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O agronegócio e a internet das coisas: desafios e oportunidades

Durante décadas, o agronegócio tem sido uma das principais fontes de sustento econômico e social no Brasil. As condições de clima, solo e extensão territorial; o grande número de produtores com potencial produtivo e os esforços conjuntos de instituições públicas e privadas voltadas para o desenvolvimento científico e tecnológico do setor diferenciam o Brasil de seus concorrentes e o tornam um dos maiores produtores e exportadores agrícolas do mundo. A inovação tecnológica chamada Internet das Coisas (IoT) está ganhando cada vez mais espaço. A Internet das Coisas desempenha um papel fundamental no desenvolvimento e inovação do agronegócio, que há décadas tem sido uma das principais fontes de apoio econômico e social no Brasil, exigindo uma discussão sobre como este fenômeno ocorre e suas consequências. O objetivo deste artigo é apresentar algumas definições sobre a Internet das Coisas, computação ubíqua (entendida como a onipresença da tecnologia da informação) e seus impactos sobre o agronegócio. Conclui-se que há evidências de que a Internet das Coisas é um fator determinante para a potencialização, e consequentemente para a expansão do agronegócio no Brasil.

Palavras-chave: Internet das Coisas; Computação Ubíqua; Agronegócio.

Agribusiness and the internet of Things: challenges and opportunities

For decades, agribusiness has been one of the main sources of economic and social sustenance in Brazil. The conditions of climate, soil and territorial extension; the large number of producers with productive potential and the joint efforts of public and private institutions directed to the scientific and technological development of the sector differentiate Brazil from its competitors and make it one of the largest agricultural producers and exporters in the world. The technological innovation called the Internet of Things (IoT) is gaining more and more space. The Internet of Things plays a key role in the development and innovation of agribusiness, which for decades has been one of the main sources of economic and social support in Brazil, requiring a discussion on how this phenomenon occurs and its consequences. The objective of this article is to present some definitions about the Internet of Things, ubiquitous computing (understood as the omnipresence of information technology) and its impacts on agribusiness. It is concluded that there is evidence that the Internet of Things is a determining factor for the potentialization, and consequently the expansion of agribusiness in Brazil.

Keywords: Internet of Things; Ubiquitous Computing; Agribusiness.

Topic: **Teoria da Computação**

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INTRODUCTION

Agribusiness has been for decades one of the main sources of economic and social support in Brazil (CRUZ et al. 2009; BYERLEE et al. 2009). The conditions of climate, soil and territorial extension; the large number of producers with productive potential and the joint efforts of public and private institutions directed to scientific and technological development of the sector differentiate Brazil from its competitors and make it one of the largest agricultural producers and exporters in the world (CRUZ et al. 2009; BYERLEE et al. 2009). However, there is the challenge of this sector to become increasingly competitive. And that is precisely where a new concept capable of revolutionizing the agribusiness world arises: IoT (Internet of Things), consists of the idea of merging the "real world" with the "digital world", allowing the individual to be in constant communication and interaction, whether with other people or objects, according Pontelli[1].

Big Data, Internet of Things and Cloud Computing are already well-known concepts in the market, especially in the retail and health sectors, which have benefited from the many data generated and analyzed for the development of new tools, products and services in their markets. It is worth noting that, with the advancement of the Internet of Things in agriculture and the consequent accumulation of data analysis, the knowledge generated will not only serve to indicate where and when the input should be applied to the land but will also be useful for decision making related to financing, insurance, logistics, marketing, among other key areas of agribusiness.

Given all the exposed content, the problem raised by this research lies in the following question: how can the Internet of Things transform the agribusiness scenario? In order to answer this question, the general objective of this theoretical essay was to discuss how the Internet of Things has been influencing the agribusiness universe, especially in Brazil. As objectives we sought to: (1) contextualize the emergence of IoT in the business world; (2) report the main technologies that impact the agribusiness segment in Brazil; and (3) list examples of companies that are using new technologies in agribusiness.

The rest of the paper is organized as follows: Methodology, Theoretical Discussion where the concepts and phenomena studied are discussed, and the conclusion about the research problem of this paper.

METODOLOGY

This work has a qualitative methodology with a bibliographical survey method. Papers, websites and news that contain the terms agribusiness and internet of things were researched. After the research, it is possible to observe the discussion about the challenges and opportunities about the theme.

DISCUSSIONS

Agribusiness

Agribusiness is the sector that has been the positive exception of the government in recent years, especially in the current economic scenario faced by Brazil (CRUZ et al. 2009; BYERLEE et al. 2009). The

country occupies a prominent position in the world scenario of agricultural products, precisely because it is a country with a huge territorial extension, a wide range of agri-food products and great diversity in the organization of rural production structures. This is a context with great challenges and opportunities, which aims to ensure competitiveness in agribusiness and well-being in rural communities. According to Brum et al. (2008):

> Agriculture has always had a preponderant role in the development of humanity in general and of Brazil in particular. The different agricultural revolutions propitiated considerable changes in this development process, allowing the sector to be inserted in the global economic context, and these advances in the capitalist logic did not avoid the exclusion of people in the rural environment; on the contrary, the selective process was more acute the more the sector was modernized.

Thus, it is evident that agribusiness has become the driving force of the Brazilian economy, above good and evil, being characterized as truly the only one responsible for the Brazilian agricultural production, and thus, the constant fiscal surpluses of the trade balance in recent months are credited, which makes it a strategic segment for the State (CRUZ et al. 2009; BYERLEE et al. 2009). For Freitas[1], agribusiness corresponds to the junction of several productive activities that are directly linked to the production and subproduction of products derived from agriculture and livestock. Thus, it is noticeable that agribusiness is one of the main sectors of the Brazilian economy, integrating both urban and rural practices. Siqueira[2] defines agribusiness as follows:

> It is the set of businesses related to agriculture and livestock from an economic point of view. The study of agribusiness is usually divided into three parts: the first part deals with the agricultural business itself, or "inside the farm gate", which represents the rural producers, whether small, medium or large, constituted as individuals (farmers or peasants) or legal entities (companies). In the second part, the businesses upstream of farming, or the "pre-farm gate", represented by industry and commerce that supply inputs for rural production, such as manufacturers of fertilizers, pesticides, and equipment. And in the third part are the businesses downstream from the farming businesses, or the "post-gateway", where are the purchase, transport, processing, and sale of the farming products up to the final consumer. This definition includes slaughterhouses, textile and footwear industries, packers, supermarkets, and food distributors.

On the other hand, it is common when we talk about agribusiness to make the association only with the in natura production, such as grains and milk, for example. However, this productive sector is much broader, since there are many participants in this process. In this sense, the agroindustrial system can be considered the set of activities that contribute to the production of agroindustrial products, from the production of inputs (seeds, fertilizers, agricultural machinery) to the arrival of the final product to the consumer (BATALHA et al., 1995). Therefore, this agroindustrial system is permeated in an interdependent way, in such a way that it is possible to satisfy the needs of consumers.

According to Bacha (2004), agribusiness can be divided into at least four segments: segment I is composed of upstream companies, i.e., companies that supply inputs to agricultural companies; segment II

[1] https://mundoeducacao.uol.com.br/geografia/agronegocios.htm

[2] https://www.dicionarioinformal.com.br/agroneg%C3%B3cio/#:~:text=Significa%20a%20cadeia%20de%20atividades,comercializa%C3%A7%C3%A3o %20e%20compra%20pelo%20consumidor

is formed by agricultural companies; segment III is composed of companies that process agricultural products; and segment IV is constituted by the distribution companies. Therefore, it is possible to mention several sectors of the economy that are part of agribusiness, among them: agricultural input industry, banks that provide credits, tractor and parts industry, and veterinary stores.

Regarding the term agribusiness, whose expression is present in the title of this theoretical essay, it was a term that was mirrored and adopted by several countries. In Brazil, this new vision of "agriculture" took some time to arrive. Its main definition, according to Rufino (1999), is that it is a set of all operations and transactions involved from the manufacturing of agricultural inputs, production operations in agricultural units, to the processing and distribution and consumption of agricultural products "in natura" or industrialized.

It is known that understanding agribusiness, in all its components and interpellations, is an indispensable tool for all decision makers, whether public authorities or private economic agents, to formulate policies and strategies with greater foresight and maximum efficiency (CRUZ et al. 2009; BYERLEE et al. 2009).

The internet of things and ubiquitous computing

The technological innovation called Internet of Things (IoT) has been gaining more and more space. It is characterized by processes involving networked objects that produce and/or process information in real time and autonomously (SINGER, 2002). The concept of a global network of connected and communicating devices is broad and makes several technologies and applications known by the name Internet of Things. The term IoT seems to be well accepted in Europe, while in the United States research is more focused around terms such as smart objects or cloud computing. The term was first introduced by Kevin Ashton of MIT Auto Centre in a presentation about RFID, (Radio-Frequency IDentification) and the supply chain of a large company, in 1999 (ASHTON, 2009). Another possible origin of the term Internet of Things can be found in the publication of the article "When Things Start to Think" by Neil Gershenfeld (1999), in which there are some predictions of some experiments in wearable computing, nanotechnology, and concerns related to emotions and civil rights in a reality where objects process information (SINGER, 2002).

Singer (2012) exemplified the application of Internet of Things, among them, a person driving a car that will show the least congested route to the driver, a house being cleaned by a smart vacuum cleaner, which works by itself, while the stove, also smart, is preparing to cook a meal. The same author also cites a real-life example from Rio de Janeiro, where sensors, cameras, and information layers show traffic and various occurrences in real time at the Operations Center.

In this context, the main components of the IoT will be radio frequency identification RFID systems, which is a method of automatic identification through radio signals, retrieving and storing data remotely through devices called tags, which are composed of one or more readers (s) and several RFID tags (ATZORI, 2010). Tags are characterized by a unique identifier and are applied to objects (even people or animals). The readers trigger the tag transmission by generating a signal, which represents a query for the possible

presence of tags in the surrounding area and the receipt of their IDs (Identifications). Consequently, RFID systems can be used to monitor objects in real time, without the need to be in visual range; this allows for mapping objects in the real world as well as in the virtual world. Therefore, they can be used in an incredible variety of application, logistics, e-health, and security scenarios (ATZORI, 2010).

A necessary discussion to understand the origin of the term Internet of Things is the concept of Ubiquitous Computing. First used by Xerox PARC chief scientist Mark Weiser (1991), it is understood as the ubiquity of information technology and information power that, in principle, permeates all everyday objects. Information power and information technology can therefore be applied in many areas, from industrial production to the private sector, thus improving everyday life. In the long term, ubiquitous computing can permeate all spheres of life: it promises to increase comfort in the home area and improve energy efficiency. "Smart" vehicles can make roads safer; adaptive personal assistance systems could increase work productivity in the office; and in the medical field, implantable sensors and microcomputers monitor patient health (AARTS et al., 2005; FRIEDEWALD et al., 2011).

According to Friedewald (2011), this ubiquity reflects a plethora of nearly identical concepts, such as ''pervasive computing,'' ''ambient intelligence,'' and '' the internet of things.'' In practice, the differences between these terms are rather academic in nature: the common goal for all these concepts is to help people as well as continuous optimization and promotion of an economy and social processes by numerous microprocessors and sensors integrated into the environment. Some characteristics of Ubiquitous Computing can be cited, such as: Decentralization or modularity of the systems and their comprehensive network, incorporation of computer hardware and software in other equipment and objects of daily use, mobile support for the user by means of information services anywhere and at any time, context awareness and adaptation of the system to current information requirements, automatic recognition and autonomous processing of repetitive tasks without user intervention. The most common devices used include small mobile computers, the development of today's cell phones, so-called "Wearables" such as smart textiles or accessories, as well as computerized implants (FRIEDEWALD et al., 2011).

Finally, for Xu (2012), the emergence of IoT is a global and local phenomenon. On the one hand, the knowledge and technological trend spreads rapidly worldwide and is driven by global actors such as international organizations and multinational companies, and on the other hand is the use of IoT in local regional contexts. Once embedded in a location, the development trajectory differs according to cultural, economic, and institutional patterns (XU, 2012). For example, compared to the upward market-oriented tradition of the European Union, the aggressive actions driven by the Chinese government in creating the industry, IoT has a top-down pattern with the government acting as initiator, investor and regulator. In the United States, the term is more dispersed in different application fields such as smart health, smart grid, smart logistics, and smart food. Therefore, it is conclusive to say that this global trend is implemented differently in varying locations. The next session discusses how the interaction between the Internet of Things and Agribusiness occurs.

Internet of things in agribusiness

The Internet of Things plays a key role in management, and enables sensed objects distributed over an area to connect to agribusiness applications. The digital agriculture boom, new entrants, cost reduction, and efficiency gains in the field increasingly come before new forms in this new scenario (ATZORI, 2010).

States that with the various predictions that the number of connected objects will pass 20 billion by 2020, the importance of networks will be even more critical. He also highlights that the most used network technologies for IoT today are cellular, Wi-Fi, Bluetooth or ZigBee networks, not to mention backbones implemented over Ethernet.

According to Brum et al. (2008), the regions that managed to reach high levels of agricultural production incorporated new technologies and increased their cultivable areas, becoming more efficient and achieving the desired economic growth. This process, however, was accompanied, in most cases, by a conditioning of agricultural production to industry. In a similar vein, Aquino et al. (2005) say that the modernization of agriculture varies among the various authors that address the subject. Some consider only the modifications in the technical base and others take into account the entire production process.

In this way, the application of IoT comes to meet this trend and involves from the mechanization of the field, with onboard technology for the preparation of planting areas, correct and uniform application of fertilizers, pruning, and harvesting, to what is being called precision agriculture (SARNO, 2017). With the use of sensors and drones, combined with big data platforms exploited with analytical and cognitive intelligence, we have, then, all the tools for better decision making.

As a first successful example of the Internet of Things, this theoretical essay presents the company Stara, one of the largest manufacturers of agricultural machinery in the country, with international operations. This company developed a prototype of IoT technology focused on agribusiness. With the support of SAP[3] Labs Latin America, SAP's Research and Development Center, located in the city of São Leopoldo (RS), Stara, which already used sensors in its tractors, developed a telemetry solution that uses the full potential of the SAP HANA Cloud platform and allows the integration of the data obtained with SAP's management systems.

With the IoT prototype, the farmer can monitor online and in real time the processes of planting (such as seed quantity), preparation, fertilizing and soil correction, spraying, and harvesting. The data can be integrated with the farm's management system, which allows for real-time analysis. "Farmers can monitor and make immediate decisions about the critical processes of their business, ensuring more efficient control of costs and input purchases," says Cristiano Paim Buss, director of Research and Development at Stara.

Among new opportunities, services and/or businesses, Lemos cited as an example changes that can happen in the agricultural machinery industry. According to the executive, with the expansion of IoT, manufacturers in the sector may, for example, start selling complete digital solutions for precision

[3] https://www.osul.com.br/prototipo-desenvolvido-pelas-empresas-sap-e-stara-pretende-simplificar-e-otimizar-a-gestao-do-trabalho-no-campo/

agriculture, and no longer only tractors or harvesters. Another successful application of IoT in Brazil was a software that helps pupunha palm heart producers to manage rural properties. In the text by Pichelli[4]:

> The Planin Pupunha is a system that performs an economic analysis of the production and helps in the management of the plantation according to production costs, interest rates and the price of the palm heart in the consumer market. Developed by researchers and analysts at Embrapa Florestas (PR), the system also allows the registration and monitoring of operational costs of implementation, maintenance, and harvest of the pupunha palm. According to its developers, the system aims to cover a gap. Research and extension created and transferred techniques for the establishment of the culture, but it was still necessary to help the producer to manage his property. "Every rural producer, no matter how simple it is, now of deciding what to plant, always makes an analysis of the benefits that that particular crop can bring him, such as environmental, social, and economic return, market and available labor, whether family or hired.

The Planin Pupunha software was developed based on the success cases of the Planin software developed by Embrapa Forestry researchers for pine, eucalyptus and other forest species. Native from the Amazon, where it is used for the production of fruits, the pupunha found space for the production of palm heart in the Atlantic Forest, biome in which it was introduced through organized plantations in areas abandoned by agriculture.

Another example of implementation of the Internet of Things comes from Pará. According to news from G1[5] in 2015 fish farmer Valdir Gama was selling up to five million alevins, the young of the fish, on his farm in the municipality of Igarapé-Açu, in northeastern Pará. To increase production and the quality of the fish, he implanted chips in the fish. The chip is injected into the fins of the tambaquis. Each "chipped" fish gets a number, a kind of badge. Some tissue samples are also collected, which will help in the identification of sex, size, and everything the producer needs to know about the fish.

CONCLUSIONS

The first conclusion is that the daily life of agribusiness will be progressively impacted by the Internet of Things, being a determining factor for the potentialization, and consequently the expansion of agribusiness in Brazil, and, moreover, modern agriculture no longer has anything to do with the idyllic image of the mud hut and the simple life in the field, making this sector more competitive. Technology is gaining space and promoting increased productivity.

Another conclusion is that the Internet of Things is a global and local phenomenon, driven by global players, such as international organizations and multinational companies, and play a key role in regional agribusiness. Its implementation occurs according to cultural, economic, and institutional patterns.

Finally, we achieved the proposed objectives, contextualizing the emergence of IoT in the business world; reporting the main technologies that impact the agribusiness segment in Brazil; listing some examples of companies that are using new technologies in agribusiness and how the Internet of Things transforms the agribusiness scenario.

[4] https://www.embrapa.br/busca-de-noticias/-/noticia/28970590/software-auxilia-produtores-de-pupunha-para-palmito-na-gestao-de-propriedades-rurais

[5] https://g1.globo.com/pa/para/e-do-para/noticia/2015/08/piscicultor-utiliza-tecnologia-para-melhorar-qualidade-do-pescado-no-pa.html

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