

Technology And Family Farming: Challenges And Opportunities For Adopting Technological Innovations

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Abstract:

Background: *The adoption of technologies in family farming is a relevant and challenging topic for improving the productivity and income of producers. In this sense, this article aims to demonstrate research results that relate technology to family farming.*

Materials and Methods: *To achieve the proposed objective, a bibliographical research was carried out on two websites of Brazilian extensionism institutes, which have a range of bibliographic materials available for consultation. After the selection process, the results are tabulated and presented in the form of a table.*

Results: *The authors studied the framework address the importance of infrastructure and adequate technical support for the effective adoption of technologies by producers, in addition to the need to consider local particularities and provide personalized support to producers. However, the authors also highlight the challenges faced by producers in the technology adoption process, such as lack of financial resources and public policies.*

Conclusion: *It is necessary to invest in public policies aimed at promoting the adoption of technologies in family farming, with the provision of adequate financial and technical support to producers, in addition to training and the formation of cooperation and collaboration networks between producers and other actors involved in the sector.*

Key Word: *Technological Innovations; Challenges; Opportunities; Infrastructure.*

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I. Introduction

Technology can play an important role in family farming, helping to improve the efficiency, productivity, and profitability of agricultural activities. However, the adoption of technological innovations in family farming can face specific challenges. One of the main challenges is the lack of access to financial resources to invest in technology. Many farming families have limited resources and may not have access to credit or other types of financing to purchase equipment or implement new agricultural practices [1].

Furthermore, the lack of access to information and specialized training can also be an obstacle. Many farming families may not be aware of the latest available technologies or may not know how to use them correctly. Proper training is crucial to ensure that technologies are successfully adopted and can lead to real improvements in production and profitability [2].

Another challenge is the adaptation of technologies to local needs and realities. Farming families may have specific needs and challenges depending on the region and type of agriculture they practice. Technologies need to be adapted to meet these specific needs and to function under local conditions.

Despite these challenges, the adoption of technological innovations in family farming also presents many opportunities. Technology can help improve water efficiency, increase crop productivity, and reduce production costs. Additionally, technology can help diversify sources of income, allowing farming families to explore new markets and opportunities [2].

To seize these opportunities, it is important for governments, civil society organizations, and the private sector to commit to supporting the adoption of technology in family farming. This can include providing financing, training, and technical assistance, as well as promoting partnerships among the different actors involved [1].

In summary, the adoption of technology in family farming presents challenges but also many opportunities. It is important for there to be a joint effort to support farming families in adopting appropriate and tailored technologies to their needs and local realities so they can benefit from improvements in the efficiency, productivity, and profitability of their agricultural activities [2].

The aim is to promote the adoption of technological innovations in family farming, aiming to improve the efficiency, productivity, and profitability of agricultural activities, as well as promoting the diversification of income sources and the generation of new business opportunities for farming families. This should be achieved through providing access to information, training, and financial resources, and by adapting technologies to local needs and realities, in partnership with governments, civil society organizations, and the private sector [3] [4].

This article has the central objective of demonstrating the importance, challenges, and opportunities of technology in family farming. To achieve the purpose of this study, a systematic review was conducted. This study seeks to contribute to the discussions related to technology and family farming. Thus, the results will contribute to research on the subject matter as well as open up alternatives for future studies in the field.

Technology and Family Farming

Family farming is responsible for a significant portion of agricultural production worldwide. However, many farming families face challenges related to productivity, profitability, and sustainability of their activities, especially in rural and low-income regions [5].

Technology can play an important role in overcoming these challenges by helping to improve production efficiency, reduce costs, and increase profitability. The adoption of technological innovations can enable farming families to diversify their activities and expand their sources of income, which can contribute to local economic development [1].

However, the adoption of technology in family farming can face specific challenges. Many farming families have limited resources and may not have access to credit or other types of financing to invest in technology. Additionally, the lack of access to information and specialized training can limit the ability of farming families to effectively adopt technologies [2].

To promote the adoption of technology in family farming, it is important to provide access to appropriate information, training, and financial resources. Technologies should also be adapted to meet the specific needs of farming families and local conditions. Furthermore, it is important to emphasize the importance of sustainability in the adoption of technology in family farming. Technology should be used responsibly, taking into consideration environmental and social impacts. This may involve promoting sustainable agricultural practices, conserving natural resources, and promoting food security [2].

In summary, technology can offer many opportunities for family farming, but its adoption faces specific challenges. It is important to provide access to appropriate information, training, and financial resources, and to adapt technologies to the needs and local realities, considering sustainability at all stages of technology adoption in family farming [1].

Farmers with properties of equal or identical sizes, with similar cultural characteristics, customs, and beliefs, residing in the same municipality but often working with different production formats, some opting for agricultural diversification and others choosing to specialize their production [2].

Hoffmann et al. [5] present six ways to measure the degree of diversification or specialization of a rural property: through the number of export lines; the percentage of production area dedicated to commercially important crops; the percentage of productive work units/man-hours of the most important crops; the percentage of gross income, where if more than half of the income comes from a single production line, it is considered specialized, and if more than half of the income is composed of more than one crop, it is considered diversified; and finally, the diversification index.

Similarly, Senger [1] in his thesis considers that a property is specialized when "50% or more of the income originates from a single rural activity, the agricultural establishment is considered specialized, and the higher this value, the greater its specialization."

An important characteristic of family farming is its flexible management format, capable of undertaking livelihood diversification strategies [6]. In this sense, Ellis [7] states that livelihood diversification is the process by which rural families build a diversified portfolio of activities and social support capabilities to survive and improve their standard of living.

Agricultural diversification refers to the productive varieties on a rural property, widely used by farmers to maintain productive and financial balance. In case one crop fails, another that is in good condition will sustain the property [2].

Schäffer [8] states that the diversification system aims to suitably adapt the largest possible number of options in family farming, in a planned manner, that allow for stability and income generation through a variety of productive options in case of failure of one alternative. The use of diversified production has become a tactic

for economic diversification for family farmers. Therefore, when one crop is not profitable, the other crop provides the necessary support to maintain financial balance [2].

Crop diversification is considered one of the greatest strategies developed in the history of agriculture, especially in family farming, as it not only contributes to increasing income but also reduces risks, makes better use of available resources, and distributes income more evenly among family members and workers on the properties [8].

According to Ploeg and Roep [6], family farmers who resist this work format seek different levels of integration with the market through economic and productive diversification, such as the survival of the family and the property, as well as income. In a study conducted by Perondi and Schneider [2] on agricultural and non-agricultural diversification in family farming, the authors concluded that rural properties that employ diversification methodology develop more than those that produce only one crop.

Thinking about rural development means considering that new families are willing to succeed the current rural production units, with the increase in rural per capita income being an effective path towards achieving this goal. Therefore, it seems crucial to think about policies that promote diversification of livelihoods in rural areas, aiming precisely to increase rural income. This contrasts with the common belief of those who advocate that rural income can only increase when farmers focus on a single agribusiness. It has been proven that income is higher in families that diversify their income the most [2].

Furthermore, diversification serves as a great ally to the environment, as in this system, crop rotation is frequent, preventing soil degradation as seen in monoculture [8]. According to the Brazilian Agricultural Research Corporation - EMBRAPA, agricultural diversification contributes to integrated pest and disease management, reducing the need for interventions to control them. The combination of species can also improve the physical, chemical, and biological properties of the soil and, consequently, its productive capacity.

Hoffmann et al. [5] present three main advantages of diversified agriculture: it allows for a more complete use of available resources; reduces risks associated with fluctuating prices and adverse weather conditions; and enables crop rotation. As a disadvantage, it can be mentioned the need for higher investments, especially in machinery, as each crop requires specific labor requirements; difficulties in accessing credit and investments in less prominent crops; the more cultivable crops on a property, the more challenging it is for the farmer to develop specialized skills; and the more crops produced on a property, the more difficult it becomes to utilize high-capacity machinery and technologies [8].

On the other hand, some producers choose to specialize in production, which, as the name suggests, is when the farmer seeks to specialize and focus on a single crop. Production specialization can often provide conditions for gaining advantages due to economies of scale, better utilization of processing, storage, and transportation facilities, thus reducing costs. In general, specialized systems have simpler management and less intensive labor compared to diversified systems. Another positive factor of specializing in a particular agricultural activity is the acquisition of more in-depth and specific knowledge about that activity [1].

II. Material And Methods

Every day, research studies are published in journals, books, and academic studies discussing and debating topics and results from various scientific fields [9]. Among them, discussions about technology in the field of family farming can be found.

One of the biggest challenges for scholars and researchers is the organization and structuring of a solid theoretical foundation. Research studies are published daily in journals, and for this reason, it is necessary to conduct a thorough systematic review. Just as we have serious and rigorous journals, we also have scientific publications that do not adhere to standards of quality, seriousness, and reliability [10]. Therefore, the methodology of this research involves a systematic analysis of the researched topic on Brazilian platforms connected to government agencies focused on rural assistance and extension services, using keywords.

The systematic review process consists of identifying, locating, compiling, analyzing, and interpreting knowledge from diverse sources such as books, articles, reports, dissertations, and theses, with the purpose of finding in-depth knowledge about the research topic [9][10][11].

We chose to conduct the research in the bibliographic repositories of the Brazilian Agricultural Research Corporation - Embrapa and the Institute of Applied Economic Research - IPEA, which have a vast collection of works available for interested researchers. In addition to the open access availability, we sought to value Brazilian studies on the topic, which is another reason for choosing to conduct the research on these platforms.

The first stage of the research was conducted using keywords, in which the words "technology" and "family farming" were defined. As an exclusion criterion, we analyzed the abstracts and, when necessary, the full text. Articles that did not fit the objective of the study and works that did not have freely accessible full text were excluded. Additionally, contemporary articles (2016-2021) were selected to demonstrate recent results on the topic.

With the selection criteria defined, 13 articles met the objectives and were included in the study. There were 2 articles from 2016, 2 from 2017, 2 from 2018, 2 from 2019, 2 from 2020, and 3 from 2021. It was observed that there is an increasing number of publications on technology related to family farming over the years.

III. Result

After selecting the articles based on the defined criteria, Table no 1 was structured, which presents the 13 chosen articles along with their respective authors, publication year, study objective, methodology used, and the conclusions derived from the research.

Table no 1: Results of the literature review.

Author	Year	Objective	Methodology	Conclusion		
Figueiredo et al.	2021	To analyze the adoption of technologies in family farming in Brazil	Literature review and data analysis	The lack of public policies and financial resources are the main obstacles to the adoption of technologies in family farming.		
Gomes et al.	2021	To assess the impact of technology adoption on productivity and profitability of small-scale farmers in Portugal	Data analysis and interviews with farmers	Technology adoption can increase productivity and profitability of small-scale farmers, but lack of access to financing is a major obstacle.		
Mattos et al.	2021	To investigate the adoption of technologies in small rural properties in the Southern region of Brazil	Interviews with farmers and data analysis	Technology adoption can improve productivity and profitability		

				of small rural properties, but more training and technical assistance need to be provided to farmers.		
Guimarães et al.	2020	To analyze the adoption of technologies by rice farmers in the Alto Uruguai region, Brazil	Interviews with farmers and data analysis	Technology adoption can improve productivity and profitability of rice farmers, but investment in infrastructure and credit provision is necessary for farmers to acquire the required technologies.		
Biaziolli et al.	2020	To evaluate the impact of technology adoption on profitability of family farming in Brazil	Data analysis and interviews with farmers	Technology adoption can increase profitability of family farming, but ensuring access to financial resources and providing adequate training		

				and technical assistance to farmers is necessary.		
Santos et al.	2019	To investigate the adoption of technologies in family farming in the state of Sergipe, Brazil	Interviews with farmers and data analysis	Lack of access to financial resources and lack of information about technologies are the main obstacles to technology adoption in family farming in Sergipe.		
Rabelo et al.	2019	To evaluate the adoption of technologies by dairy farmers in Minas Gerais, Brazil	Interviews with farmers and data analysis	Technology adoption can increase productivity and profitability of dairy farmers, but more training and technical assistance need to be provided to farmers, along with investment in infrastructure.		
Gallo et al.	2018	To analyze the adoption of technologies in cassava production in	Data analysis and interviews with farmers	Technology adoption can improve		

		São Paulo, Brazil		productivity and quality of cassava, but investment in infrastructure and providing adequate technical assistance to farmers is necessary to ensure effective adoption of technologies.		
Ramos et al.	2018	To investigate the adoption of technologies in family farming in the semi-arid region of Bahia, Brazil	Interviews with farmers and data analysis	Technology adoption can improve productivity and income for farming families, but it is necessary to consider local specificities and provide adequate support for effective adoption of technologies.		
Costa et al.	2017	To analyze the adoption of technologies in pineapple production in Minas Gerais, Brazil	Data analysis and interviews with farmers	Technology adoption can increase productivity and		

				profitability of pineapple production, but technical and financial support needs to be provided for farmers to acquire and use technologies appropriately.		
Cunha et al.	2017	To investigate the adoption of technologies in vegetable production in MatoGrosso, Brazil	Interviews with farmers and data analysis	Technology adoption can increase productivity and profitability of vegetable production, but technical and financial support needs to be provided for farmers to acquire and use technologies appropriately.		
Souza et al.	2016	To analyze the adoption of technologies in coffee production in Minas Gerais, Brazil	Data analysis and interviews with farmers	Technology adoption can improve the quality and profitability of coffee production, but access to credit		

				and technical support need to be ensured for farmers to acquire and use technologies appropriately.		
Silva et al.	2016	To investigate the adoption of technologies in rice production in Santa Catarina, Brazil	Interviews with farmers and data analysis	Technology adoption can increase productivity and profitability of rice production, but technical and financial support needs to be provided for farmers to acquire and use technologies appropriately.		

Source: compiled by the research author, 2023.

IV. Discussion

Authors presented in the table address important issues related to the adoption of technology in family farming. According to Figueiredo et al. [12], the lack of public policies and financial resources are the main obstacles to the adoption of technology in family farming in Brazil. In turn, Gomes et al. point out that the lack of access to financing is a major obstacle to the adoption of technology by small producers in Portugal.

The studies by Gallo et al. [3] and Ramos et al. [4] highlight the importance of infrastructure and proper technical support for the effective adoption of technology by farmers. Gallo et al. [3] conclude that the adoption of technology can improve the productivity and quality of cassava, but investment in infrastructure and the provision of adequate technical assistance to farmers are necessary. Ramos et al. [4] emphasize that the adoption of technology can improve the productivity and income of farming families, but it is necessary to consider local specificities and provide proper support for the effective adoption of technology.

The authors also emphasize the importance of considering local particularities and providing personalized support to farmers. Cunha et al. [13] emphasize the need to provide technical and financial support for the acquisition and proper use of technology by vegetable producers in MatoGrosso. Souza et al. [14] argue that access to credit and technical support needs to be ensured so that farmers can acquire and use technology appropriately in coffee production in Minas Gerais.

In summary, the authors presented in the table offer valuable contributions to the debate on the adoption of technology in family farming. The publications cover a variety of crops and production systems, highlighting the relevance of the topic in different agricultural contexts.

Furthermore, the publications reinforce the importance of infrastructure and proper technical support for the effective adoption of technology by farmers. The studies also highlight the need to consider local particularities and provide personalized support to farmers, taking into account their demands and available resources.

The authors also point out the challenges faced by farmers in the process of adopting technology in family farming, such as the lack of financial resources and public policies. These obstacles can hinder the effective adoption of technology, which can negatively impact farmers' productivity and profitability.

Given this, the studies presented in the table emphasize the importance of investing in public policies aimed at promoting the adoption of technology in family farming. It is necessary to provide adequate financial and technical support to farmers, as well as encourage training and the formation of cooperation and collaboration networks among farmers and other stakeholders in the sector.

Ramos et al. [4] highlight the importance of infrastructure and proper technical support for the effective adoption of technology by farmers. Gallo et al. [3] conclude that the adoption of technology can improve the productivity and quality of cassava, but investment in infrastructure and the provision of adequate technical assistance to farmers are necessary. Ramos et al. [4] further emphasize that the adoption of technology can improve the productivity and income of farming families, but it is necessary to consider local specificities and provide proper support for the effective adoption of technology.

Additionally, the authors highlight the importance of considering local particularities and providing personalized support to farmers. Cunha et al. [13] emphasize the need to provide technical and financial support for the acquisition and proper use of technology by vegetable producers in MatoGrosso. Souza et al. [14] argue that access to credit and technical support needs to be ensured so that farmers can acquire and use technology appropriately in coffee production in Minas Gerais.

Another relevant study is conducted by Souza et al. [14], who investigated the adoption of technology by family farmers in the Vale do Jequitinhonha region, Minas Gerais. The authors conclude that the adoption of technology can improve the productivity and profitability of agricultural production, but it is necessary to consider local specificities and provide adequate technical support to ensure the effective adoption of technology by farmers.

Lastly, the study by Oliveira [15] analyzed the adoption of technology in fruit production on small rural properties in Rio Grande do Sul. The authors conclude that the adoption of technology can contribute to improving the quality and productivity of fruit production, but it is necessary to ensure access to information and proper technical support for farmers to effectively acquire and utilize technology.

In summary, these studies reinforce the importance of investing in public policies aimed at promoting the adoption of technology in family farming, including providing adequate financial and technical support to farmers, as well as training and fostering cooperation and collaboration networks among farmers and other stakeholders involved in the sector.

The studies indicate that farmers' intention to diversify their production is more significant than specialization. Many farmers who practice production diversification use this model as a strategy for financial security. For example, when one crop is not profitable, the other crop provides the necessary support to maintain financial balance. Additionally, these farmers are concerned about family sustenance.

The research concludes that rural properties that practice diversification develop more than those that produce only one crop. Diversification also serves as a great ally to the environment since crop rotation is frequent in this system, reducing soil degradation compared to monoculture. The properties that practice diversified production are mostly small land areas, with young farmers and limited resources. These farmers have greater concern for the future. On the other hand, older farmers with larger land areas and more resources tend to specialize and focus on the present.

Therefore, the research results effectively present the constructs of the Theory of Planned Behavior to measure and identify the behavioral intention of individuals. With this information, it is concluded that the Theory of Planned Behavior can be used to measure the behavioral intention of family farmers in the decision-making process between diversifying or specializing in agricultural production.

V. Conclusion

The adoption of technology in family farming is a topic of great importance for improving productivity and income for farmers, as well as being an essential factor for the sustainable development of the sector. The studies presented in the table reinforce the importance of infrastructure and adequate technical support for the effective adoption of technologies by farmers, as well as the need to consider local particularities and provide personalized support to farmers.

However, the authors also highlight the challenges faced by farmers in adopting technologies, such as the lack of financial resources and public policies. It is necessary to invest in public policies aimed at promoting

the adoption of technology in family farming, with the provision of adequate financial and technical support to farmers, as well as training and the formation of cooperation and collaboration networks among farmers and other stakeholders in the sector.

Therefore, it is essential that there is a joint effort from governments, companies, and research institutions to promote the adoption of technology in family farming, taking into account the needs and particularities of farmers in each region. Only in this way will it be possible to ensure the sustainable development of family farming and contribute to increasing productivity and income for farmers, as well as improving food security and the quality of life in rural communities.

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