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TECNOLOGIA DA INFORMAÇÃO NA PRODUÇÃO DE NOZ-PECÃ: CASO NO ESTADO DO PARANÁ, BRASIL

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Nota dos Autores

Autores declaram que não há conflitos de interesses.

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Abstract

The aim is to assess the insertion of information technology in properties of pecan nut producers of the Western Region in Parana State, in Brazil. A questionnaire was applied to 21 pecan producers in the West Region of Paraná. Significant difference was tested using Kruskal Wallis in relation to the age of the farmer, working time, property size and use of information technology (IT). In the PDCA analysis, suggestions for continuous improvement were presented. In the findings, differences in the use of IT in properties of pecan nut producers are statistically significant in variables of property size and working time. The size, working time, number of computers, IT service outsourcing, and quality of data access are significantly and positively correlated. The practical implication is to use the implantation of IT in companies, as a methodological lens to evaluate the scenario of pecan producers of the Western Region in Parana State.

Key-words: information technology, organizational performance, production, pecan nut, local development.

Resumo

O objetivo é avaliar a inserção da tecnologia da informação em propriedades de produtores de noz-pecã da Região Oeste do Paraná. Um questionário foi aplicado a 21 produtores de noz-pecã da Região Oeste do Paraná. Diferença significativa foi testada usando Kruskal Wallis em relação à idade do agricultor, tempo de trabalho, tamanho da propriedade e uso de tecnologia da informação (TI). Na análise do PDCA, foram apresentadas sugestões de melhoria contínua. Nos resultados, as diferenças

no uso de TI nas propriedades dos produtores de noz-pecã são estatisticamente significativas em variáveis de tamanho da propriedade e tempo de trabalho. O tamanho, o tempo de trabalho, o número de computadores, a terceirização de serviços de TI e a qualidade do acesso aos dados estão significativamente e positivamente correlacionados. A implicação prática é utilizar a implantação da TI nas empresas, como lente metodológica para avaliar o cenário dos produtores de noz-pecã da Região Oeste do Paraná.

Palavras-chave: tecnologia da informação, desempenho organizacional, produção, noz-pecã, desenvolvimento local.

1 Introduction

The phase of connected intelligence is increasingly being defined by the propensity related to information technology (IT), determined by the insertion of software in companies, by the automation of labor and by the increase in competitiveness and the use of technology models (Ízmirli, Ekren & Kumar, 2020).

The 1990s marked the information age due to the impact caused by technological development and IT. A structure and integration of ideas capable of forming a new administrative theory is not yet developed, but modern approaches in the midst of the information age favor organizational aspects, such as simplicity, agility, flexibility, teamwork, autonomous units (Rodrigues & Caldeira, 2020), in addition to cultural aspects, such as broad participation, commitment, focus on internal and external customers, orientation towards goals and results and the search for continuous improvement (Barrios et al., 2010).

The evolution of technology affects all forms of production. In view of a new market concept and the remarkable deduction in information expenses, the area of natural resource exploration in Brazil demonstrates accessibility to innovation, just as it happened with the service and industry area some years ago (Fronza et al., 2018; Franco, Soares, Doliveira & Santos, 2020).

Barriers are perceived in the insertion of different technologies in the rural area, notably in information technology. In this scenario, the research problem is related to the following question: what aspects influence the insertion of information technology of the properties of pecan nut producers?

The aim of this study is to assess the insertion of information technology in properties of pecan nut producers of the Western Region in Parana State, Brazil. This study analyzes the scenario of pecan nut production properties to identify the difficulties and technologies that they employ. Also considered were the characteristics that are relevant to the organization's management system and how to achieve the complete management benefits.

The increase in technology has influenced the emergence of a population of consumers with different needs and desires, which has generated development in the innovation of market opportunities. This scenario is also found in the production of pecan nut, where it is necessary to enjoy favorable situations.

Overcoming barriers that farmers encounter internally in the market is a fundamental aspect for the growth of pecan nut production, with emphasis on the conflict in the face of inequality actions in the chain, where there is an imposition on the purchase value of pecan nut for farmers, establishing double pressure in this segment of the production chain (Bilharva, Martins, Hamann & Fronza, 2018).

Therefore, the use of detailed information on the use of technology by organizations is becoming increasingly relevant, with the aim of structuring management activities, in order to benefit from its mechanisms (Rodrigues & Caldeira, 2020; Porter, 2001; Parsons, 1983).

Some research gaps in the IT literature and most specifically on the matter of pecan nut production were identified by Leite, Junior, Calaboni & Igari (2020), Fronza et al., (2018), Barrios et al., (2010), among others. Specifically, these authors claim that there is little research on developing the insertion of IT in the pecan nut production process.

The strategic tool of the PDCA cycle was used to contribute to the pecan nut production market in the management of changes for the implementation of IT in production processes. According to Lodgaard, Gamme & Aasland, (2013), the PDCA cycle was developed in the 1950s by management consultant Dr William Edwards Deming. The tool can be used by entrepreneurs from all areas to carry out projects and better structure strategic business approaches.

In this context, the study seeks to understand the behaviors, impediments, consequences arising from the insertion of information technology and how it is used. In view of this form of analysis, the study presents the strategies of information technology by producers in the organization of decision making.

2 Theoretical framework

2.1 Pecan nut production

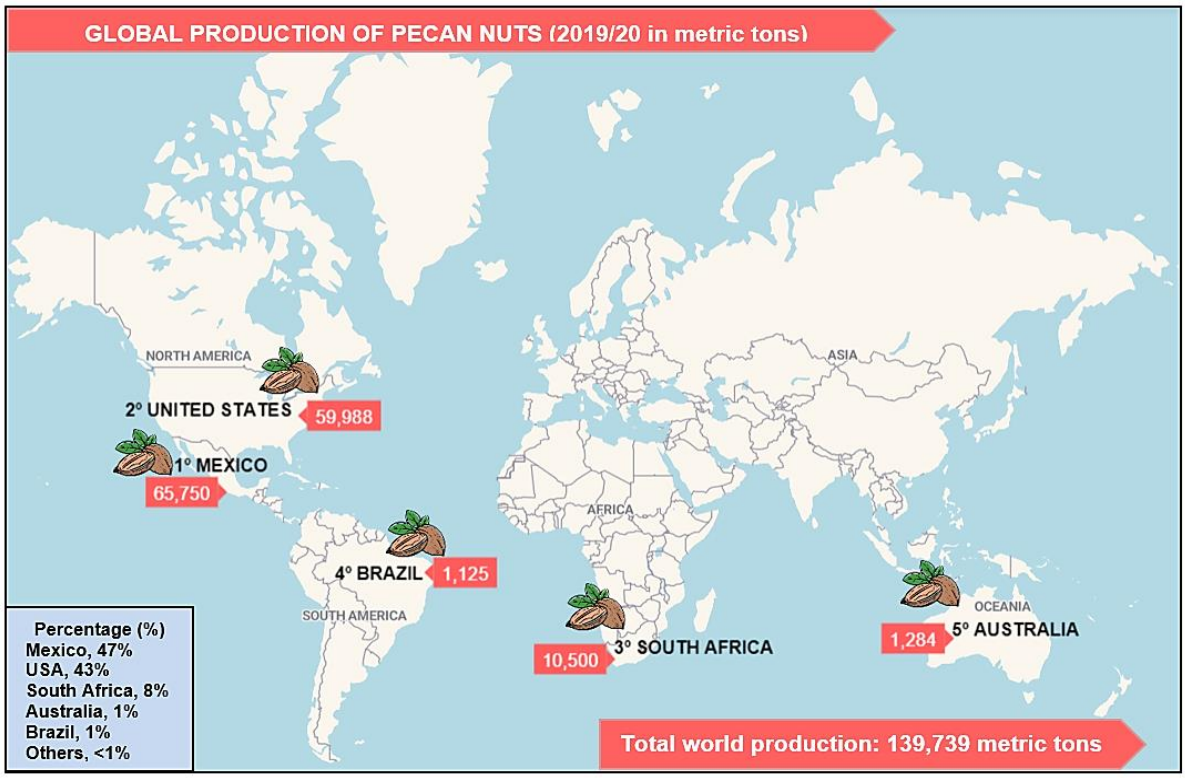
According to International Nut and Dried Fruit Council (INC), pecan nut whose scientific name is Carya illinoinensis (Wangenh.) K.Koch is a plant that belongs to Juglandaceae family and native in Northern Mexico. Globally, the Mexico is a world leader in the manufacture of pecan nut with 47% of global production. United States is the second largest producer responsible for 43% of the production (International Nut & Dried Fruit – INC, 2020).

A significant volume of sales and trade of the pecan nut are also established in South America in countries like Argentina, Brazil and Peru (Barrios et al., 2010). The pecan nut production in southern Brazil presents an increasing financial investment. It is necessary researches, assisting in solve problems and proposition of information technologies to enhance this production chain (Fronza et al., 2018).

According to the Brazilian Institute of Pecaniculture, the culture arrived in Brazil around 1870, through some people who lived in the United States and used pecan nut in local cuisine. After a while, the culture started to expand and in the last ten years there has been a very large increase, especially when the population began to think about healthier eating (IBPecan, 2019). According to INC (2021), in 2020/21 Brazilian production reached 1,125 tons, placing the country among the world's top four pecan nut producers, behind only Mexico, USA and South Africa (see Figure 1).

Figure 1

Global production of pecan nut



Source: Authors, according to data recovered from: "Annual Report", from International Nut & Dried Fruit, INC (2021).

Although it is a long distance from the major producers, Brazil shows its aptitude for growing the fruit. Parana State stands out in the production of pecan nut. The State is the second largest producer in the country, Parana lands are responsible for 35 percent of national production, behind only in Rio Grande do Sul. In total, eight cities in Parana have fruit production: Diamante D'Oeste, Missal, Ventania, Londrina, Porto Amazonas, Medianeira, Santo Antônio do Sul, Matelândia and Uraí. In them, just over 100 producers from Paraná work with culture (Embrapa, 2017).

In the last few years the pecan nut culture has been considered as an alternative source of income diversification or investment for rural producers, this is due to the ease of handling and rusticity of the culture, in addition to the great demand in the domestic and foreign markets.

Although already established a little over a hundred years ago in the country, there is a lack of production mechanisms for technicians and producers on information technologies for the production of pecan, as they are found for other cultures in Brazil (Boscardin & Costa, 2018).

The productive system in the properties involves the production function, administrative services for pecan nut storage, commercial system, technical assistance (agronomy), storage and processing of pecan nut.

2.2 Information technology

In this study, following the fundamentals of information technology (for example, Porter, 2001; Drucker, 2000; Henderson & Venkatraman, 1993), we propose that as markets become more sophisticated, it is necessary to improve the information areas of companies, adding strategies for success. The strategic message that an economy based on information conveys is so visible, that information has become the basis for competition, capable of triggering technological alternatives for its management. Information is, therefore, an essential element in organizations, which makes it possible to establish the necessary conditions to achieve their objectives and increase their competitiveness (Laurindo, Shimizu, Carvalho & Rabechini Junior, 2001).

Information technology corresponds to objects (hardware) and vehicles (software) intended to create information systems that, in turn, result from the implementation of IT through the use of computers and telecommunication (Balarine, 2002; Henderson & Venkatraman, 1993). Investments in IT are significant and companies hope, through these, to expand the list of management objectives that may influence their performance (Rodrigues & Caldeira, 2020; Brito & Mariotto, 2013).

Information technology refers to all technologies used to process information and facilitate communication. IT allows individuals to collect, create and disseminate information through different means: voice, text or image. Today, all human activities are affected by the IT revolution. Agriculture is no exception, especially in Brazil, where awareness of the importance of access to information is growing (Brito & Mariotto, 2013).

However, the use of information technologies in the agricultural sector comes up against barriers: interruptions in electricity supply, grid instability, high infrastructure costs, low income of farmers in rural areas, lack of political incentive and lack of skills can prevent farmers from using IT. Despite these obstacles, opportunities remain to promote the adoption and dissemination of new agricultural practices. With the proliferation of training courses, more operators are mastering these technologies. It is also recognized that IT is transforming agricultural extension through easy access to content (Salampasis & Theodoridis, 2013).

Today's farmers need continuously updated information. As a result, traditional communication techniques – post office and contact agents – are no longer sufficient. However, while IT is preferred, the two forms of communication, modern and traditional, can be combined for optimal efficiency (Campenhout, 2021; Salampasis & Theodoridis, 2013).

IT has a complementary role, farmers can, for example, use these technologies to disseminate information during their field visits. To further develop the IT-based extension, several conditions are required. In particular, steps should be taken to subsidize internet subscriptions in order to provide farmers with access to information in all circumstances. Developing the infrastructure necessary to deal with power outages and network instability is another key challenge to address in driving IT impact at scale (Silva, 2019).

Agricultural professions are undergoing profound changes. Genetics, automation, and biological control are all major developments observed in the last five years. The farmer, more and more, is a technician and a data manager. To develop precision agriculture and adopt IT and digital tools on the farm, the farmer needs practical knowledge (Campenhout, 2021; Balarine, 2002).

Michael Porter, one of the pioneers in strategy, puts an emphasis on information as an essential factor of competitive advantage. The author reaffirms the fundamental role that “traditional” strategies continue to be used and the need to combine them with the “new” practices (digital marketing and e-commerce) made possible by the Internet (Porter, 2001).

Other theories, for example, the approaches of Parsons (1983) and Ives & Learmonth (1984) present an analysis to assess the competitive impact of IT. Parsons (1983) examines the issue of the impact of industry, competitive environment and organization (strategy). As pointed out at the industry level, IT can modify the product's life cycle, change its distribution mode, modify market barriers and the economic bases of production. In terms of the competitive environment, IT can change the company's balance of power with its competitors, customers and suppliers. In addition, according to Ives & Learmonth (1984), the implementation of IT accelerates the rate of appearance of substitute products, decreases the expansion of existing barriers and the creation of new barriers to entry.

Rezende (2001) clarifies that, in order to facilitate the implementation of information technology in the company, it is necessary to create a strategic vision, that is, a vision that, in the strategic context, is not only capable of aligning business, organization and information technology, but also to cover the competitive strategy and the organizational models that can direct or be directed by the information technology system.

One of the difficulties encountered by small companies is obtaining information about the internal and external environments, which are essential for decision-making, since they all seem to be important and deserve to be analyzed (Franco et al., 2021). In this way, it is convenient to understand the reasons why it is not easy for such companies to achieve effective advantages with the use of information technology, although it can assist the strategic management of information, by providing appropriate and significant variables to the decision-making process (Moraes, Terence & Escrivão Filho, 2004).

2.3 Information tecnology in rural property

In Brazil, the rural properties have common barriers, such as production costs, difficulties in commercialization and the acquisition of better technology. The new competitive context puts pressure on many rural properties that have not yet managed to assimilate changes in technology

(Leite et al., 2020). According to Helfand, Pereira & Soares (2014), the rural properties are undergoing major restructuring, as they are moving from patrimonial production to technological production.

Therefore, it is evident that for companies to survive and sustain market changes, the correct use of IT is essential for administrative modernization, technological updating (in all environments) and to identify new business opportunities. Therefore, the use of IT becomes a criterion so that technology can contribute to adversity (Michalski, Metzger & Peres, 2010).

IT provides an infrastructure to meet the demand in various production and communication activities in a representative way for organizational management. Administrators, in general, invest in new technologies, in order to provide agility and lower cost (Porter, 2001).

Agricultural production in Brazil, and also in Parana State, is based on some factors, such as, for example, government support for food production, through subsidies offering credit lines for the sector, raw material in abundance, work capacity, among others (Leite et al., 2020). However, these are factors that can no longer be seen as a competitive advantage over competitors. Technological resources are factors that provide quality and flexibility in production, investments in new goods and services, which serve increasingly demanding consumers (Parsons, 1983; Rezende, 2001). Currently, a source of competitive advantage is one that meets the specific needs of an industry (Rodrigues & Caldeira, 2020).

The main objective of IT is to automate administrative procedures for the definition of rules, such as human resources and financial control. During this process, as rural properties in Brazil face several barriers, such as the need for training and adaptation of employees; lack of internet coverage at the property location, lack of knowledge in the use of software, among others (Michalski, Metzger & Peres, 2010).

The PDCA cycle or Deming cycle is a tool to assist in decision making when implementing IT in the production process. Thus, the barriers faced by rural properties may be subject to planning before, during and after the implementation of IT in the production process. Development is the phase in which the activities are carried out, followed by a control to verify the work, allowing the manager to

present evaluation indexes that can be quantified as results. At the end, the PDCA evaluation phase allows comparing all the factors of the production process in search of continuous improvement (Aquino & Castro, 2016; Lodgaard et al., 2013).

One of the main objectives of the dissemination of the information technology process in the cultivation of pecan nut is the development of technologies that generate the sustainable improvement of the production system in the cultivation of this fruit tree in the southern region of Brazil (Boscardin & Costa, 2018). According to Censo Agro (2017) even with the expansion of information technology in rural property, Brazil has 5.07 million rural establishments, however, 71.8% do not have access to the internet (about 3.65 million properties).

3 Method of Data Collection and Analysis

As presented in the theoretical framework, barriers occur in the insertion of different technologies in the rural area, notably in information technology. Pivoto et al., (2018), has argued that the use of information technology in rural property, can structure management activities for producers to benefit from its mechanisms.

This paper will extend beyond knowing the use of information technology processes but to know how rural properties differs from each other in terms of farmer age, working time and property size; and also to know if this disclosure is correlated to any variables.

Lodia (2010) has argued that owner work time and property size are variables that can impact the use of information technology processes. To analyze this issue, this article seeks to know whether age and working time (in years) and property size (defined as small, medium, and large) impact the use of information technology processes.

According to Machado and Nantes (2011), variables such as website use, amount of technology equipment, ease of internet access in rural regions are factors that facilitate an IT implementation process. Moraes et al. (2004), highlight that some barriers can impact the use of IT, such as lack of quality of access to data and the resistance of employees to use IT resources.

Also, Carrer, Souza Filho & Batalha (2017) concludes that Brazilian rural properties are not maximizing the potential to use of information technology processes to improve production mechanisms. This paper through the use of set of samples will support the literature contribute to current literature and consequently promote the appropriate use of information technologies as avenue of communication and production processes.

Using the operational framework, the following hypotheses will be tested: i) demographics variables: farmer age, working time and property size; ii) use of information technology processes: website, number of computers, form of internet access, outsourced service (information technology), resistance of employees to use IT resources, and quality of access to property data.

H01- There is no difference in the use of information technology processes in terms of the producer's age.
Ha1 - There is a difference in the use of information technology processes in terms of the producer's age.
H02 – There is no difference in the use of information technology processes in terms of the producer's working time.
Ha2 – There is a difference in the use of information technology processes in terms of the producer's working time.
H03 – There is no difference in information technology processes in terms of the size of the property.
Ha3 – There is no difference in information technology processes in terms of the size of the property.

The research was carried out on pecan nut production properties located in the municipalities of Missal, Diamante D'Oeste, Vera Cruz do Oeste, Medianeira, Foz do Iguaçu and Matelândia, which totaled 21 producers from different properties. The option for the west of Paraná is justified by the habit of planting, processing and selling pecan nut. Regarding the sampling process, it is considered as non-probabilistic. The choice of the population components to constitute the sample is partially due to the researcher's decision. Thus, the study used the technique of sample by intention, with the choice of elements of the population seen as qualified in the area and as an ideal source of knowledge.

The options for the study units consider the following characteristics: capacity and location of properties, whether or not to adopt management based on an information system. These precepts were defined to verify comparative studies in view of the aspects that made the productive units adhere to this technique. In view of the 21 properties surveyed, the definition of the property size was according to the classification proposed by Sebrae (2013), eight companies presented small characteristics, according to the number of employees (10 - 49), seven companies presented medium size (50 - 99) and six companies were classified as large (100 or more).

The data collection in this research was through semi-structured questionnaires for the owners responsible for the production of pecan nut, related to the use, difficulties, behaviors and applicability of information technology. It was also considered content related to the use of information technology for management decision making and the relationship between employees and owners in terms of management support and alternatives with technologies. Open questions were included in the questionnaire in order to assess the main barriers of owners in the use of information technology.

According to the established selection processes, rural entrepreneurs were chosen to constitute the case, identifying the profile and relevance in the place. Initially, a contact was made with the owners of the production units by telephone, for knowledge and consent to the performance of sending a questionnaire by e-mail. Data collection was carried out in April 2020.

Before testing the significant difference among the use of information technology processes, the researcher has tested the normality of distribution of the data using Shapiro-Wilk normality test. As a result, the researched determined which statistical Test to use in testing the significant difference. Kruskal-Wallis Test was used. As referred to by Ostertagova, Ostertag & Kováč (2014), the Kruskal-Wallis Test is the non-parametric test used in the comparison of three or more independent samples.

According to Driscoll and Lecky (2001), the most common criterion in hypothesis tests was used, that is, fixing the error (test significance level), which is committed when rejecting H0, given that

it is true and called level significance of the test. The variable tested by rejecting the null hypothesis (H0), consequently, the alternative hypothesis (H1) is accepted.

In testing the correlation among the variables, Spearman Correlation was used because the data is non-parametric. The data analysis for the Correlation Test was with a 95% confidence level and p-value <0.05. The classification of the values found in the correlation coefficients follows the one proposed by Devore (2006, p.432). Correlation coefficient p (+ ou -): very weak correlation (0.00 / 0.19), weak correlation (0.20 / 0.39), moderate correlation (0.40 / 0.69), strong correlation (0.70 / 0.89), and very strong correlation (0.90 / 1.00).

After collection, data were stored in a database structured in the Microsoft Office Excel 2010. All data was processed in Statistical Package for the Social Sciences (IBM SPSS Statistics) version 24.

The reasons that encourage the use of information technology processes and the observed barriers to the implementation of this process were calculated using the answer counts of pecan nut producers to generate a Pareto chart using Microsoft Office Excel 2010. The Pareto theory is based on the idea that 80% of the effects come from 20% of the causes (Dawson, 2019).

Finally, we propose the PDCA cycle analysis based in concept of Lodgaard et al., (2013). This analysis tool can contribute to the pecan nut production market in the management of changes for the implementation of IT in production processes, based on the case of the Western Region in Parana State, Brazil.

4 Analysis

Through the data obtained through the application of questionnaires, we sought to identify the field and profile of the properties under study, according to: farmer age, working time, property size and use or not of information technology to support management decisions. The level of computer knowledge, frequency of use of computers and use of the computerization system were considered as a strategic form.

Table 1 shows the frequencies of the respondents' profile variables and their properties analyzed.

Table 1

Frequencies of profile variables

Gender	Frequency	Percent
Male	17	81.0
Female	4	19.0
Age	Frequency	Percent
20-29	5	23.8
30-39	2	9.5
40-49	9	42.9
50-59	5	23.8
Working time in nut production (years)	Frequency	Percent
From 1-5	3	14.3
From 6-10	3	14.3
From 11-15	8	38.1
More than 15	7	33.3
Property location (city)	Frequency	Percent
Diamante D'Oeste	2	9.5
Foz do Iguaçu	6	28.6
Matelândia	2	9.5
Medianeira	4	19.0
Missal	4	19.0
Vera Cruz do Oeste	3	14.3
Property size	Frequency	Percent
Small	8	38.1
Medium	7	33.3
Big	6	28.6
Use of information system for administrative services	Frequency	Percent
Yes	21	100.0
No	0	0
Website	Frequency	Percent
Yes	16	76.2
No	5	23.8
Number of computers	Frequency	Percent
Less than 20	5	23.8
From 21 to 40	10	47.6
More than 40	8	28.6
Main form of internet access	Frequency	Percent
Broadband	8	38.1
Via radio	6	28.6
Optical Fiber	7	33.3
Outsourcing of IT services	Frequency	Percent
Yes	8	38.1
No	13	61.9
Resistance of employees to use software	Frequency	Percent
Small	4	19.0
Medium	12	57.1
Big	5	23.8
Quality of data access	Frequency	Percent
Easy access	6	28.6
Satisfactory	10	47.6
Regular	5	23.8

Source: survey data (2021).

In general, 81% of the producers are male, with an average age of 41 years and work about 12 years in the pecan nut production activity. The municipality of Foz do Iguaçu-PR obtained the highest number of respondents, with 28.6% of the producers. On average, 38.1% of the properties were classified as small and 33.3% were classified as medium.

In the information technology processes, all properties use information systems for administrative services, 76.2% work with a website and 47.6% have 21 to 40 computers, including notebook, desktop and tablet. The main form of Internet access was broadband with 38.1% of respondents. The majority, 61.9% answered that they do not outsource the IT services that are used on the property.

Broadband with lower speed is still the most used means of accessing the internet. According to the Ministry of Science, Technology, Innovations and Communications (MCTIC, 2020), the government estimates that currently 800 out of 7,645 inhabited rural areas in Brazil have 4G. Until 2023, the government estimates that another 622 locations will have access to technology, reaching 1,422.

The resistance of employees to use information technology software was considered average by 57.1% of respondents. With advances in market techniques and technologies, there is a need to improve the training of agricultural workers. A rural owner who does not follow this trend puts his management at risk. Information technology in agribusiness facilitates service in the fields, but it also brings a need to remodel the profile and qualification of rural workers. The advantages for the agricultural worker are the exchange of manual labor for new operational forms. However, training is needed so that employees know how to use the current tools and feel able to the new way of working. In Brazil, according to Censo Agro (2017), 15.5% of rural producers said they had never attended school and 63.4% did not pass the basic level. However, this scenario needs to be adjusted to new needs.

The quality of access to data and information was perceived by 47.6% of producers as satisfactory. No producer claimed unsatisfactory quality. Internet access in the countryside is one of

the main challenges facing Brazilian agribusiness. According to the latest Censo Agro (2017), approximately 71% of the more than five million rural properties have no connection.

In practice, it means that more than 3.64 million properties lack access, for example, to education, communication and entertainment. And, when considering the productive bias, there is a lack of means to improve traceability processes and strategies, such as precision agriculture, which can increase productivity and agility in infrastructure (Safraes, 2020).

The result of the Shapiro-Wilk normality test showed that none of the variables has a normal distribution (see Table 2).

Table 2

Normality test

Variables	Shapiro-Wilk		
	Statistic	Df	Sig.[a]
Gender	0,484	21	0,000
Age	0,829	21	0,002
Time working with pecan nut production	0,839	21	0,003
Property size	0,796	21	0,001
Website	0,533	21	0,000
Number of computers	0,815	21	0,001
Form of internet access	0,784	21	0,000
Outsourced IT service	0,620	21	0,000
Resistance of employees to use IT	0,800	21	0,001
Quality of data access	0,815	21	0,001

[a] Significance > 0.05 represents a group of date normally distributed.
Source: survey data (2021)

The Kruskal Wallis Test was used to test the significant differences in the use of information technologies in the production process, in terms of the producer's age, time working in the area and size of the property. The results of the Kruskal Wallis test are shown in Table 3.

Table 3

Result of Kruskal Wallis

Farmer age		
Variable	P value*	Decision
Website	0,060	Failed to reject
Number of computers	0,166	Failed to reject
Form of internet access	0,352	Failed to reject
Outsourced IT service	0,130	Failed to reject
Resistance of employees to use IT	0,402	Failed to reject
Quality of data access	0,366	Failed to reject
Working time		
Variable	P value*	Decision
Website	0,272	Failed to reject
Number of computers	0,003	Reject the null
Form of internet access	0,855	Failed to reject
Outsourced IT service	0,041	Reject the null
Resistance of employees to use IT	0,274	Failed to reject
Quality of data access	0,187	Failed to reject
Property size		
Variable	P value*	Decision
Website	0,882	Failed to reject
Number of computers	0,007	Reject the null
Form of internet access	0,771	Failed to reject
Outsourced IT service	0,681	Failed to reject
Resistance of employees to use IT	0,650	Failed to reject
Quality of data access	0,041	Reject the null

* Significant (p<0,05)

Source: survey data (2021)

As a result, there is only statistical difference in terms of working time and property size. The results indicate that the number of computers and the use of outsourced IT services are statistically different depending on the producer's working time in years. In addition, the number of computers and the quality of access to data are also statistically different depending on the size of the property.

Thus, the null hypothesis 1 was not rejected, which means that the difference in the use of information technologies in the production process for the producer's age is not statistically significant. The null hypotheses 2 and 3 were rejected, which means that there is a statistically significant difference in the use of information technologies in the production process in terms of working time and property size.

The result of the Spearman correlation test (for non-parametric data) is shown in Table 4.

Table 4

Result of Spearman's Correlation Test

Variables		Age	Working time	Size	Website	Number of computers	Form of internet access	Outsourced IT service	Resistance of employees to	Quality of data access
Age	Correlation Coeficient	1.000								
	Sig. (2-tailed)	*								
Working time	Correlation Coeficient	-0,123	1.000							
	Sig. (2-tailed)	0,595	*							
Size	Correlation Coeficient	-0,022	0,744*	1.000						
	Sig. (2-tailed)	0,924	0,000	*						
Website	Correlation Coeficient	0,156	-0,282	-0,069	1.000					
	Sig. (2-tailed)	0,499	0,216	0,789	*					
Number of computers	Correlation Coeficient	-0,070	0,617*	0,654*	0,110	1.000				
	Sig. (2-tailed)	0,762	0,003	0,001	0,636	*				
Form of internet access	Correlation Coeficient	0,090	0,017	0,004	0,294	-0,081	1.000			
	Sig. (2-tailed)	0,699	0,942	0,987	0,196	0,726	*			
Outsourced IT service	Correlation Coeficient	0,394	0,419	0,155	-0,022	0,044	0,301	1.000		
	Sig. (2-tailed)	0,078	0,037	0,503	0,925	0,851	0,185	*		
Resistance of employees to use IT	Correlation Coeficient	-0,127	0,175	0,259	-0,041	-0,109	0,340	0,054	1.000	
	Sig. (2-tailed)	0,583	0,448	0,992	0,859	0,639	0,131	0,815	*	
Quality of data access	Correlation Coeficient	0,265	0,312	0,476*	0,189	0,366	0,165	0,227	0,102	1.000
	Sig. (2-tailed)	0,246	0,168	0,029	0,411	0,103	0,476	0,322	0,659	*

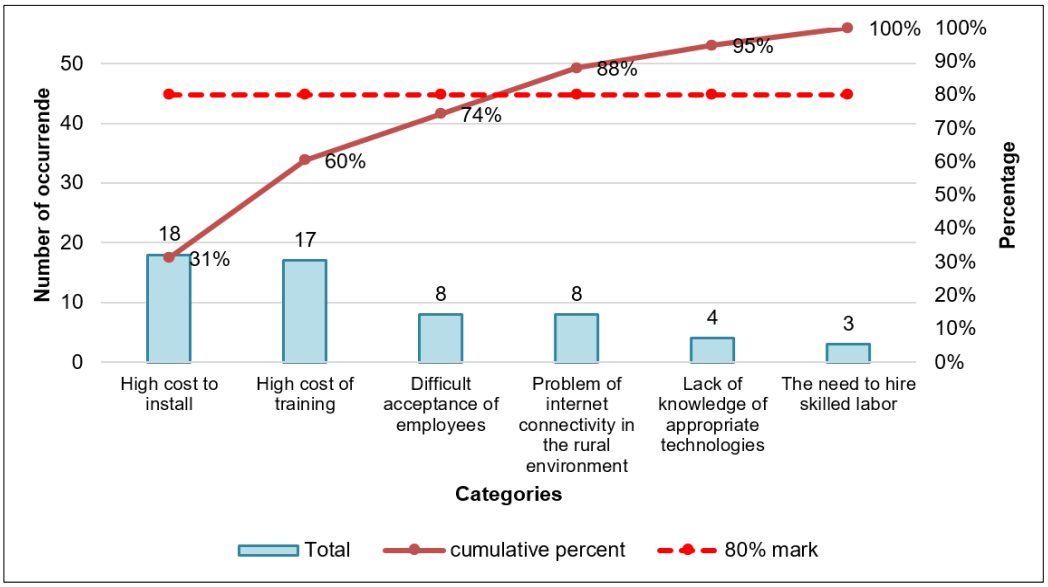
Source: survey data (2021)

It is possible to see that the use of information technologies in the production process for working time, property size, number of computers, outsourced IT service and quality of access to data are significantly and moderately correlated. The positive sign indicates that as the use of information technologies in the production process for each category increases, another category is also increasing. In addition, categories of the use of information technologies in the production process are significantly correlated with the size of the property and the work time of the producer. This is consistent with the Kruskal Wallis result that the differences in the use of information technologies in the production process are statistically different compared to the size of the property and working time.

Producers reported the main barriers during the IT deployment process. Respondents could mention more than one or no barrier, the count of the main barriers were represented by means of the Pareto chart (see Figure 2).

Figure 2

Pareto chart of main barriers counts



Source: survey data (2021).

The Pareto chart is a tool to help users understand problems and their causes (Dawson, 2019). In order to identify the main barriers to deploy information technology in the rural properties, the

80/20 principle is applied to all barriers reported by the farmers. The Y-axis of the Pareto chart has "counts" on the data used. Each vertical bar (X-axis) represents the contribution to the total from a given barrier.

The Z-axis represents the cumulative percentage. The cumulative percentage indicates what percentage of all barriers can be removed if the most important types of barriers are solved. We can see that the cumulative percentage line is steep, the barriers are likely to have a significant effect.

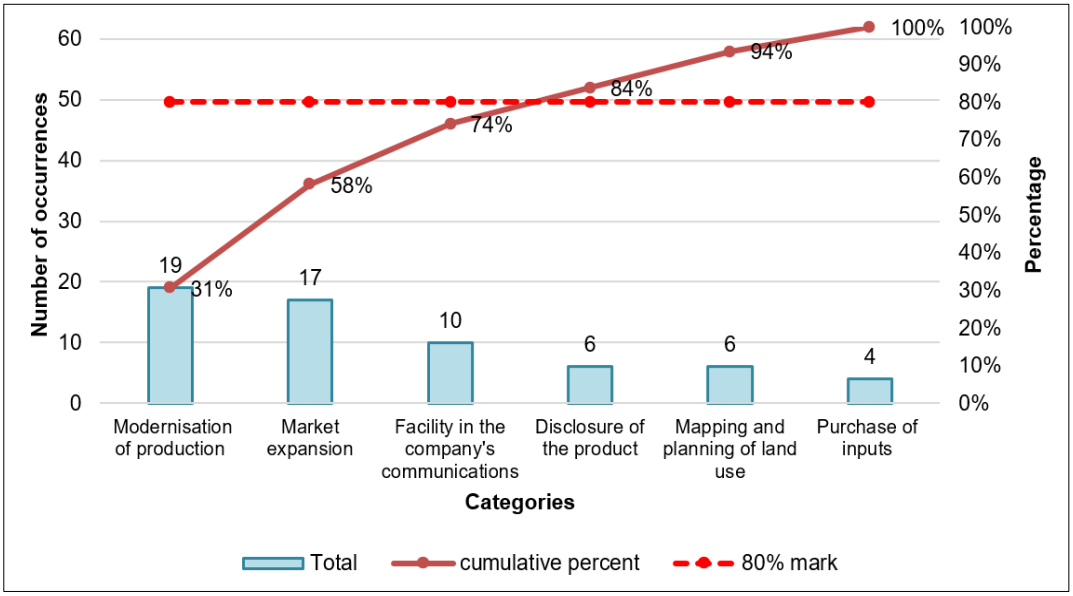
The charts enable farmers of pecan nut to focus their attention on the most critical of information technology in their production systems, reducing barriers as we move left to right. The high cost to install is responsible for about 31% of the overall barrier impact, the high cost of training is added to high cost to install percentage for a combined total of 60% of the overall barriers impact. The difficult acceptance of employees is added to high cost to install and high cost of training percentage for a combined total of 74% of the overall barriers impact, and so on.

The high cost was the main factor presented by the producers for IT implementation. According to IBPecan (2019), the cultivation of pecan nut requires a high initial investment and cultural treatment, but the return on profit will only happen after eight years and can reach US $ 10,000 in yield per hectare. Due to the high cost of production, the financial resources end up not being sufficient for investments in IT.

Respondents also reported the reasons for using IT, represented on the Pareto chart (see Figure 3).

Figure 3

Pareto chart of reasons for using IT



Source: survey data (2021).

The predominant factors that lead to the implementation of information technology systems in the surveyed properties are: modernization of production, expansion of the market, and ease of communication. It is noticed that there is a need for modernization of production, as reported by producers.

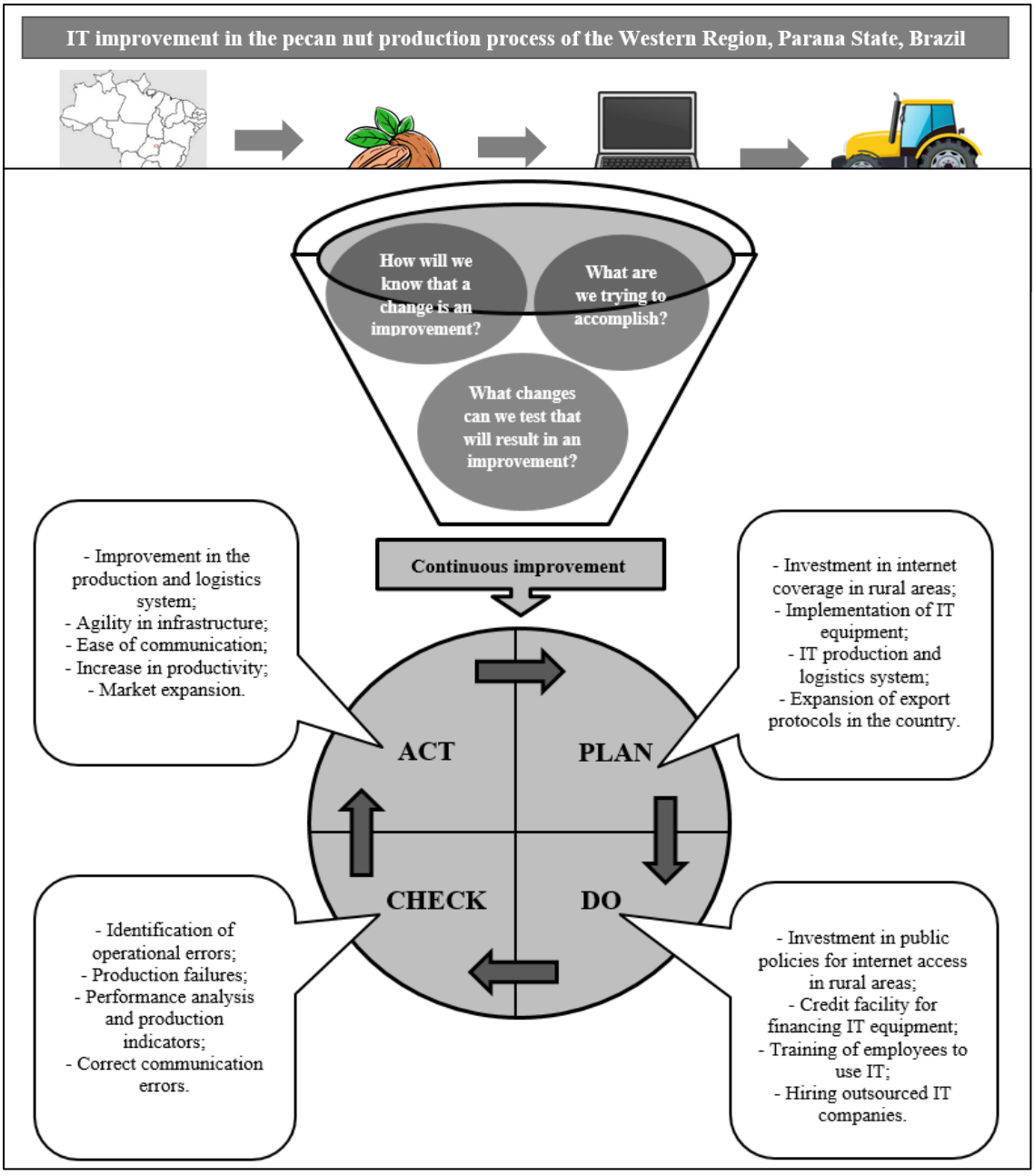
According to the Ministry of Agriculture, Livestock and Supply (MAPA), pecan nut was introduced in Brazil over 100 years ago and remained informal until November 2018. The absence of its registration in the Map hindered the development of the production chain, that could not count on the technical indication of chemical pesticides for culture. After registration, input companies can register chemical or biological control products used in the crop (MAPA, 2018).

Despite the advances in the MAPA registration that facilitated the producers' management system, factors such as the expansion of the international market still need advances. According to data from Brazilian Institute of Pecaniculture (IBPecan), Brazil does not yet have a pecan nut export protocol to China and ends up making investment in culture and, consequently, expanding the international market difficult (IBPecan, 2019).

As a suggestion for the region under study to present a growth in the pecan nut production, through the insertion of information technology, generating agility in the production infrastructure, we propose the PDCA cycle analysis. This analysis tool can contribute to the pecan nut production market in the management of changes for the implementation of IT in production processes, based on the case of the Western Region in Parana State, Brazil (see Figure 4).

Figure 4

IT improvement in the pecan nut production process of the Western Region, Parana State, Brazil



PDCA cycle analysis (Plan; Do; Check; and Act) stands out in the organizational environment as an analysis tool for process improvement and problem solving, based on the process of continuous improvement. The PDCA cycle can be used in any type of organization (private company, non-profit organization or public sector).

PDCA is a method that manages decision making to improve an organization's activities. This makes the PDCA contribute significantly to obtaining better results (Lodgaard et al., 2013).

Plan is the step of description and basic understanding of the whole process. Necessary actions were defined to dimension resources and conditions, for example, investment in internet coverage in rural areas, implementation of IT equipment, and expansion of export protocols in the country. To complete these actions, a detailed plan is needed to carry out the execution.

Subsequently, the do step is responsible for obtaining resources until the process is implemented. The execution of processes, such as investment in public policies for internet access in rural areas, credit facility for financing IT equipment, and training of employees to use IT. According to Lodgaard et al., (2013), the result of implementing these processes provides better production conditions to achieve the desired effect.

Check or control step, means ensuring the execution of the process by observing the performance described in the “Plan” step. Therefore, some observations need to be made, for example, identification of operational errors, production failures, and performance analysis and production indicators. Production monitoring reports can be used, showing the compliance or not of the established parameters.

Finally, act step is performed to understand the mistakes and successes. The stage is responsible for the results of the practical application of the process, which can be positive or negative results. In the case under study, it is possible to verify whether there was improvement in the production and logistics system, agility in infrastructure, ease of communication and market expansion. People need to be trained to act on the parameters that were positive, following a new cycle (Plan; Do; Check; and Act) for the organization to learn from its results.

These transformations in the agricultural world caused by the rise of digital technology also generate new forms of relationship in the sectors and in the logistics organization of the food chain. This induces changes in terms of value production and distribution (Silva, 2019). Digital tools for communication, information, remote control and decision support appear simultaneously in many sectors. Agriculture is therefore naturally attracted to the new possibilities offered by this technological development (Rodrigues & Caldeira, 2020).

The transition to data-driven agriculture is not easy and cannot be achieved in a short time. The process is necessarily long and complex, as is the transition to the use of motorized tools and chemical inputs (Silva, 2019).

The farmer must train and complement his skills. The farmer must be able to analyze data and ultimately decide, even if decision-making tools are implemented in the area (Leite et al., 2020). Finally, among the difficulties raised remains the question of ownership of agricultural data and information. These are the object of plan, do, check and act strategies (Lodgaard et al., 2013; Boscardin & Costa, 2018).

5 Conclusion

This paper has studied the insertion of information technology in properties of pecan nut producers of the Western Region in Parana State, Brazil. The profile was identified according to: farmer age, working time, property size and use of information technology (IT). In addition, this determined whether significant correlation exist among the variables. The result showed that use of information technologies in the production process is statistically different in terms of working time and property size.

In correlation, number of computers and outsourced IT service are significantly and positively related with working time category. In addition, number of computers and quality of data access are significantly and positively related with property size category.

The Pareto charts enable farmers of pecan nut to focus their attention on the most critical of information technology in their production systems, reducing barriers as we move left to right. The

high cost to install is responsible for about 31% of the overall barrier impact, the high cost of training is added to high cost to install percentage for a combined total of 60% of the overall barriers impact. The difficult acceptance of employees is added to high cost to install and high cost of training percentage for a combined total of 74% of the overall barriers impact.

Also according to the Pareto chart, predominant factors that lead to the implementation of information technology systems in the surveyed properties are: modernization of production, expansion of the market and ease of communication. It is noticed that there is a need for modernization in production, as reported by producers.

PDCA cycle analysis can contribute to the pecan nut production market in the management of changes for the implementation of IT in production processes, based on the case of the Western Region in Parana State, Brazil. It is perceived that the PDCA cycle contributes to an overview of the case study scenario, providing actions that can be planned, executed, verified and performed as continuous improvement in the production of pecan nut of the Western Region in Parana State.

The theoretical contribution of this research is the advancement of knowledge in the insertion of information technology in rural properties. The practical implication is to use IT implementation in companies, as a methodological lens to assess the scenario of pecan producers in the Western Region of the State of Paraná. This result made pecan producers and public policies in general aware of the low investment in information technologies in the production process. Some companies are encountering barriers due to the high cost of installing and training employees, as well as difficulties with internet connectivity in rural areas. Therefore, it is essential to increase investments in the insertion of information technologies to pecan nut producers in the Western Region of the State of Paraná, obviously the level of investment varies depending on its available resources, measured by the size of the property.

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