A Review of Internet-based Technologies and Applications in the Food Industry

Saeed Samadi
Food Machinery dept.
Research Institute of Food Science & Technology (RIFST)
Mashhad, Iran
s.samadi@rifst.ac.ir

Abbas Pourzaki
Electrical Eng. dept.
Asrar Institute of Higher Education
Mashhad, Iran
a_pourzaki@yahoo.com

***Abstract*— In the modern world, information technology (IT) has been incorporated in most development activities. The food production industry is one of the recent industries to embrace IT in their major daily operations. The aim of this paper is to review the technical and scientific state of the art of internet-based technologies and future trends in the Food industry. These technologies are mainly classified into Radio Frequency IDentification (RFID) for supply chain management, quality and safety monitoring, e-commerce, robotics, Wireless Sensor Networks (WSN), and Geographic Information Systems (GIS). Since all emerging technologies are coupled with challenges, the study addresses both challenges and benefits of incorporating IT in the food industry. This paper discusses how IT can be integrated to enhance the safety and quality of food products. Internet standards and the role of social media and smartphone applications in agriculture and food industry are the other important aspects that are discussed in separate sections. Also, this paper highlights the potential of Internet-based applications, which may be efficient in future as well as the role of IT in support of sustainable food choices. The paper concludes by arguing that awareness be raised within the agro-food industry on the importance of the adoption of Internet-based technologies as a critical success factor in the twenty-first century.**

Keywords - food industry; information technology; Internet; RFID; standards; social media; e-commerce; SME.

I. INTRODUCTION

This paper is an improved and expanded version of the AFIN 2014 conference paper "Applications and Opportunities for Internet-based Technologies in the Food Industry" [1].

Information and communication technology has been defined as capturing, exchange, processing, transforming, and emission of the data. Its advances are based on penetrating of internet and mobile set in mass people all around the world.

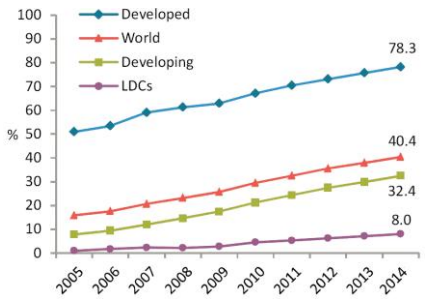

Figure 1. Individuals using the Internet, 2005-2014 [2]

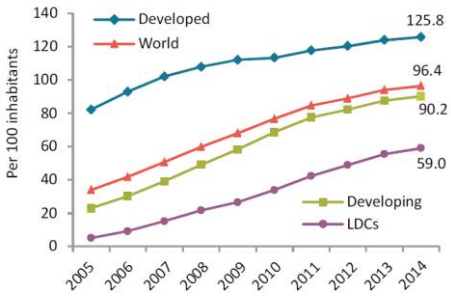

Figure 2. Mobile-cellular subscriptions, 2005-2014 [2]

Information technology (IT) is one of the individual forces that has contributed to globalization and advancement of life standards. These advancements have been occurring rapidly due to the rate of innovation from the IT industry. Significant incorporation of IT in most of the developmental activities is proof of the spread and importance of this technology. IT has been globally incorporated in construction industries, production, manufacturing, healthcare, education, information management, security, and food and agricultural production. However, IT has been embraced at different levels by the fields mentioned above. Information management ranks as the most advanced field concerning use of IT [3]. On the other hand, agriculture ranks as the least innovative field as far as incorporation of IT is concerned. Other fields of production besides agriculture and food obtain maximum potential production from their fields due to highly incorporated IT systems [4]. Unfortunately, agriculture and food production do not extract their maximum potential because of their low level of IT incorporation. Most of the yield available in the agricultural sector is retrieved from small and medium sized enterprises (SME). Therefore, high scale production firms from the food and agriculture production industry are not constructive parties in the business [5]. SME are characterized by either low or medium financial capacity. This financial background is not able to fully fund state-of-the-art technologies such as radio frequency identification (RFID), wireless sensor networks (WSN), and integration to e-commerce. These technologies are available for application by the food and agriculture industry, and once incorporated, agricultural and food production would be able to maximize its potential [6]-[8].

The rest of this paper is organized as follows. Section II summarizes a review of literature. Section III discusses the use of the most important and available Internet-based technologies in the food industry, the main aim of the paper.

It is includes: RFID, Tracking and Tracing, monitoring, E-commerce, Robotics technology, Wireless sensor network, and Farm management. Section IV discusses internet standards in the agro-food industry from EDI protocol to AgroXML and trace2p2 in finer detail. Section V includes applications of social media to smartphones. Section VI describes future internet based solutions and Section VII demonstrates information technology in support of sustainable food choices. Finally, Section VIII includes overall discussions and concluding remarks.

II. LITERATURE REVIEW

Currently, food and agricultural production has incorporated IT to a significant degree. Unfortunately, there still exist technical challenges that have resulted in the industry incurring losses and gaining a bad reputation. These technical challenges can be corrected through application of the mentioned technologies [9]. IT is signified by techniques that result in faster, efficient production with minimal human effort. Agricultural production is an economic activity that is more dependent on human input relative to machine input than other activities. This does not mean that technologies to minimize human effort and input in the industry are absent. Technologies that can result in reduction of human input exist in the industry, but the prevailing challenge is the cost of operation. As initially stated, SMEs comprise robust producers in the industry and lack sufficient capital to sustain these technologies [10]. IT applications relevant to the field of agriculture require high initial capital, but are cost effective. Areas within the field of agricultural production that can incorporate IT include: supply chains, harvest, standardization, marketing, soil fertility, and yield prediction [11]. These areas can be improved by the following technologies: RFID, WSN, GIS, robotics control, and e-commerce. These technologies are applied in the agricultural and food production industry to fulfill different objectives. These technologies utilize networks for communication. However, some technologies such as RFID have more than one application in the industry. It can be used in supply chain management and also in traceability for standardization [12].

III. AVAILABLE TECHNOLOGIES

In this section some main technologies on it-based food topics are discussed.

A. RFID Technology

This technology uses radio frequency to identify or retrieve information from production. It operates using the same mechanism as barcodes with magnetic strips [13]. Instead, of a barcode, RFID uses microchips that are embedded on the product of interest. RFID has two main advantages over barcodes. In the case of a barcode, it has to be on the line of sight of the barcode reader for information to be obtained from it. RFID is advantageous because the chip and the reader do not have to be on a line of sight to retrieve information from the chip, because the chip produces specific radio frequencies. The other advantage of RFID is that the chip is more reliable than the barcode [10]. This is because validity of barcodes is ruined once the code is scratched or removed. RFID microchips are not easily removed because they are not attached to the surface of the product.

RFID technology can be used in supply chain management and standardization. Food quality has been the cause of controversy in the food industry. Food that has not been properly stored has higher chances of going bad and once food has attained this status, it can become toxic. Food toxicity is dangerous as it can result in complex health disorders or even death. Therefore, a compromise on the quality of food is likely to ruin the reputations of the supplier and manufacturer, and this translates into losses [5]. RFID enables the user to establish the amount and type of ingredients contained in the food product. In addition, it also provides the time elapsed from the time of manufacture to the time of first use. This information is imperative to both the retailer and the consumer. Cases of food poisoning as a result of consuming expired food or allergic substances would be substantially reduced.

The other core challenge in the food production and agriculture industry is supply chain management. Some food products are essential for humans, but their production is unique in specific regions. Therefore, a comprehensive supply chain should be established so as to benefit both the manufacturer and consumer. The supply chain involves the food transit process from harvest, to processing, to distribution to the retailer [14]. Food undergoes this process before reaching the end user. Despite the extensive route, which is undergone before a product's use, monetary value has to be established. This means that the end user is not overcharged and the manufacturer is not underpaid [15]. RFID technology establishes an infrastructure that tracks a food product's location and ingredients, thus enhancing reliability of the end product. Farmers, specifically involved in food production, have been discouraged from expanding their investment due to limited profit from their enterprise. Previously, middle-men have benefited more than either the farmer or the consumer, minimizing profits to these constituents. Currently, with the employment of RFID, profits and satisfaction have improved because the supply chain of the goods has been bolstered by the technology. RFID technology has to be applied from the point of production (farmer) to the consumer. This reduces the bulk cost that could have been incurred by the distributor or supplier [16]. Wal-Mart is among the supply companies that have encouraged manufacturers to incorporate RFID to increase their profits. They encourage manufacturers through financing part of the RFID implementation. This practice is prevailing in most developing countries, as SMEs are financed to increase agricultural food production performance in the international market.

B. Tracking and Tracing

Traceability is the track or trace product ability in a production line, distribution processes, etc. It indicates that product flows are recognizable and can be logged uniquely and systematically (see Figure 3). The main reasons for growing attention to traceability in the food technology are new legislative requirements and the increasing demand for administrative systems and quality [16].

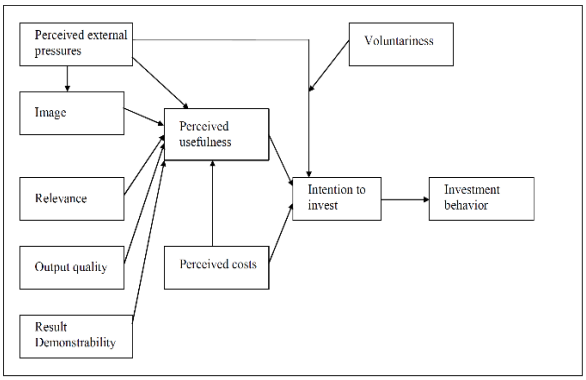

Figure 3. Tracking and Tracing Systems Investment Model [16]

Tracking and tracing are similar in some features but different in main characteristics. Tracing can be divided into upstream and downstream. Tracking follows the flow of downstream wares in in real-time (e.g., for creating situation data) while downstream tracing is not due to time. Tracing can be used in marketing or it can active goods recalls. Tracing has the ability to follow a product reverse direction, from the end product towards its start point. This can detect potential fail origin in food source networks [17]- [18].

In Japan, for safety assurance, a food traceability design has been constructed, which got knowledge about food production and distribution chains. Toward this object, the Japan Agricultural Cooperatives (JA), local governments, and the Japanese government have been incorporating in the proceeding of national projects, i.e., food traceability systems (FTS).

Filling the data forms of farm management is a labor work for almost farmers. Nowadays, Internet services and mobile phones are spread among peoples, especially farmers. Thus, for managing the agricultural production process an efficient "Farming Diary System" is developed. It use web compatible mobile phones [19]. As a commercialized version of this system, an internet software, "Application for Agricultural Methodological Analysis" (AFAMA) was developed in 2002.

Farmers, the major users of AFAMA, can insert their agro-food process information such as farm works and material applications in their cultivated fields while he/she do his activities in farm. The individuals can select input options such as materials, machines, fields, and crops. Using the AFAMA can be stepped as following:

a) Connecting a computer or mobile phone to the AFAMA Website log in using user ID and password.
b) Insert own data to customize one's materials, machines, fields, and crops.
c) Input the designs of material and cultivation and the operation data to choice the scheduled items.

C. Monitoring

Intervention in hot situations can be succeed if real-time data available. This avoids the cargo have been missed because of quality deficits. For example, fruits and vegetables transport from the countries of Southern European to Germany suffer transport time of about 50 hours (Spain to Germany). In this interval, the quality of products can decreases considerably under undesired conditions. In failing cooling system the monitoring system generates instantaneous information to the owner of the cargo. The cargo can be delivered to a near cold storage until the cooling system of the vehicle have been repaired.

Advances in the sensor network adding to communication allow the ability to real time observe of trucks positions and status. These technologies are developed more by new logistic service suppliers. These service suppliers get real time monitoring data and are able to convert them as a service for fresh produce customers. Especially, distribution chain data such as approximated arrival times and the transport status activate development in the commercial system of distribution shops. These developments decrease time of arranging reception of products and the shipping of them from distribution shops.

The position due to quality monitoring is such that cause the communication and processing will be unsuitable. High quality monitoring of food needs complicated sensor and information communication technology. Fresh goods sense out changes.

Temperature and humidity are the most important parameters for maintain desired food quality. They must be controlled and communicated within the information service, throughout the distribution chain from start (harvest) to end (retail outlets). Other interests in monitoring are far from forward product quality and include more environment data (e.g., CO_2 or NH_3 emissions).

Food quality and safety monitoring

In China, profits in the food industry have declined by 50 percent as a result of contaminated food. This shows the sensitive nature of the food industry as a single flaw has the potential to bring down the whole industry. In addition, China's food production is also mainly extracted from small scale investors. This means the sector is not fully exploited. One of the technologies that the country has embraced to enhance the status of the food supply is RFID food packaging. This technology uses RFID to identify the ingredients and the inventory of food products [21]. It utilizes disposable biosensors that produce an antigen-antibody reaction to identify any bacterial cells in the food product. When bacteria thrive in an enclosed food product, the result is a bio-chemical reaction that would either make the food product stale or poisonous. Therefore, this technology helps the food industry upgrade their monitoring systems, and the quality and safety of food products is enhanced. As a result, IT has aided in the restoration of trust between consumers and manufacturers. Furthermore, since the introduction of RFID food packaging, the number of health issues associated with food poisoning or food quality has declined by more than 50 percent. RFID technology also has an additional use as biosensors used in the tags containing inventory information that can be used in supply chain management. Traceability of food products from the farmer to the consumer is the other main concern in the food production industry. Effective supply management is a barrier that prevents SMEs from maximizing their potential. RFID detection technology poses a remedy to this barrier; RFID stores ingredients, destination, and the appropriate

geographic location of products [21]. This helps the food industry realize their market extent and as a result increase or reduce their production where necessary, thus minimizing losses. This technology enables rapid detection of poisons or derailed quality of finished food products. It also enables automatic identification of food products along a supply chain.

D. E-commerce

Internet technologies within the context of e-commerce have provided a more interactive market that enhances communication between manufacturers and consumers. This can be accomplished through existing social networking sites such as Facebook and Twitter. Manufacturers append their social networking websites on containers of food products so that in case of a complaint or compliment, the user can directly communicate with the food company [22].

When there is a reliable communication pathway between service or good providers and the end user, performance of the product is likely to be high. This is relative to a scenario where there is no elaborate communication between the user and manufacturer. IT provides better database management systems that portray the accurate needs of consumers. E-commerce expands the food market as the Internet is able to establish new consumers from regions where a specific food product has not yet been sold. E-commerce serves to benefit SMEs more because of their otherwise insufficient capital to market their food products. E-commerce is cheaper than hiring a marketing firm. This system requires less than five users to conduct online marketing and thus is affordable for SMEs [23].

As a result, SMEs can access a larger market without seeking additional financial assistance to facilitate marketing. Therefore, Internet technologies ensure development of a more reliable supply chain, higher quality food products, and a larger market for food products [24].

SMEs and consumer groups in local agribusiness

The main activities in retail is focused on decreasing the number of firms controlling portions of the retail bazar [25]. It is motivation of agrifood SMEs to give competitive advantages in their businesses. Some of their ways were joint initiatives and new methods for co-working [26]. A new method to exploit the benefits of repositioning is the new food networks for exchanging coalitions of consumers and clusters of agrifood producers in order to overcome the large-scale chain of retails. These arrangements have become increasingly important as a tools of decreasing cost, or mitigating economic risk [27].

If the compatibility of a commerce ICT proposal allows to purchase/sell agrifood goods more economic and efficiently, the main activator is "trust". Trust is a key in e-commerce and that its lack is one of the main factors for buyers to not use the Internet market. From the view of customers, for an online business trust in sellers is required but not sufficient [28]. It is investigated that customers trust almost are based on the reputation of the intermediary, web usability, and transaction security. So, intermediary should guarantee completion of the transaction chain and the sellers trust.

The trusted third party (TTP) is a systematic unit that uses equal trust from both the agrifood suppliers and buyers. Its goals are influence on innovation decisions, facilitate transactions, systemize the agrifood trade network, and, more important, provide and manage the 'trust structure', where e-commerce motivated by agrifood supplier clusters and buyer groups can be sufficiently guaranteed.

TTP has three roles in intermediation between suppliers and buyers groups:

- Technology intermediary, whose duty is to supply the ICT components such as security, hardware, and communication;
- Transaction intermediary services such as consultancy, hosting, and applications software. Among its roles, there are the co-working and direction of data flows (from agribusiness to consumers and vice-versa) and the logistic process (from agribusinesses to consumers application).
- Ensure authority that defines an "ethical code" and behavioral laws in transaction chains.

In practice, it reserves cumulative buying orders from consumers and reform individual orders for each agrifood producers cluster by analysis them. Once products get from clusters, they have been packed due to each consumers order and send to the primary consumers group location;

TTP is a main tool in obtaining the commitment of future participants, as groups and/or individuals, to insert the aggregation. It supplies a wide governance duty, actives the promotion of co-working among groups and controls interactions to guarantee transactions behavioral correctness in the network nodes.

The consumers group (CG): it is a special no-profit buying group that is self-systemized. The members are typically households, who need to buy cheap agrifood products. However, due to advances in discovery of regional traditions as tools to trust the quality and origin of goods, consumers request to gain secured local foods, where trace and producers reputation can be obtain assure and trust. For accessing purchasing power to gain the favorite traditional off, consumers must share "shopping lists" in one order. In creating the cumulative order, the CG follows previous ethical code and behavioral laws.

E. Robotics technology

Opposed to human input, machine input (as a result of IT) is both uniform and reliable. In addition, it is faster and produces more profit than human input. Robotics is applied in land preparation, planting, and weeding [24]. A series of corporative IT devices can sufficiently handle agricultural production leaving human application to solely play an oversight role. A combine harvester is one of the machines that has replaced human involvement in harvesting activity (see Figure 4). In cases where the machine has been used, there has been a greater than 100 percent advantage in yield compared to regions where human effort was used in harvesting. This prevailed in areas with the same size and climatic conditions.

Figure 4. Diagram showing robotic harvesters

F. Wireless sensor network

Wireless sensor network (WSN) differs from RFID in that it is able to integrate with other network devices in the field while an RFID tag can only be read with the RFID tag reader. WSNs comprise of Wi-Fi, Bluetooth, and ZigBee. The latter two operate within the Industrial Scientific and Medical (ISM) band of 2.4 GHz, which provides license-free operations, enormous spectrum allocation, and global compatibility. Other devices deployed on a farm to aid agricultural activities [30].

Diagram showing robotic harvesters is used in this industry for monitoring and surveillance of crops within a farm. However, weather variation is the sole challenge that affects performance of WSN in the agriculture industry. The technology utilizes radio frequencies that can be interfered with by weather conditions [31]. The technology is used in maintenance and monitoring of farmlands. This is achieved through installation of sensors and cameras on the field. These devices are linked to the control station on the farm via the mentioned wireless technology. Monitoring fields enables identification of severe conditions on the soil and weather. When soil moisture content is below the minimum, the information is transferred to the control that commands the irrigator to sprinkle the soil. Phytophotra is a disease that affects potatoes and is influenced by temperature and humidity conditions. Between 868MHz and 916MHz, motes can be used in determining moisture content on air and temperature [32]. Extreme temperatures can be reflected and relayed to the control station, which initiates spray of pesticides.

G. Farm management

In the new societies, from any place the farmer can connect to the network. It is done by powered wireless links. Nowadays, all farm equipment, machinery, and animals are supplied with various sensors and computers, which connected to the network; so he/she can observe any data in all point of the farm.

In East Asia, i.e., Japan and Korea, greenhouse farming has been extended. Shin et al. access the data by remote control by connecting the computer of the controlled greenhouse weather to the Internet [33]. Nonomiya and Kouno developed similar conjuration with a remote camera to visualize the crop conditions impression as a valuable marketing aspect [34].

The microchips can compute in much farm machinery and equipment, e.g., automatic feeding, in-house weather control. These computers will have networking so easy in the future. The farm boss will have remote control ability, and he may monitor the system functions anywhere in the farm.

A particularly non-neglectable extension may take place in animal husbandry [35]. A microelectronic herdsman can get information about the position by GPS (Global Positioning Systems) and about the health and welfare situation of cows, sows or sheep. In hot conditions, the microelectronic herdsman retains the animal at a feed suspensor and alarm the farm staff by a mobile set call.

Train animals respond to impulses of the electronic herdsman, which forces a suitable behavior of the animal. The perspectives of such a development are increasing animal welfare and higher outdoor care, because the need of keeping a control on animals systems, in which animals are integrated in small regions. This technology allows a cheap goods with no animals' natural need for free space and movement or the observation of the animals' welfare and health.

The farmers can communicate with out sources via networked farms, at any position and time. For example, the farmer can obtain weather updated observations data and its decision support throughout the day. For precise plant protection, the chemicals apply abilities can be enhanced. Plant weakness and illness alarming systems are new applications for local offices by the Internet.

Some advice can reach to former about where and when by natural speak powered by photos or video recordings; time and position are saved automatically. Then the problem can be send by email to the extension operator and receive a response later, or they may dialogue with each together.

GIS applications

A GIS uses unique colors and shades of colors to represent different atmospheric and soil conditions. It also uses the same set of unique colors to depict different terrains and ground cover. They utilize satellites to obtain aerial images of the Earth's surface. These satellites exist exclusively for GISs as the colors of objects and surfaces are different from ordinary depiction and representation. For instance, a water body would appear blue from ordinary satellites, whereas a GIS satellite depicts water bodies in dark. Food production and agriculture is governed by atmospheric conditions and soil fertility. Globally, farmers' yields are affected by changes in weather and climate. This is because of poor decisions that are dependent on farm activities [33].

For instance, harvesting time is signified by dry weather and medium to high temperatures. Therefore, when a farmer harvests during other atmospheric conditions, the resultant yield will be low. Through GIS technology farmers have been able to obtain atmospheric conditions in real-time diagram of remote-sensed image of the soil (GIS image) that have enabled them to conduct farming activities appropriately.

GIS images are specific to natural, physical features. As a result, farmers or investors are able to locate ideal regions that will favor their agricultural investments.

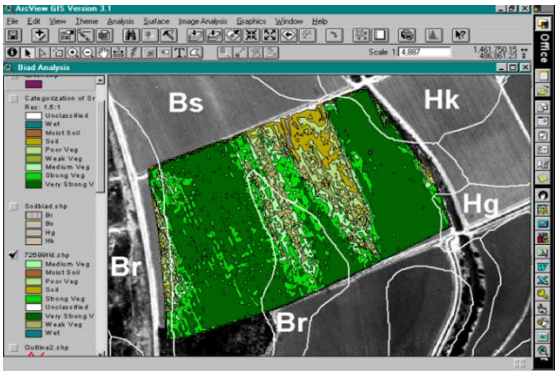

Figure 5. Diagram of remote-sensed image of the soil (GIS image)

Planting on the wrong soil will result in lower yield and losses. Analyzing a soil using the naked eye does not necessarily yield an accurate description of the soil's composition [37]. Therefore, advanced methods induced by IT would result in better land use, thus maximizing yield from the food production and agricultural industry (see Figure 5).

Mapping technologies

The accessibility of Internet-based atlas facilities (for example Google Maps) have motivated home location-based services as a whole. These are based on GIS tools to accumulate, form and register spatial records and maps. Such tools incorporate and spread over spatial and non-spatial databanks for combined examination, and are used to interconnect and bit geographic information.

In nutrition aid, as shown in Figure 6, these tools funding procedures related to, food security examination, eventuality and crisis planning, first cautionary organizations and logistics arrangement, by incorporating records taken in the ground with spatial records to funding result- making.

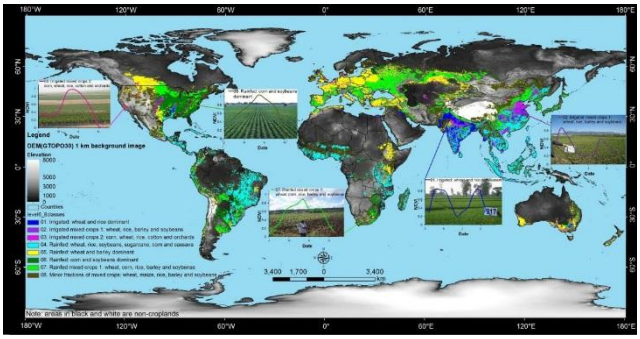

Figure 6. Map of global croplands and their water use for food security

IV. INTERNET STANDARDS CONSIDERATIONS

In this section some important notes on it-based standards in food industries are described.

A. *Electronic Data Interchange*

Electronic Data Interchange (EDI) is the technique of using computers to exchange commercial docs among firms. Before, facsimiles or customary mail was used to exchange docs. Mailing and faxing are still used in commercial, but EDI is a much quicker method to get the same object. EDI is used by an enormous number of companies. Over 100,000 businesses have substituted the more old-style means by EDI. This innovative scheme has a number of aids; price is one of them. Computer to computer exchange is much cheaper than old-style means of doc exchange.

EDI structures are expected to be Internet-based in the future. Although now only very insufficient initiatives use Web EDI, over 50 percent of the initiatives strategy to appliance this technology in the future. A main stage in decrease of costs of EDI answers is the use of the Internet with its current communication substructure as a means of carrying for EDI messages. A number of dissimilar communication rules can be used for the transmission of EDI messages via the Internet. Depending upon the task, the exchange can be made via FTP (File Transfer Protocol), HTTP (Hypertext Transfer Protocol) or SMTP (Simple Mail Transfer Protocol), whereas the files are encoded either with PGP (Pretty Good Privacy), S/MIME (Secure Multipurpose Internet Mail Extension) or SSL (Secure Socket Layer). Cheap combination with the huge number of emerging technologies for the Internet possibly will create a significant involvement to the rise of EDI users and particularly permit SMEs to join in EDI networks. The clear benefit of using the Web as a tool for EDI communication is that the single precondition is an Internet linking and a web browser. All communication uses the omnipresent HTTP-protocol. Safety subjects can be addressed by using SSL, for instance. Thus, all mandatory substructure is most possibly nearly anyplace accessible minus obliging the partners to participate bulky amounts of cash. In this situation, form-based EDI evidences to be a respectable hint for large businesses looking for means of having their small users send their documents in a regular layout.

B. *Extensible Markup Language*

The extensible markup language (XML) has the ability to be the information format of choice used together with the programming language of choice for the Web, Java, to allow the next stage in the development of EDI. Using open standards can significantly decrease the time and money consumed on realizing a solution. By escaping exclusive formats, the risk of asset ruins is decreased and future-oriented resolutions can be advanced. Though traditional EDI connections are regularly long-term and highly integrated, which are meaningful solitary with a large number of connections and for a long time, the readiness to devote into open, compatible IT-substructures is robust at any point of the Value Chain. Conventionally, the founding of compatibility between dissimilar EDI solution-systems was recognized over deep mixing of the EDI standard into the applications of the communication partners. XML is a guileless, very elastic text format resulting from SGML (Standard Generalized Markup Language). Formerly aimed to encounter the challenges of large-scale electronic publishing, XML has also a significant role in the exchange of an inclusive diversity of information on the Web and in another place. XML shares common origins with HTML and SGML (ISO 8879). The latter was envisioned for semantic rise that would assist computer classification and indexing. SGML delivered flexibility that had not been obtainable earlier and turn into very general beyond the

intentions of the original inventors. But it was very difficult and costly.

C. EDI - XML technologies in the agri-food industry

The continually cumulative requests for the level of tracing and tracking sequentially require even more innovative IT methods. Growing the speed of a tracing process is frequently the motive to accumulate data about loads and tracing in an ERP system, but these systems can also be applied to RF scanning and for EDI to communicate with customers and providers. In addition, speed also raises the efficiency of registration that guarantees recording the information totally suitable. Moreover, a data system that has been arranged well will decrease need to persons, since some data is kept in the information system itself. There are three main features of the donation of data:

- Identification of the lot, which is to be observed. A lot has an exclusive identity made by the mixture of item quantity and lot quantity.
- Recording and management of the lot past when provider send the raw material and when it was used in production, and so on.
- Link about the lot with other nodes in the chain network. EAN standards for barcodes and EDI have a significant role.

D. AGRO EDI Europe (AEE)

Later than 1992, Agro EDI Europe is working on association and regularization of information interchanges on the agricultural and its industrial parts. Nowadays, the association collects about 250 members from several sectors (farming input, agro equipment, management and accounting Sections, money support and reservation, insurance, packing, storage, quality control laboratories, etc.).

Since 2001, the commercial partners the Agro EDI Europe association introduced a regular data-processing format of exchange the data harvest page: the DAPLOS message. After rising this "plot message", AEE tries to solve the problems of supplement of farming works and computation of uncultured boundary, and benchmarking of harvest growing methods. Then, AEE faces to the domain of traceability, wholly tools allowing farm production administration being marketed nowadays as traceability resolutions. AEE formed the "plot message" (DAPLOS: Data Plot Sheet), which is a standard for relating data related to a particular social plot, to enable information exchange between different information systems. French software editors tried to twig to this standard though extending databases and programs, generally by executing some transfer data functions according to AEE message, which has focused consideration on the interactions of the farmer and service providers. Compared with AgroXML, the data description is not involved because it is an EDIFACT message.

E. AgroXML

Farmers must document agricultural activities. AgroXML is the consequence of a fitted assistance with agricultural software makers and online service suppliers, which mix AgroXML into their software. AgroXML presents a standard, which enables data exchange and storage. AgroXML is based on the worldwide standard XML and contains several content lists. Several claims in marketable software are surviving ever since two weeks. AgroXML is a language that assists the explanation of agricultural data that will assist a whole documentation of agricultural creation chains. The AgroXML object is to permit data exchanges minus dismissal among land proprietors, farmers, food industry, etc. AgroXML will be obtainable open on the web, and will be free of platform.

An XML Schema introduces electronic documents to exchange information. The AgroXML schema is founded on a model of the actual procedures in agricultural production. They are denoted in a tree-like hierarchy. Schema expansion will be taken place in the English linguistic. Presently delimited terms have previously been interpreted. Other subjects to be functioned upgrading of geo-data in addition to elements for farm animals and plants. At present, various corporations are applying AgroXML as a files exchange standard. Creators of agricultural tools like Claas and John Deere funding expansion of AgroXML. AgroXML has a high primacy for the agricultural software.

F. The benefits of AgroXML

Prospective users of AgroXML comprise someone along the making and providing process in the agricultural.

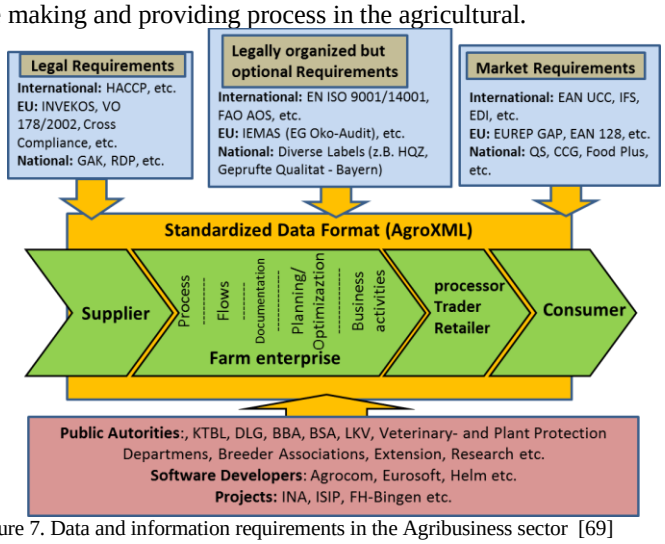

Figure 7. Data and information requirements in the Agribusiness sector [69]

1. Farmers

Hereafter farmers will not be knotted to a particular gathering or analyzing of data through the wide translation of documentation obligations. AgroXML does not register information and enables a struggle free communication with the farming management, accessing services and software corporations, without demanding an additional information input. Production procedures data, which must be stored, are accessible whenever must be used.

2. Consulting services

Combined vegetable production requires measuring agronomic must to be compatible to the local circumstances of the only one type. For adaptation there are many tools, available at the business position, or must be buy (monitoring section, weather station, warning tools, etc.). Farmers used the power of the combined vegetable production, if advisors and

development experts will access to type and specific oriented select aiding from internet. This method of obtaining advisor services makes advanced agriculture principally interesting [69].

3. Software companies

The requirement of a uniform information exchange protocol such as AgroXML will rise and quicken the development growth for farming software corporations. Agricultural software is progressively reliant on the information input from outer the commercial place. Although this worries the updating and care of forms and loads for request of subsidies, and the use of data relate the tools of the business. The matching updates need more work, so tend to more charge, which can be decreased greatly if this data will be accessible in a standardized format through the internet. Gradually, the clients will presume that the business software and type oriented online advisory services can networked suitably, so easy using AgroXML application.

G. Trace2p2

The P2P Project, co-supported by the European Community, goals to training, progress and test dissimilar procedures and apparatuses backup the speedy gathering of data from unlike traceability systems, in order to describe and extend a joined method to gather data from the different traceability systems working at the various corporates. In this method every corporation can pick its personal traceability system with fit to buyers, people and official personnel that will take a united line to ask automatically for goods information through Internet.

The key aim of the P2P plan are defining a Procedure (Trace Methodology) and a Software Style as the base of solution the crucial topics of incorporation. It means to regard and grow an answer intended at backup rapid gathering of data from dissimilar traceability systems of corporations of assumed farming cost procedure, presenting solution to the entire cost procedure traceability. An experimental system is developed for the swine value procedure. The most significant section of the software is the link standard to share data, i.e., the TRACE-XML protocol. The TRACE-XML defines the least set of data to trace all goods collection.

The TRACE-XML protocol will characterize the first stage to describe standard of automatic catching traceability data and documents of all corporation of the farming sector. For example, it could comprise of a subgroup of data and comments of the ebXML protocol. The TRACE-XML could denote an open protocol that could report the swine and especially all farming section. In brief, the key results of the project are:

- Trace Methodology: a procedure backup traceability data group in the corporations (especially what and how data);
- Trace-XML protocol: a least set of data to trace each collection and the associated communication standard;
- Trace-SW: a software assistant protocol and organization of data and documents associated to the traceability;
- Trace-Browser: a tool for browsing the traceability data obedient with the TRACE-XML protocol.

V. FROM SOCIAL MEDIA TO SMARTPHONE APPLICATIONS (APPS)

Each societal medium has an important role in passing data to publics via diverse internet tools, it has added improved usage in new times [38]. Social media service mobile and web-based tools to generate communicating platforms through which persons and groups share, debate, and adapt operator- produced content [39]. It includes a various kind of word-of-mouth, online forums including blogs, corporation backed argument boards and chat rooms, customer-to-customer e-mail, customer goods or service grades homepages and forums, Internet argument boards and forums, sites encompassing digital images, movies, or photos), and communal networking webs, to term a few [40] Administrations big and minor have hopped on the communal media fashion, feeling their method everywhere to make sense of its utility. They have peeped on Twitter, shaped pages on Facebook, and sent videos on YouTube [41] Internet has many sites for interacting users altogether and deliberate numerous viewpoints on nutrition. These variety from the farm and its situation of food making to the end artefact, investigation where, when and how to eat food, through furthermost sites based about an unambiguous objective or sphere. For example, Allotment Veg Growing [42] gives people data on vegetables, a forum for this and a webpage section for showing comment of users. Allrecipes.com [43] is similar, whereby people can add a storeroom to select recipes with ingredients and they can provide assured standards when browsing such as superior nutritional wants, season, or meal time kind. Using websites people can also instruction, catch and assessment food formations, JustEat [44] is a site that provides data on the adjacent carryout, whereby user can observe the menu, other user's comment and instruction the food to be conveyed. Urbanspoon [45] is a site to review eating locates, the people can division on liking the place, leave written comments and add data about the menu. EatPost [46] is like previous but it appraisals the meal, users send photographs of the plate with info about its origin place, other plates from the similar place, evaluations of the plate and proposals of extra alike founding.

Farm Blogs from Around the World has the purpose of gathering in one locate the best farm blogs, suggested farm blogs are requested to guide a short email on their farm and blog, and to contain private suggested farm blogs [47]. It provides attracted parties a gamble to study more about farming, with bloggers inclining to post at most one-time per day, and their posts tending to be one page length to less work for keeping up-to-date. Blogs are similarly obtainable that appearance at food in a more overall method, the Guardian's Word of Mouth Blog provides users data from the profits of red shoots [48], and the damage of Harry Ramsden's famous Fish and Chip Shop [49], these are all posted by dissimilar users sending the blog a broader comment.

Twitter is a microblogging site concentrating on donation real time updates with an middling of 90 million daily 'tweets', every one containing of 140 characters or fewer, these are typically small status updates of what people are undertaking, where they are, how they are feeling, they have confidence in

attention to the follower [38]. Many big food administrations have twitter pages, e.g., McDonalds [50], where the user can study about McDonald's history, food, persons and news everywhere in the world. It passes on data via twitters to 17,157 followers generous the positive social sensitivity, cooperating with a more 'human' singing than a 'corporate' singing [41] that McDonalds demands people to hear [50]. Burger King [51], a competing to McDonalds also has a twitter account and provides users data from the corporation. These corporations can show their wider worries through twitter, as shown from Burger King 'Through our BK CROWN Program, kids can learn about the National Parks Conservation Association. What's your favorite park?' (ibid.). There are also tweets that customers use for chatting eating food. Fastfoodie [52] in title of 'This is what we eat' where users tweet eating date and location online. Food.com [53] has 450,000 recipes, millions of reviews and photos, it is uses the twitter feed to direct people to the website for different recipes. There are also bloggers using these microblogs, where Irish Foodies is one of the largest who created a site for Irish and Irish-based food bloggers to link to others [54].

Food on Facebook is seen typically in two methods either via some initiative desiring to inspire the potential consumer to purchase their product or observe their locations [41]. This can been seen from the minor farm bazars, for example, Becketts Farm [55] , through to the larger supermarkets and professional shops, such as Camp Cupcake [56]. These corporations use facebook to shape a community and get members, they present new products, proposal discounts vouchers and competitive through the site. Facebook has different pages on awaring of food production, for example Farmers weekly, where one can find all the strangest news from the landscape [57]. Dairy Farming UK is a people cluster of all ages who support dairy agriculture in the UK [58]. There are more overall clusters who love Arable, Dairy, Poultry, Livestock, Horticulture, Mud, Tractors, Wellies, and The Crunchyside [59].

VI. FUTURE INTERNET BASED SOLUTIONS

In this section, a set of potential FI or electronic based results and expected applications were identified, which may be efficient in the future. In the focus clusters, these thoughts were discussed in order to try to acquire if a reason is applicable or not.

In Smart Farming area, the most applicable ideas uniformly were the "System for inessential and foreign bodies' detection ", the "Recommending system", and the "Development of the day-to-day work of the farmer "; beside these the idea of "Barcode/RFID system -Traceability system facilities" also was initiate significantly by the contributors of emphasis groups.

Recommending system for choosing the refined vegetation based on a databank

A large databank on diverse farming techniques must be accessible to notify every farmer about his/her refined crops. The system will compare the information provided by the farmers with the effects of dust trainings and principles and must recommend for vegetation, which could be grownup well on the explicit zone.

Watching surroundings for farms and vegetation - recommending system

The young farmers want access to a dependable and regularly updated watching / recommending system for their plants' or animals' health. The farmer should give information that may contain sensors' information, on and off time video, pictures, activities etc. The watching system should trigger an alarm when some thresholds have been passed; suitable advisory could be showed to the corresponding farmer in order to do further activities. For illustration if the temperature is too high and the humidity is too low, an approval can find a contractor for spraying, or a fertilizer contractor since those situations are hazardous for the vegetation to be infected by a illness.

Barcode/RFID system -Traceability system facilities

The farmer requires printing an elementary barcode tag for his/her ending product in the past it's storing or delivery. This barcode tag must encompass data such as the title of the corporation- farm, its origin area, the title of the product, the epoch of the production, etc. An internet based system may be beneficial for farmers with small production. They cannot spend a lot of money for resident software to make and printing the needed barcode tags. This automation must propose online barcode producer and RFID facilities, error tolerant without the load of managing hardware, organizing patches and upgrades, or watching performance.

Fundamentally, the accused named the most key functions of the FI as receiving more data (climate and ambient circumstances, dust conditions, etc.), and accumulating this united into an associated databank. Though, it should be considered that as a giant amount of data can be composed, it must can be shared. Accomplishment the right data or sharing the data and knowledge with the adjacent farmers - via a shared substructure - was similarly essential.

Many of these above stated systems are previously applied, but not common for their costs. Habits of such great numbers of sensors or applying such automatic interference systems have quite a high price.

A QR or RFID founded system, with developed traceability, is similarly excessively classy currently, though it is vital for the farmer. After the prices, two restrictions were recognized in the present exercise for a well- functioning, QR/RFID founded traceability system. One is the absence of a complex and public database, where the data can be composed and integrated. The other one is that in farming exercise it is rather hard to recognize a group or a smaller unit of crops in the harvest. In additional, Grease contributors agreed that farmers could use this type of systems if the program translated into the nationwide linguistic and had an actually modest user interface.

In Smart Agro-logistics area the maximum appropriate thoughts totally were the "Road watching application", the "Dock booking system" and the thought of "Combined cargo and navy organization for selling machines and small retail outlets" in a more wide-ranging way as "Combined cargo and navy organization in overall". The thought of "secure bank system" also was mentioned as being quite important.

Road observing application

The scope of this example is to share online monitoring information from trucks during the transport of cargo. Current practice allows monitoring trucks during transport with individual software applications and collects the monitoring data with available telematics systems. However, the access to such monitoring data is not organized on standards, which makes the exchange of data a complex task. Due to a divers spectrum of possible events disturbing the transport process (e.g., traffic jams or technical malfunctions) information needs to arise from uncertainties about arrival times and complications for further distribution planning as well as warehouse dock organization. The example shows an idealistic aggregation of information from different systems (order management system, online monitoring and event management system). This application can be opened for customers contracting a specific logistic service provider and enable a real-time event management in order to support decisions and planning.

Dock booking system

Current society systems of cross-docks are concentrating on first-come-first-serve philosophies. Online applications for dock booking are just applied for a short time. These applications permit reservation of dock places for a definite time ahead, but regularly need the recording up to 24 hours before passage entrance. The logistic service providers require an elastic solution, which has benefits for all joining enterprises. The procedure presented is based on the credentials of trucks and their mission in a particular topographical area (geo-fence) based on GPS directs around the storeroom/cross-dock. The telecommunication between storeroom and truck association needs the exchange of data on the truck (identification data based on license dish) and its duty (loading or unloading cargo) in addition to the recording and communication of a dock interplanetary and time epochs for the truck user approaching the storeroom.

Combined cargo and navy organization for selling machines and small retail outlets

Farmers expect a combined management system, which can improve logistics assets and to develop the typical control and production organization.

A software and/or internet reinforced stockholding and storing system - which assistances the corporation to enhance its stock, and the stock recording and the stock picking are automatic - is a common request by the people, but it is used previously at a number of corporations. Furthermore, this organization should grip the essential connections (worrying, re-ordering etc.) automatically too.

In small sales markets, which cannot reserves large stock such as selling machines and containers, it is expected that at the reduction of the stock to a regular level, an alarm indicator should be on or an automatic re-order should be produced for the provider. The problem of vending machines is that the provider has to convey lesser quantities of dissimilar products to numerous sites, the automatic orders encompass as much data as thinkable (what kind of product is wanted, in what quantity and how many portions can be served from the remained stock). Thus, the distribution way can be programmed after accumulating and processing the data from the diverse selling machines.

Refining the stock control is hope of the manufacturers, retailers and logistic service supplier too, then they could advantage by the better estimate and prediction (production plan, distribution ways), by the decrease of distribution and production budgets.

So, outside a GPS system, it needs a straight, real-time and long-range communication and information transmission among the solo units, the provider and the sole trucks of the provider. A sole selling machine should capable to show its data. This automatic alarming and re-ordering system may be used in smart households for refining the stock control in the storeroom or in the fridge, and for supplying input for the real shop list.

As a whole, all the particular applications have the same real profits as charge lessening, better organization and better data for choosing, and the practical control of procedures tending to cumulative efficacy.

Thoughts of a road watching application and the dock booking system essentially belongs to the opinion of navy organization - all these collected looked to be relatively applicable for two main reasons. First, numerous application previously exist and are applied, as GPS based navigation system, telematics systems or dock booking systems. Instead, most of the corporations considers needed in having these applications or systems for the easier association and more effective accomplishment of the conveyance procedures.

VII. INFORMATION TECHNOLOGY IN SUPPORT OF SUSTAINABLE FOOD CHOICES

Nowadays, attentions to application for data on agriculture and food choices are rising. Many local and international associations, events, and papers are developed to support its advance [60].

This kind of ingesting is a vital form of political commotion. A concentration sustainable ingesting may lead customers towards specific farming. Cohen [61] lists five contradictions intrinsic in the perception of sustainable ingesting: it encounters the universal delusion of customer dominion that occurs in most industrialized countries; the efforts to generate a distinct space for examination of sustainable ingesting are challenged by labors to place it in sustainable production area; superior ingesting efficiency and the development of technically "green" customer predilections together loan themselves to unwanted ricochet things; customer policymaking in greatest industrial countries is actual muddled and controlling answerability is fragmented; and public explanations of "customer interest" do not usually approve policy programs that intend to reduce the capacity of ingesting or the variety of elections.

Should one attentive in sustainable ingesting always choose organic, regardless of how it was created and qualified? The honestly new growth of large, conservatively accomplished, organic farms has produced subjects around strengthening. Guthman [62] pronounces how customary organic farms are challenging force to exaggerate their operations, which undercuts their skill to practice their accurate form of organic farming. Duchin [63] designates the

use of input-output and life-cycle examines in assessing food choices. For instance, Faist et al. [64] recognize that efficient cooling applications had more ability to drive requirements than a wholesale change to organically produced foods. Pretty et al. [65] do a cost analysis based on food miles and the various charges of conveying food over long road. The March 2, 2007 of TIME magazine issued that read "Forget Organic. Eat Local." Such a note is too unsophisticated, but the cover story [66] presented more steadiness. Merger of these numerous compound models in decision provision tools for customers interested in sustainable ingesting.

Globalization is an affluence of food choices, but it have a bad influence on food safety, security, and dominion. How does a customer choose between these options? Epistemic distance [67] is significant in setting primacies for customers, but how can one successfully progression all the variables? Waldfogel [68] discovers that customer dominion is necessary in convinced definite circumstances including choices between accustomed objects, but when user want to make inter-chronological ingesting choices, for example, "authoritarian involvements could advance their conclusions."

The producer must be sustainably operate before a customer can choose an ecological food item. Carolan [67] dialogs about the requirements to make the assistances of sustainable agriculture more noticeable to farmers. The assistances of sustainable agriculture are much less noticeable than those of conservative agriculture. Likewise, the charges of conservative agriculture are much less noticeable than those of ecological agriculture. What sustainable farmers might call "wildflowers" or "biodiversity", conservative farmers might demand "weeds". Cumulative the scale of thoughtful, from a solo farm to the entire watershed or food shed helps to visualize the benefits of ecological agriculture and the charges of conservative agriculture. Classification and "food miles" calculations are other techniques the corresponding benefits and charges can be made more noticeable. Caution is vital because of the incomplete viewpoint any one inventiveness can deliver.

Excessive transaction of potential in considering tend to use the internet for existing data in a method that develops easily criminal. The propensity is to fragment and the challenge is how to keep the whole thing together. This larger community must be addressed in some way. To get a model of an umbrella organization that can exist on the web and handle communication is also worthwhile. To move from a concept of "no wrong answers" to an available procedure for counting the sustainability of diverse food picks is significant. This data can be developed over the progress and use of complete computer models.

The internet can be used to advance the expediency of ecological food choices, for makers and customers by generating online clearinghouses for food objects that enable both commercial to commercial and commercial to customer interconnection. Cheap tries to assist traceability of products will expand the customer's belief in makers and affluence the acceptance of these another food chains. Although fruitful local food creativities may become, but everybody convoluted will progress individual relations with each other. So, as source chains grow, it is significant to stability local with expediency and sanctuary.

VIII. DISCUSSION

The primary goal of IT incorporation in the food industry is to foster food security and extract maximum sustainable yield. Once the primary role has been fulfilled, there are numerous secondary goals that IT ensures are effectively addressed. They include: processing, distribution, marketing, and storage [69]. IT, through the technologies previously discussed, fulfills each of these goals successfully. RFID ensures comprehensive results from supply management, which constitutes a secondary goal of the industry [71]. Regions that have incorporated RFID in their supply chains receive more revenue from the agriculture and food production industry than regions that have not applied RFID technology [72]. Similarly, regions that have incorporated WSN practice sustainable farming on a larger scale than in regions where the technology has not been applied. After production, the other barrier to extracting maximum potential from agriculture is the marketing of harvested goods. Large scale producers in farming have extensive marketing strategies that cover almost ninety percent of their produce. On the other hand, SMEs in agricultural and food production lack elaborate marketing avenues that can ensure intake of their products in the market. The first obstacle is the cost, which is a requirement for establishing an elaborate marketing network. The other obstacle is technology. Technology now offers a solution to its initial problem in that the Internet has contributed positively towards establishing global villages. Farmers are able to establish first person contact between the manufacturer and the user or processing firm. For instance, the Kenyan association of coffee growers has established a direct link to coffee processing firms in England and the United States. This ensures that farmers obtain maximum compensation for their products, and therefore represents an appropriate motivation for farmers to expand their farms. As a result, the potential of food and agricultural production is optimized.

Food investors who have embraced robotics and e-commerce receive more income from the food industry than food investors not aware of the technology or those who have shunned it. Consequently, in countries where these practices have been encouraged and are prevailing at significant levels have a better economy than in countries where IT application is limited.

Another added value of internet-based technologies in the agro-food industry is the improvement of efficiency and reactivity from real-time management of supply chains from farm to fork [73]. From a “food miles” point of view, this could result in a reduction in greenhouse gas emissions and in the carbon footprint, e.g., decrease of transport kilometers or empty vehicles, less waste, and better decay management.

The digital divide is a challenge that might hinder the applicability of the technologies discussed in this paper. Digital divide is mainly the gap between those with and those without access to ICT technologies and/or skills necessary to take advantage of ICT services. In addition, there is a widening gap between the urban and rural sectors on utilizing

advanced and emerging technologies [74]. To overcome this, measures should be taken to strengthen informatics in the agro-food industry by fostering the development of national information capacity and new databases, linking national and international databases, and adding value to information to facilitate utilizing them at various levels. Also, innovative ways of combining ICT-based information sources (such as agro-food information systems) with traditional ones should be considered.

IX. CONCLUSION

This paper gives an overview of major IT-based technologies and their impact on the food industry. It presents how selected fields of application can make a considerable contribution to food industry both in increasing efficiency and making data more available and easily managed. It discusses how these technologies can be integrated to enhance safety and quality of food products and provide advantages such as mobility, transparency and autonomy. The example technologies are mainly built on networked devices or utilize networks for communication. However, much additional work still should be done for a large scale integrated communication and scalable coordination throughout the agro-food networks.

Traditional industrial food manufacture has the objective of maximizing productivity and income. The motivation for acceptance of sustainable approaches comes first from customers who influence significantly on the obtainability of sustainable food choices by advantage of their purchases. By emphasis on food, ingesting efficiency and green partialities tend to very remarkable choices with doubtful sustainability.

Nowadays, farm smarting problems have been become more interesting and important for people. We can divide Smart Farming duties in main sections:

1. Recommending system for choosing the refined vegetation based on a databank
2. Watching surroundings for farms and vegetation - recommending system
3. Barcode/RFID system -Traceability system facilities
4. Shared substructure
5. Watching surroundings for animal welfare and sensors
6. e-commerce
7. System for inessential and foreign bodies' detection

Monitoring of product and their change is especially relevant for fresh products such as fresh fruits, warm meat, and daily vegetables, need monitoring of quality control in the distribution chain. Data of quality control is required to reserve the product quality during carrying.

In the last 20 years the structure of agrifood business industry has been improved considerably. For a lot of reasons such as advances in ICT, enhancing the customer quality prediction, nowadays hard functions, low agriculture commodity charges, the force of international retails and increasing of huge stores, all details of this industry has been changed and deformed. The disadvantage of Internet technology among SMEs is that the business owners and staff have to undergo training so that they can understand computer. This is an additional cost that a small scale investor aims to reduce by all means necessary. IT exposes SMEs to Internet hazards such as hacking and fraud, which can cause huge losses to investors.

Another important aspect of food networks, which is discussed in this paper is trade characteristics of a close relationship between customers and producers of goods/services using purchasing groups. Farmers can fill their agro-food process information forms on farm works, material applications, and so on, in their cultivated fields while he/she do his/her activities in farm. Using web connected mobile phones, the farmer store data in the databank. With this information, farmers make comprehensive decisions concerning planting activities. Wireless technology also enables pest control and irrigation activities that are essential when pursuing maximum yield. Sensors deployed on the soil are able to determine moisture content of the soil.

The utility of Internet-based atlas facilities have motivated home location-based services. Social media service mobile and web-based tools to generate communicating platforms through which persons and groups share, debate, and adapt operator- produced content. Weblogs naturally define a private diary, reserved on the web, which can be corrected by people with few web edition abilities, as well as blogs to increase wakefulness of food goods. An online public forum can combine a somewhat large amount of rich, including data on a subject. These societies can cover a range of dissimilar zones.

The paper also highlights that there is great opportunity for internet-based applications in developing countries. However, in most developing countries, strategies should be employed to overcome technical and societal barriers that can hinder further development of these technologies in agro-food sector. Therefore, it is a mandate of the ministry of agriculture and/or other governmental authorities to ensure IT techniques are being used in the food and agriculture sector to boost production and create an extensive market for the produced goods.

REFERENCES

[1] S. Samadi, "Applications and Opportunities for Internet-based Technologies in the Food Industry," In The Sixth International Conference on Advances in Future Internet, AFIN 2014, Lisbon, Portugal, Nov. 2014, pp. 67-71.

[2] “Measuring the Information Society Report,” International Telecommunications Union, 2015.

[3] N. P. Mahalik and A. N. Nambiar, “Trends in food packaging and manufacturing systems and technology,” Trends in food science & technology, vol. 21, 2010, pp. 117-128.

[4] Z. Abbasi, N. Islam, and Z. A. Shaikh, “A review of wireless sensors and networks' applications in agriculture,” Computer Standards & Interfaces, vol. 36, 2014, pp. 263-270.

[5] D. Prajogo and J. Olhager, “Supply chain integration and performance: The effects of long-term relationships, information technology and sharing, and logistics integration,” International Journal of Production Economics, vol. 135, 2012, pp. 514-522.

[6] A. Suprem, N. Mahalik, and K. Kim, “A review on application of technology systems, standards and interfaces for agriculture and food sector,” Computer Standards & Interfaces, vol. 35, 2013, pp. 355-364.

[7] M. Cinque, D. Cotroneo, C. Di Martino, S. Russo, and A. Testa, "Avr-inject: A tool for injecting faults in wireless sensor nodes," In IEEE International Symposium on Parallel & Distributed Processing, IEEE IPDPS 2009, May 2009, pp. 1-8.

[8] D. Martino, G. D'Avino, and A. Testa, "icaas: An interoperable and configurable architecture for accessing sensor networks," International Journal of Adaptive, Resilient and Autonomic Systems, vol. 1 , no .2 , 2010, pp. 30-45.

[9] J. Von Braun, The world food situation: new driving forces and required actions. Intl Food Policy Res Inst, 2007.

[10] M.E. Yüksel and A. S. Yüksel, "RFID technology in business systems and supply chain management," Journal of Economic and Social Studies, vol. 1, no. 1, 2011, pp. 53-71.

[11] J. Wolfert, C. N. Verdouw, C. M. Verloop, and A. J. M. Beulens, "Organizing information integration in agri-food—A method based on a service-oriented architecture and living lab approach," Computers and electronics in agriculture, vol. 70, no. 2, 2010, pp. 389-405.

[12] T. Kelepouris, K. Pramatari, and G. Doukidis, "RFID-enabled traceability in the food supply chain," Industrial Management & Data Systems, vol. 107, no. 2, 2007, pp. 183-200.

[13] E. A. Soujeri, R. Rajan, and A. Harikrishnan, "Design of a zigbee-based RFID network for industry applications," Proceedings of the 2nd international conference on Security of information and networks. ACM, 2009, pp. 111-116.

[14] A. Sarac, N. Absi, and S. Dauzère-Pérès, "A literature review on the impact of RFID technologies on supply chain management," International Journal of Production Economics, vol. 128, no. 1, 2010, pp. 77-95.

[15] J. Fontanella, "Finding the ROI in RFID," Supply Chain Management Review, vol. 8, no. 1, 2004, pp. 13-16.

[16] L. Theuvsen and T.Hollmann-Hespos, 2005, The Economics of raceability: A Model of Investments in Tracking and Tracing Systems in Agriculture and the Food Industry, Vila Real (Portugal), pp. 914-921.

[17] J. H. Trienekens and J. G. A. J. van der Vorst, 2006. Traceability in food supply chains. Wageningen Academic Publishers, Wageningen, pp. 439–470.

[18] M. Fritz and G. Schiefer, "Tracking, tracing and business process interests in food commodities: a multi-level decision complexity," International Journal of Production Economics vol 117, no. 2, pp. 317–329, Feb.. 2009.

[19] K. Sugahara, "Farming Diary System using Internet-enabled cellular phones". In Internet Workshop 2001, Proceeding II Applications. pp. 247-252.

[20] K. Butner, "The smarter supply chain of the future," Strategy & Leadership, vol. 38, no. 1, 2010, pp. 22-31.

[21] X.Zhu, S. K. Mukhopadhyay, and H. Kurata, "A review of RFID technology and its managerial applications in different industries," Journal of Engineering and Technology Management, vol. 29, no. 1, 2012, pp. 152-167.

[22] N. P. Mahalik, "Processing and packaging automation systems: a review," Sensing and Instrumentation for Food Quality and Safety, vol. 3, no. 1, 2009, pp. 12-25.

[23] M. J. Meixell, "Quantifying the value of web services in supplier networks," Industrial Management & Data Systems, vol. 06, no. 3, 2006, pp. 407-422.

[24] R. A. Tabile et al., "Design and development of the architecture of an agricultural mobile robot," Engenharia Agricola, vol. 31, no. 1, 2011, pp. 130-142.

[25] A. C. Vias, "Bigger stores, more stores, or no stores: paths of retail restructuring in rural America," Journal of Rural Studies, vol. 20, no. 3, pp. 303-318, July 2004.

[26] G. Schiefer, "New technologies and their impact on the agri-food sector: an economists view. Computers and Electronics in Agriculture," Industrial Management & Data Systems 106.1, 2006, pp. 5-20.

[27] P. Wang and A. Watts, "Formation of buyer-seller trade etworks in a quality-differentiated product market," Canadian Journal of Economics, 2006, pp. 971-1004.

[28] K. Myoung-Soo and A. Jae-Hyeon, "A Model for Buyer's Trust in the E-marketplace," Proceedings of ICEC'05, August 15-17, 2005, Xi'an, China.

[29] L. Ruiz-Garcia, P. Barreiro, and J. I. Robla, "Performance of ZigBee-based wireless sensor nodes for real-time monitoring of fruit logistics," Journal of Food Engineering, vol. 87, no. 3, 2008, pp. 405-415.

[30] A. Testa, M. Coronato, and J. C. Augusto, "Static verification of wireless sensor networks with formal methods," In Signal Image Technology and Internet Based Systems (SITIS), 2012 Eighth International Conference on, IEEE, November 2012, pp. 587-594.

[31] M. C. Cinque, D. Di Martino, and A. Catello Testa, "An effective approach for injecting faults in wireless sensor network operating systems," Computers and Communications (ISCC), 2010 IEEE Symposium on. June 2010.

[32] Baggio, "Wireless sensor networks in precision agriculture," ACM Workshop on Real-World Wireless Sensor Networks (REALWSN 2005), Stockholm, Sweden. 2005.

[33] J. H. Shin, W. S. Hahn, and B. W. Lee, "Development of greenhouse control environment analysis system on World Wide Web," Second European Conference of the European Federation for Information Technology in Agriculture, Food and the Environment, 27-30 September, 1999, Bonn, Germany, pp. 83-87.

[34] S. Nonomiya and T. Kouno, "Internet remote camera system and its application in agriculture," Second European Conference of the European Federation for Information Technology in Agriculture, Food and the Environment, 27-30 September, 1999, Bonn, Germany, pp. 75-81.

[35] W. Rossing,"Electronic animal identification. Computers and Electronics in Agriculture," (Special Issue), 1999.

[36] I. Thysen and P. K. Haneveld, "Evading murphy: A sensor network deployment in precision agriculture," O teu-Delft, Xuño 2007.

[37] T. Kalaivani, A. Allirani, and P. Priya, "A survey on Zigbee based wireless sensor networks in agriculture," Trendz in Information Sciences and Computing (TISC), 2011 3rd International Conference on. IEEE, 2011.

[38] D.Westerman, P. Spence, and B. Van Der Heude, "A social network as information: The effect of system generated reports of connectedness on credibility on Twitter," Computers in Human Behavior, 28(1), pp. 199-206.

[39] Kietzmann J.H., Hermkens K., McCarthy I.P. and Silvestre B.S., "Social media? Get serious! Understanding the functional building blocks of social media. Business Horizons," 54(3), pp. 241-251.

[40] W. G. Mangold and D. J. Faulds, "Social media: The new hybrid element of the promotion mix. Business Horizons" vol. 52, pp. 357-365.

[41] B. Weinberg and E. Pehlivan, "Soical spending: Managning the social mix. Business Horizons," 54, pp. 275-282.

[42] Allotment Veg Growing, Retrieved September 2, 2015 from http://www.allotment.org.uk.

[43] Allrecipes, 2011. Retrieved September 2, 2015 from http://Allrecipes.com.

[44] JustEat, 2011. Retrieved September 2, 2015 from http:// www.just-eat.co.uk .

[45] Urbanspoon, 2011. Retrieved September 2, 2015 from http://www.urbanspoon.com.

[46] EatPost, 2011. Retrieved September 2, 2015 from http://www.eatpost.com.

[47] R. Kwai Fun and C. Wagner , 2008. Weblogging: A study of social computing and its impact on organizations. Decision Support Systems 45, 242-250.

[48] O. Thring, 2015. Benefit of the (red) sprout. Guardian.co.uk Word of Mouth Blog, [Blog] 28 September. Retrieved September 2, 2015 from http://www.guardian.co.uk/ lifeandstyle/wordofmouth.

[49] M. Wainwright, 2015. Harry Ramsden's famous original fish and chip shop faces closure after losses. Guardian.co.uk Word of Mouth Blog, [Blog] 30 September. Retrieved September 2, 2015 from http:// www.guardian.co.uk/lifeandstyle/ wordofmouth.

[50] McDonaldsCorps, 2015, 28 September. Happy Cyber Monday! Scoring any good deals today? It's chilly in McDonald land so I'm gonna shop w/a McCafe Hot Chocolate in hand. :) [Twitter post]. Retrieved September 2, 2015 from http://twitter.com/ #!/McDonaldsCorp>

[51] BurgerKing, 2011, 28 September. Through our BK CROWN Program, kids can learn about the National Parks Conservation Association. What's your favourite park? [Twitter post]. Re trieved September 2, 2015 from http:// http://twitter.com/ #!/BurgerKing>

[52] Fastfoodie, 2015, 30 September. [Twitter Post]. Retrieved September 2, 2015 from http://twitter.com/#!/fastfoodie>

[53] Food.com, 2015, 30 September. [Twitter Post]. Retrieved September 2, 2015 from http://twitter.com/#!/Fooddotcom>

[54] IrishFoodies, 2015, 30 September. [Twitter Post]. Retrieved September 2, 2015 from (http://twitter.com/#!/IrishFoodies>

[55] Becketts farm, 2015, 30 September. [Twitter Post]. Retrieved September 2, 2015 from http://twitter.com/#!/BeckettsFarm>

[56] Camp Cupcake, 2015, 30 September. [Facebook Update] Retrieved September 2, 2015 from http://www.facebook.com/campcupcakecakes>

[57] Farmers weekly, 2015c, 30 September. [Facebook Update] Retrieved September 2, 2015 from https://www.facebook.com/farmersweeklyuk>

[58] Dairy Farming UK , 2015, 30 September. [Facebook Update] Retrieved September 2, 2015 from https://www.facebook.com/group.php?gid=6220759330#!/gro up.php?gid=41237147430>

[59] Farming, 2015, 30 September. [Facebook Update] Retrieved September 2, 2015 from https://www.facebook.com/pages/Farming/1021816?sk=info>

[60] D. Stolle et al., Politics in the Supermarket: Policitical Consumerism as a Form of Political Participation, International Political Science Review, Volume 26, Number 3, 2005, pp. 25-269.

[61] M. J. Cohen, Sustainable Consumption Research as Democratic Expertise, Journal of Consumer Policy, Springer Verlag, Volume 29, 2006, pp. 67-77.

[62] J. Guthman, The trouble with 'organic lite' in California: a rejoinder to the 'conventionalisation' debate, Sociologia Ruralis, Volume 44, Number 3, 2004, pp. 3-16.

[63] F. Duchin, Sustainable Consumption of Food: A Framework for Analyzing Scenarios about Changes in Diets, Journal of Industrial Ecology, MIT Press, Volume 9, Number 1-2, 2005, pp. 99-114.

[64] M. Faist et al., The impact of household food consumption on resource and energy management, International Journal of Environment and Pollution, Volume 15, Number 2, 2001, pp. 181-199.

[65] J. N. Pretty et al., Farm costs and food miles: An assessment of the full cost of the UK weekly food basket, Food Policy, Volume 30, 2005, pp. 1-19.

[66] J. Cloud, Eating Better Than Organic, TIME Magazine, Time Inc., March 2, 2007. http://www.time.com/time/magazine

[67] M. S. Carolan, Do You See What I See? Examining the Epistemic Barriers to Sustainable Agriculture, Rural Sociology, Volume 71, Number 2, 2006, pp. 232-260.

[68] J. Waldfogel, Does Consumer Irrationality Trump Consumer Sovereignty?, Review of Economics and Statistics, Volume 87, Number 4, September 2005, pp. 691-696.

[69] R. Doluschitz, 2004. Der Beitrag der Informationstechnologie zu Produktionsmanagement, Qualitatssicherung und Ruckverfolgbarkeit in der Agro-Food-Chain - Notwendigkeit, Strategien und Perspektiven: In: FAT-Schriftenreihe, Agroscope FAT Tanikon/CH, 2004, H. 59, 5-25.

[70] D. Restuccia, et al, "New EU regulation aspects and global market of active and intelligent packaging for food industry applications," Food Control, vol. 21, no. 11, 2010, pp. 1425-1435.

[71] M. Bolic, D. Simplot-Ryl, and I. Stojmenovic (Eds), RFID systems: research trends and challenges. John Wiley & Sons, 2010.

[72] M. Canavari, R. Centonze, M. Hingley, and R. Spadoni, "Traceability as part of competitive strategy in the fruit supply chain," British Food Journal, vol. 112, no. 2, 2010, pp. 171-186.

[73] G. Schiefer, R. Reiche, and J. Deiters, "Transparency in Food Networks – Where to Go," International Journal on Food System Dynamics, vol. 4, no. 4, 2014, pp. 283-293.

[74] R. Bertolini, "Making information and communication technologies work for food security in Africa," International Food Policy Research Institute (IFPRI), No. 11, 2004.