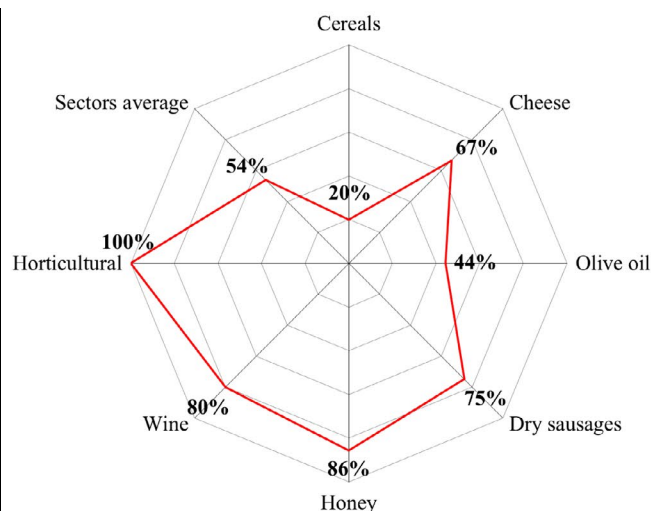
(b)

**FIGURE 7** ICT solution: webpage. (a) Existence of company webpage. (b) Reasons for lack of company webpage



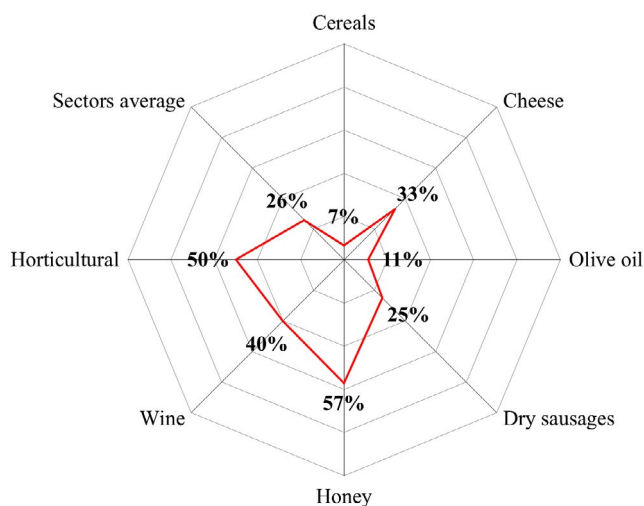


(a)

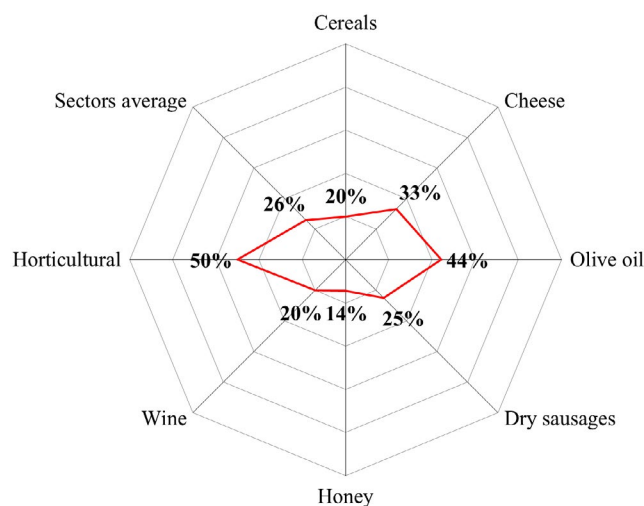


(b)

**FIGURE 8** Use of ICT solutions for promotion and business. (a) Promotion of advertising campaigns via Internet. (b) Use of social networks for business purposes



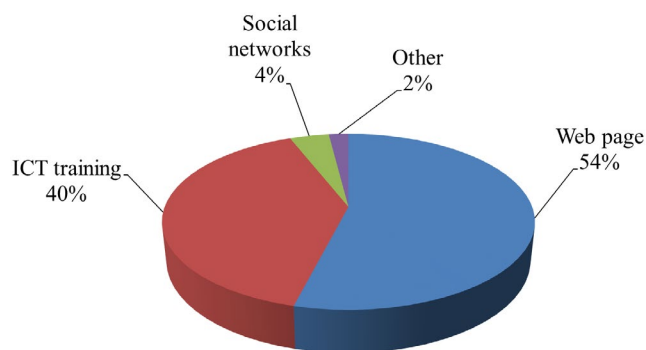
**FIGURE 9** Companies selling products via Internet



**FIGURE 10** Training in ICT for company collaborators in the last year

- Promoting ICT system upgrade in order to implement internal networks, which encourages setting corporate email and improves the communication between company employees. Thus, it is also recommended to assign the ICT responsibilities to a trained collaborator.
- Promoting the use of financial management tools, not only invoicing software. There are several suitable freeware tools for companies that do not want to affect more costs to this area.
- Promoting the use of CRM systems.
- Promoting the use of ERP systems.
- Promoting the use of ICT tools in the process-oriented quality management.

- Promote the use of ICT tools in product traceability.
- Creating a company account on online social networks to promote the company's products.
- This analysis provides a technological assessment of ICT that may help achieving more modernization and technological innovation in the traditional and strategic sectors. However, not all companies are suited to apply this set of recommendations. The suggestions and recommendations in terms of ICT tools application will depend on the specific characteristics of the company. Thus, it is necessary an in situ analysis to the manufacturing and marketing processes in order to determine the particular conditions that can be improved using ICT tools.



**FIGURE 11** Equipment and technological solutions to improve productivity and/or marketing of products and services

### 5.1 | Application of ICT solution for technological modernization and innovation in strategic and traditional sectors

The results analysis of the survey applied to 51 traditional agri-food companies in the Central region (Portugal) on the assessment for their technological modernization an innovation based on ICT, allowed to identify a number of opportunities for improvement that are believed to have cross-impact on the agri-food sector. So, a limited number (thirteen) of agri-food companies in traditional sectors were supported on ICT, from web page creation process, Facebook pages to CRM configuration, in order to boost their online sales. The consequent results of the companies are analyzed to evaluate and measure the influence of ICT in the competitiveness and economic growth.

## 6 | COMPANIES' ICT STATUS AND NEEDS

Table 2 gathers the ICT status and needs of each agri-food company belonging to different traditional agri-food sectors that participate

in the study. The table describes if the company uses regularly a CRM system; if it has webpage; if it uses social networks (Facebook and other) for business purposes; and if it carries out advertising campaigns using the Internet.

## 7 | COMPANIES' ICT SOLUTION

Table 3 shows the ICT solution developed to improve the competitiveness and economic growth of each agri-food company of traditional sector participating in the study.

The manager of Company C01 allowed the creation of the company's Facebook page (<https://www.facebook.com/tapadadassortes/?fref=ts>). An access to the personal account of company responsible was required to create the company's Facebook page associated to that user. The company C02 was supported in the development of a website to supplement the advertising campaigns performed through Facebook and to reach out their potential customers (<http://quintadocapile.pt/>).

The Company C03 did not used any type of ICT solution. Therefore, in order to start advertising products through the internet, the manager choose to be supported with the creation of a web page (<http://www.saboresdasoalheira.pt/>). The manager requested a webpage available in two languages, Portuguese and English. A multipage structure was developed with a minimal and clean design, focusing on the UX (user experience) and use on mobile platforms. The webpage of company C04 was also created to better disclosure the products and consequently to reach more customers (<http://casaagricolacabecocavao.pt/>). The ICT solution for Company C05 was the development of the webpage (<http://queijariacasadomorgado.com/>). In regards to Company C06 (<http://queijariaabreu.pt/>), the respective webpage was developed since it manager mentioned that the company' productivity and/or commercialization of products and services could be improved

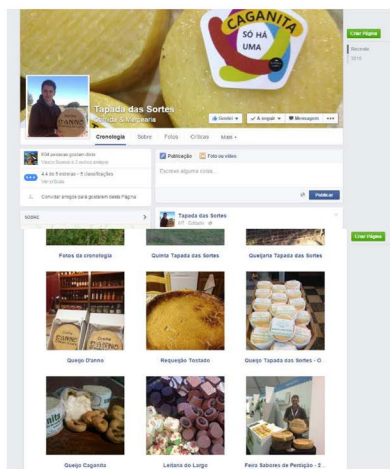
Number	Agri-food sector	CRM	Website	Social networks	Advertising via Internet
C01	Dairy (cheese)	N	N	N	N
C02	Dairy (cheese)	N	N	Y	Y
C03	Dairy (cheese)	N	N	N	N
C04	Dairy (cheese)	Y	N	Y	Y
C05	Dairy (cheese)	N	N	Y	N
C06	Dairy (cheese)	N	N	N	N
C07	Honey	Y	N	N	N
C08	Honey	Y	Y	Y	Y
C09	Honey	N	N	N	N
C10	Honey and sweet jams	Y	N	Y	Y
C11	Meat (cured sausages)	N	Y	N (outdated)	–
C12	Horticultural	Y	N	Y	Y
C13	Wine	N	Y	Y	Y

Abbreviations: N, No; Y, Yes.

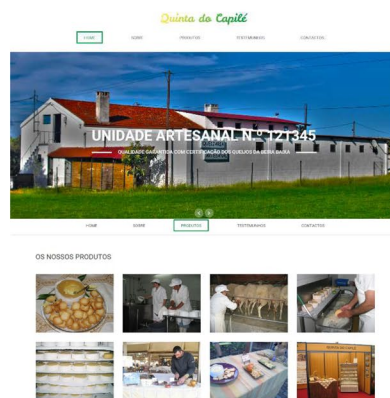
**TABLE 2** ICT status and needs of agri-food companies of traditional sector participating in the study

**TABLE 3** ICT solution developed for the agri-food companies of traditional sector participating in the study

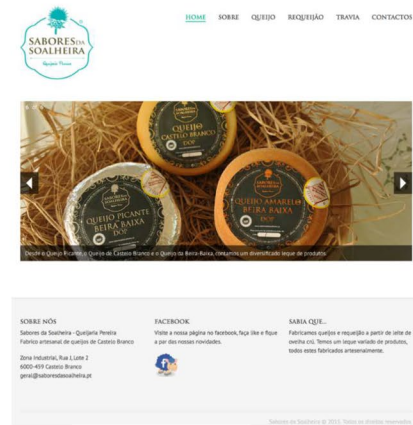
Number	Agri-food sector	ICT solution
C01	Dairy (cheese)	1. Company's Facebook page
C02	Dairy (cheese)	1. Company's website
C03	Dairy (cheese)	1. CRM system 2. Company's webpage 3. Improvement of the company's Facebook page
C04	Dairy (cheese)	1. Company's webpage
C05	Dairy (cheese)	1. Company's webpage
C06	Dairy (cheese)	1. Company's webpage
C07	Honey	1. Company's webpage 2. Improvement of the company's Facebook page
C08	Honey	1. Improvement of the company's webpage
C09	Honey	1. Company's webpage
C10	Honey and sweet jams	1. Company's webpage
C11	Meat (cured sausages)	1. CRM system 2. Improvement of the company's Facebook page
C12	Horticultural	1. Company's webpage
C13	Wine	1. CRM system



(a)



(b)



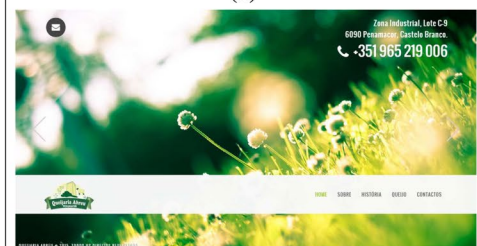
(c)



(d)

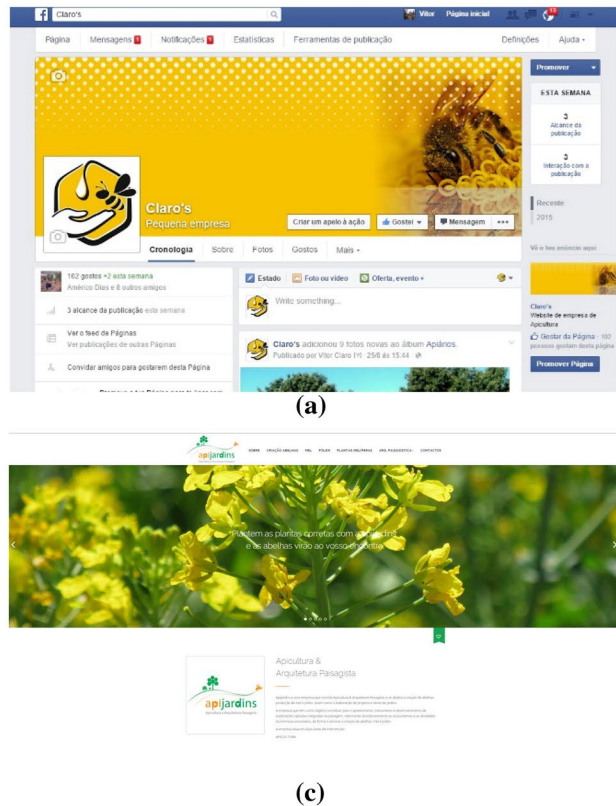


(e)

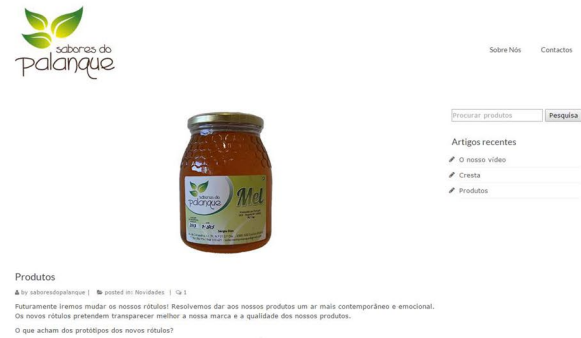


(f)

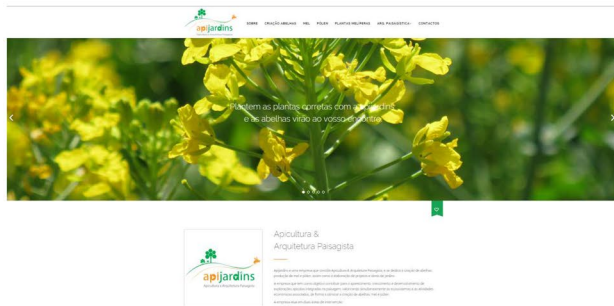
**FIGURE 12** ICT solutions developed for the companies of the dairy (traditional cheese) sector. (a) Company's C01 Facebook page. (b) Company's C02 webpage. (c) Company's C03 webpage. (d) Company's C04 webpage. (e) Company's C05 webpage. (f) Company's C06 webpage



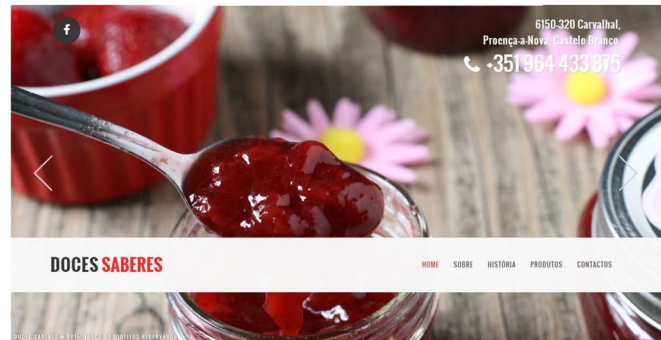
(a)



(b)



(c)



(d)

**FIGURE 13** ICT solutions developed for the companies of the honey sector. (a) Company's C07 Facebook page. (b) Company's C08 webpage. (c) Company's C09 webpage. (d) Company's C10 webpage

by disclosure them in the webpage. Figure 12 shows the ICT solutions developed for the companies of the dairy (traditional cheese) sector.

Company C07 already uses one of the recommended ICT solutions. The manager choose to be supported in the improvement of the Facebook page ([https://www.facebook.com/claros.pt?ref=aymt\\_homepage\\_panel](https://www.facebook.com/claros.pt?ref=aymt_homepage_panel)).

Once the webpage of company C08 (<http://saboresdopalanque.pt/>) already existed, the company intended to be supported in few changes to the webpage, in particular, the correction of some text, removing and adding some photos of their products, and also adding a newsletter.

Likewise Company C06, the ICT solutions for Companies C09 and C10 (<http://doceassaberes.pt/>) consisted in the development of the companies webpages, since it managers pointed the same reasons that lead to the development of these ICT solutions. Figure 13 shows the ICT solutions developed for the companies of the honey sector.

Among the possible ICT solution for Company C11, the manager chosen the creation of a Facebook page of the company (<https://www.facebook.com/Enchidos-Malpica-do-Tejo-982437265111567/>) to show products and it production, as well as the pictures of participation in fairs and events. Since the responsible had no personal Facebook account, it was necessary to first create a profile and then create a company page. The results are shown in Figure 14.

The webpage of company C12 was created to show the company's history, products and contacts. The websites of companies (C02,

C03, C04, C05, C06, C09, C10, and C12) were created using HTML5 technology, CSS3 (Bootstrap framework and Font Awesome), JavaScript (jQuery). The homepage of the Company's C12 webpage is shown in Figure 15.

The Company C13 choose to be supported in the development of a CRM system. The development of the CRM system required the organization of the following data: Contacts, Organizations, Opportunities, Home, Reports, Projects, FAQ, Calendar, Leads, Documents, email campaigns, Social module, Forecasts, builder module, Recycling, and Label Editor. A window of the CRM tool is shown in Figure 16.

As output of the project, several webpages, Facebook pages, and CRM tools were developed or improved and configured, in order to boost the online sales of a set of agri-food companies belonging to traditional sectors. It was intended that in the course of this activity improving the ICT of at least 25 of the 51 companies where the survey conducted under the Activity 1 was conducted. However, most companies did not show interest to cooperate and proceed with the implementation of ICT improvements. The main argument pointed out by the companies' managers was the lack of time. It is worth mentioning that even though interventions at the level of the production process and the introduction of support tools in some of its modules (accounting, logistics, and human resources) were planned, the companies expressed particular interest in the development of webpages and Facebook, and only one of which required setting up a CRM system. The major constraint pointed out was the time





**FIGURE 14** ICT solution developed for the company of the meat (cured sausages) sector



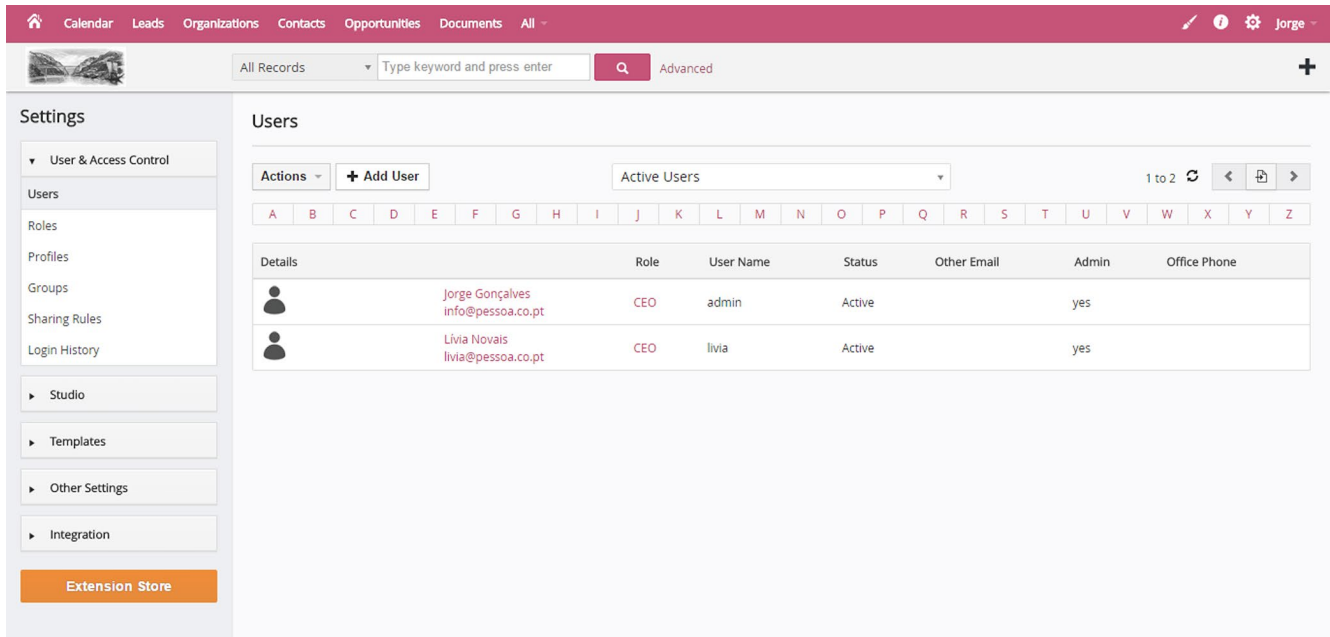
**FIGURE 15** ICT solution developed for the company of the horticultural sector

required to setting up the ICT improvement that took significantly longer than originally planned, mainly due to delays in collecting data process, information needed and validation of implementations. It is considered that so far interesting results have obtained, which sustain the reasons to further proceed with this kind of support in agri-food companies. The 13 companies intervened expressed full satisfaction with the ICT solution. Figure 17 shows the satisfaction

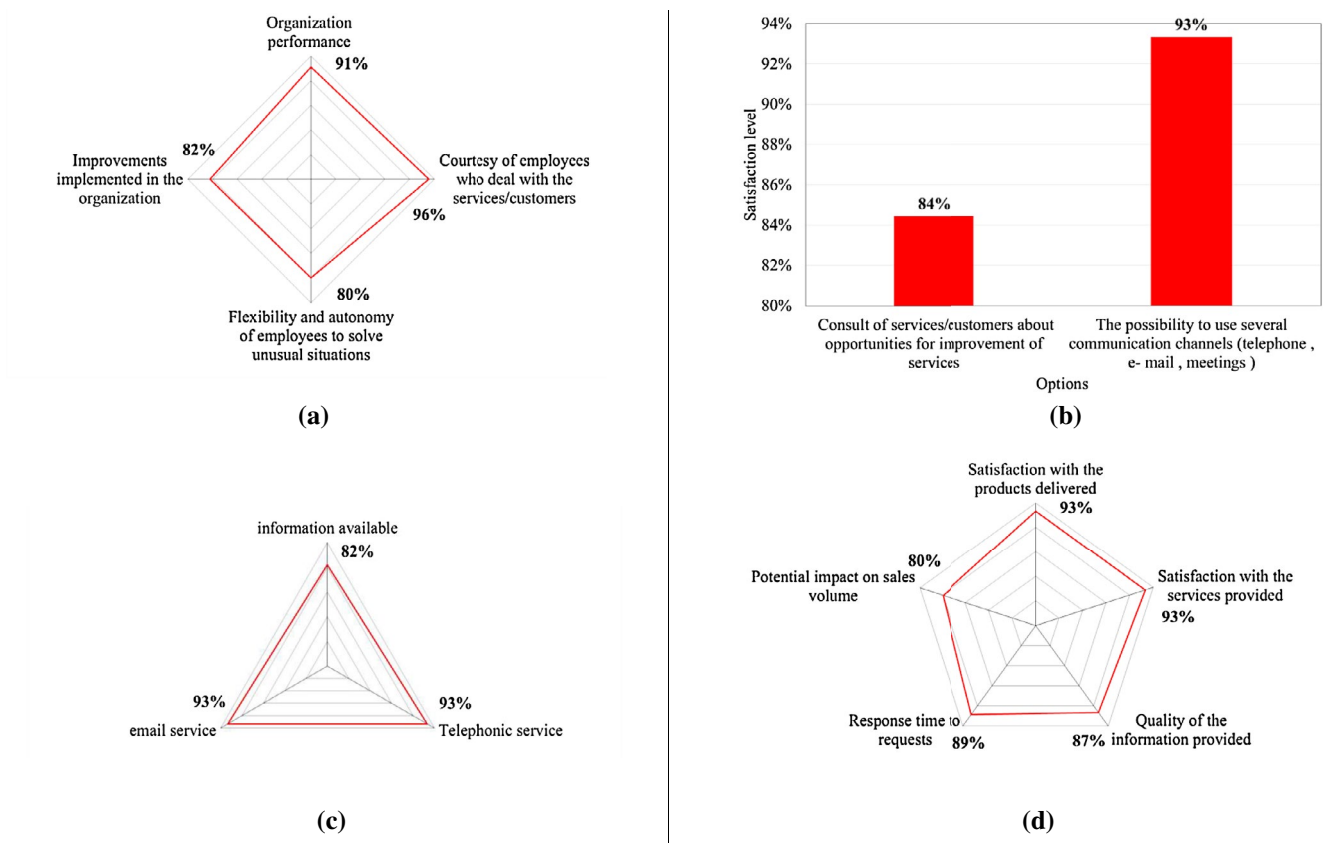
survey results on the ICT solution that was developed. The satisfaction survey analyzed four main topics: (a) overall image of the organization responsible for the development of the ICT solution; (b) involvement and participation; (c) accessibility; and (d) products and services.

Figure 17 clearly shows that companies' managers consider very positive the ICT solution developed and provided feedback





**FIGURE 16** ICT solution developed for the company of the wine sector



**FIGURE 17** Results of the satisfaction survey results on the ICT solution that was developed. (a) Overall image of the organization. (b) Involvement and participation. (c) Accessibility. (d) Products and services

concerning the positive impact in sales due to the visibility of the company on the web.

## 8 | CONCLUSIONS

This paper presents the results of a survey for the assessment of the potential for technological modernization and innovation based on ICT. The survey was applied to 50 agri-food companies belonging to cereals, cheese, olive oil, dry sausages, honey, wine, and horticultural sectors located in the central region of Portugal. The main objective of this analysis is to propose actions and measures that promote economic growth and employment by increasing competitiveness in economy strategic and traditional sectors.

The analysis of results suggests that most company owners and/or managers use ICT tools, but at different levels. There are those that are familiarized in the use of ICT and use it in their enterprise, but also the precise opposite type where they claim total disinterest for ICT, either due to cost or no need for its application in their specific business. Although the study was performed in a single limited region of Portugal, what can be seen as limitation by reducing the results generalization, the results are especially useful for countries, like Portugal or Spain, with great opportunities to improve ICT diffusion rates.

From the results analysis, it is recommended to promote ICT training among company collaborators to improve the knowledge on ICT applications as well as their skills. These educational programs aim not only to improve these competences but also to change distrust and suspicion attitudes about ICT tools. The creation of web-pages is also fundamental to promote the visibility of the company and to increase the e-commerce.

The recommendations and suggestions that result from the assessment were applied to a limited set of companies to evaluate and measure the influence of ICT in the competitiveness and economic growth of agri-food traditional sectors. The main ICT solution were the creation of Facebook page and company webpage. A CRM system was developed for one company. A satisfaction survey was carried out at the end of the implementation of the ICT solutions. Companies' managers were fully satisfied with the ICT solution developed specifically for their companies and asserted that the company sales increased due to the web visibility gained by the company products.

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## CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

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## REFERENCES

- Bayo-Moriones, A., & Lera-López, F. (2007). A firm-level analysis of determinants of ICT adoption in Spain. *Technovation*, 27, 352–366.
- Boccia, F., & Covino, D. (2016). Innovation and sustainability in agri-food companies: The role of quality. *Rivista di Studi sulla Sostenibilità*, 1, 131–141. <https://doi.org/10.3280/RISS2016-001010>
- Botsiou, M., & Dagdilelis, V. (2013). Aspects of incorporation of ICT in the Greek agricultural enterprises: The case of a prefecture. *Procedia Technology*, 8, 387–396.
- Covino, D., & Boccia, F. (2016). Potentialities of new agri-biotechnology for sustainable nutrition. *Rivista di Studi sulla Sostenibilità*, 2, 97–106. <https://doi.org/10.3280/RISS2016-002009>
- EC. (2010). *A Digital Agenda for Europe*. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, European Commission (EC), COM/2010/0245 f/2, May 2010.
- EC. (2015a). *A Digital Single Market Strategy for Europe*. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, European Commission (EC), COM/2015/0192, May 2015.
- EC. (2015b). *Cyber Security Report—Special eurobarometer 423*. European Commission (EC), Directorate-General for Home Affairs.
- Eurostar. (2014). *Enterprises—Level of internet access (NACE Rev. 1.1 activity)*. Luxembourg: Statistical Office of the European Communities (Eurostat).
- Eurostar. (2015). *Households—level of internet access*. Luxembourg: Statistical Office of the European Communities (Eurostat).
- Eurostar. (2016a). *Social media—Statistics on the use by enterprises*. Luxembourg: Statistical Office of the European Communities (Eurostat).
- Eurostar. (2016b). *Information society statistics—Households and individuals*. Luxembourg: Statistical Office of the European Communities (Eurostat).
- InovCluster. (2013). *MITTIC—Technological Modernisation and Innovation based on ICT in strategic and traditional sectors*. Retrieved from [www.inovcluster.pt](http://www.inovcluster.pt)
- Kaloxylas, A., Wolfert, J., Verwaart, T., Terol, C. M., Brewster, C., Robbemond, R., & Sundmaker, H. (2013). The use of future internet technologies in the agriculture and food sectors: Integrating the supply chain. *Procedia Technology*, 8, 51–60.
- Lehmann, R. J., Reiche, R., & Schiefer, G. (2012). Future internet and the agri-food sector: State-of-the-art in literature and research. *Computers and Electronics in Agriculture*, 89, 158–174. <https://doi.org/10.1016/j.compag.2012.09.005>
- Mayer, W. H. (2013). Integral ICT solutions supporting farmers businesses as well as environmental caretaking incl. carbon optimization. *Procedia Technology*, 8, 550–553.
- Moghaddam, B. K., & Khatoon-Abadi, A. (2013). Factors affecting ICT adoption among rural users: A case study of ICT Center in Iran. *Telecommunications Policy*, 37, 1083–1094. <https://doi.org/10.1016/j.telpol.2013.02.005>
- Schiefer, G. (2004). New technologies and their impact on the agri-food sector: An economists view. *Computers and Electronics in Agriculture*, 43, 163–172.
- Senthilkumar, S., Chander, M., Pandian, A. S. S., & Kumar, N. K. S. (2013). Factors associated with utilization of ICT enabled Village Information Centres by the dairy farmers in India: The case of Tamil Nadu. *Computers and Electronics in Agriculture*, 98, 81–84.

- Sturiale, L., & Scuderi, A. (2013). Evaluation of social media actions for the agrifood system. *Procedia Technology*, 8, 200–208.
- Verdegem, P., & De Marez, L. (2011). Rethinking determinants of ICT acceptance: Towards an integrated and comprehensive overview. *Technovation*, 31, 411–423. <https://doi.org/10.1016/j.technovation.2011.02.004>
- Zhang, Y., Wang, L., & Duan, Y. (2016). Agricultural information dissemination using ICTs: A review and analysis of information dissemination models in China. *Information Processing in Agriculture*, 3(1), 17–29.

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