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SCIENTIFIC PRODUCTION AND INTELLECTUAL PROPERTY OF FEDERAL INSTITUTES: A COMPARATIVE STUDY OF THE CENTRAL-WEST REGION

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ABSTRACT

This article analyzes the scientific and intellectual property production of the Federal Institute of Mato Grosso (IFMT) over the past five years, comparing it with other Federal Institutes in the Central-West Region. The study investigates the impact of scientific production in the areas of Exact Sciences, Engineering, and Agricultural Sciences, in addition to mapping the contributions of intellectual property records generated by these institutions. The methodology adopted was quantitative and based on documentary analysis, with a survey of bibliometric data in the Scopus, Web of Science, and Google Scholar databases, as well as in the intellectual property registration platforms of the National Institute of Industrial Property (INPI). The study indicates that, in addition to the growth in scientific production, the Federal Institutes have shown important advances in the generation of intellectual property, which is directly linked to technological innovation and the practical application of the research developed. However, the lack of consolidation of investments in research and connections between academia and the productive sector make it difficult for academic research to become technological assets for society.

Keywords: Bibliometric analysis. Scientific production. Intellectual property. Federal Institutes. IFMT.

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INTRODUCTION

In recent years, Federal Institutes (FIs) have established themselves as fundamental pillars for regional and national development, mainly due to their work in strategic areas such as education, science, technology, and innovation. These institutions have not only contributed to the advancement of academic knowledge but have also stood out in the generation of intellectual property, including patents and industrial designs, which are essential for the practical application and transformation of scientific innovations into products and technological solutions (Guedes et al., 2018; Silva et al., 2020).

Scientific production and the production of intellectual property (IP) are often seen as two complementary indicators of the impact of a higher education institution on the global scene. Scientific production reflects the generation of new knowledge, while IP is an indicator of how this knowledge can be applied to economic and social development. This article seeks to explore, through a comparative analysis, how the Federal Institutes of Mato Grosso (IFMT) and other IFs in the Central-West Region have contributed to both the generation of scientific knowledge and the creation of patented technologies and other forms of intellectual property.

THEORETICAL FRAMEWORK

Scientific production at Brazilian universities has expanded over the last few years, reflecting a growing investment in research and development (R&D). However, national scientific production still faces challenges, such as the need for greater internationalization, quality of publications, and the strengthening of collaboration networks with other institutions and the private sector.

According to Bastos and Pereira (2021), scientific production in Brazil has shown growth, especially in the areas of exact and biological sciences, but challenges remain, such as low visibility in high-impact journals and the lack of a robust infrastructure for technological innovation. They emphasize that the increase in publications in more prestigious journals has been accompanied by a greater number of international collaborations, which has contributed to the expansion of the country's scientific influence.

On the other hand, the study by Vieira et al. (2020) analyzed the growth rate of Brazilian scientific production, highlighting that Federal Universities and Federal Institutes have been responsible for a large part of this production. They point out that the North and Central-West regions still have significant challenges regarding scientific production

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compared to the South and Southeast of Brazil. Santos and Ribeiro (2022) argue that, despite the advances, Brazilian universities still face obstacles in transforming scientific production into innovations applicable to the market, due to a disconnect between academia and industry.

Over the years, Brazilian scientific production has been consolidated, but it has not yet reached the scale of the main international universities. According to Lopez & García (2021), universities such as Harvard, MIT (Massachusetts Institute of Technology), and Stanford have not only high volumes of scientific production, but also a large number of international collaborations, partnerships with the private sector, and high levels of investment in innovation.

A study conducted by Medeiros et al. (2020) compared Brazil's scientific production with that of the United States, highlighting that, although Brazil has significantly increased its scientific production, the country still has a qualitative difference in terms of citations and international impact. The lack of private funds for research and the concentration of resources in the most visible universities are still factors that limit the international competitiveness of Brazilian institutions, which was already demonstrated by Price (1963).

Another point that has been highlighted by several researchers is the relationship between scientific production and the generation of intellectual property in Brazil. According to Figueiredo et al. (2021), Brazil still faces challenges in translating its scientific production into innovations, a process that is essential for the country's technological and economic advancement. The lack of a culture of innovation applied in universities, consequently the low number of patents generated from academic research, and the scarce collaboration with the private sector are highlighted as the main obstacles, as stated by Shulman and Quinn (2001).

The research by Costa e Silva (2020), which analyzes Brazilian patents, shows that, although the country has increased the number of registered patents, this production is concentrated in a few sectors, especially those linked to agribusiness and renewable energy. On the other hand, Mendonça et al. (2021) show that comparing the production of patents and intellectual property in Brazil with countries such as the United States and Germany, Brazil is still far behind in the number of patents per capita and cutting-edge technological innovation.

Universities such as the State University of Campinas (UNICAMP) and the University of São Paulo (USP), for example, have stood out in the production of patents

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over the years, but most Federal Institutes still face challenges in promoting a greater conversion of scientific research into marketable intellectual property. Dantas and Costa (2022) conclude that, despite the high quality of research, interaction with industry and support for the technology transfer process needs to be strengthened internally in Federal Institutes.

Although the number of patents has increased, there is still a significant barrier between the academic and industrial environments, which hinders technology transfer, as highlighted by Borges and Nunes (2021), on the interaction between universities and industry in Brazil. The authors point out that utility models and industrial designs are often more developed in Brazilian universities since these types of registrations are more accessible and less costly compared to complex patents.

On the other hand, Prado et al. (2020) highlight that, in countries such as Germany and Japan, there is a strong culture of patent registration as part of academic production. They state that the number of patents is a crucial indicator of the impact of scientific research on innovation and economic development. According to the authors, the direct relationship between the creation of intellectual property and competitiveness in the global market is widely recognized as a fundamental strategy for the scientific and technological development of a country.

Wang et al. (2021), for example, conducted a study on the correlation between patents and economic growth in developed and emerging countries. They note that the production of patents is a reflection of a country's ability to transform knowledge into innovation, which in turn drives the national economy. According to the authors, countries such as China, South Korea, and India have invested heavily in the production of patents and utility models as a strategy to accelerate their scientific and technological development.

In this context, structural challenges, such as lack of funding and integration with the productive sector, are still the main obstacles to the development of technological production in Brazilian institutions. Although most universities and Federal Institutes are making progress, scientific production still lags behind that of the leading international universities, which have strong internationalization, greater access to private funds, and robust partnerships with industry.

Although the production of intellectual property, especially patents, is a critical point, the universities that invest most in technology parks, technology transfer, and industrial

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partnerships show that there is a possible path to integrating science and technological innovation more effectively.

At federal Institutes, there is a growing trend in the registration of patents, utility models, and industrial designs, but the need for greater investment in the training of human capital specialized in innovation management and technology transfer is evident. University-industry cooperation and internationalization are, therefore, key elements for Brazil to advance both in scientific production and in applied innovation.

In particular, the combination of scientific production and technological innovation in IFs reflects the capacity to solve practical problems and contribute to the economic and social development of the regions in which these institutions are located. The research by Silva et al. (2020) reveals that Federal Institutes have contributed to the increase in the number of patents and intellectual property registrations, especially in the areas of Engineering and Agricultural Sciences, as a way of applying the knowledge generated in the institutions to concrete solutions for society.

THE SCENARIO IN THE CENTRAL-WEST REGION

Analyzing the Central-West Region of Brazil, the scenario is growing about scientific production and the generation of intellectual property. Traditionally, the region is recognized for its agricultural production, but in recent decades, science, technology, and innovation have gained relevance, with emphasis on areas such as agribusiness, biotechnology, engineering, and health.

The advancement of scientific production in the Central-West Region has been driven by universities and research centers, such as the Federal University of Goiás (UFG), the Federal University of Mato Grosso (UFMT) and the State University of Mato Grosso do Sul (UEMS). According to Siqueira (2022), universities in the region have established themselves as important research centers, not only in the field of agribusiness but also in the areas of biotechnology, health, and engineering. The research carried out in these centers contributes to the development of technologies that better manage sustainability and productivity, especially in the agricultural sector, which is one of the most competitive in the world.

Scientific production also benefits from the growing partnership between educational institutions and companies. As Campos (2023) points out, the interaction between universities and companies has been an important strategy for transforming academic

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knowledge into practical solutions for the market, especially innovations in the agricultural sector.

The field of intellectual property in the region has evolved as the production of patents and technological innovations grows, especially in the areas of biotechnology and genetics. Research in areas such as genetically modified seeds, biopesticides, and precision technologies in the field has generated patents that strengthen Brazil's position in the international innovation market. In this sense, Souza (2021) highlights that the protection of intellectual property is essential to ensure that technological innovations generated in universities and research centers in the region have a significant economic impact and can be transferred to the productive sector.

The promotion of the creation of technologies aimed at increasing agricultural productivity and environmental sustainability has also been a focus in this region, with the state of Goiás being a pioneer, where the state government has been seeking partnerships with educational institutions to structure biotechnology innovation hubs, which has generated an increase in the number of new patents, which are “fundamental for sustainable development and for ensuring the competitiveness of local companies in the global market” (Almeida, 2024). In this sense, the Central-West Region plays a vital role in the country, especially in strengthening agribusiness and technological innovation. The region's agricultural production, which is one of the largest and most modern in the world, depends heavily on the constant evolution of technologies to maintain global competitiveness. Thus, the innovations produced in this region are fundamental to ensuring the country's food security and its leadership in agricultural exports, in addition to the fact that “technological innovation, combined with sustainability, is one of the pillars that will guarantee the future of Brazilian agribusiness” (Rodrigues, 2020). Although still incipient when compared to the South and Southeast regions, the impact of technology production in the Central-West region is significant, both economically and socially. Innovation in the agricultural sector has generated new job opportunities, in addition to optimizing production processes, reducing costs, and improving efficiency. Technology production has also contributed to strengthening the region's scientific and technological base. As Gadelha (2022) notes, the transformation of scientific knowledge into new products and processes has become essential for Brazil's competitive insertion in the international scenario.

In short, the Central-West region has consolidated itself as a center of innovation and research that directly contributes to the country's technological advancement and

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competitiveness. The scientific production and intellectual property generated in this region are fundamental to Brazil's sustainable growth and to strengthen its position in the global market.

METHODOLOGY USED

The methodology adopted in this study is quantitative, with a bibliometric approach and analysis of the intellectual property of the institutions surveyed. The following databases were used to collect data on scientific production: Scopus, Web of Science, and Google Scholar. The search was conducted using the following terms: “Instituto Federal de Mato Grosso”, “IFMT”, “IFGoiano”, “IFG”, “IFB” and “IFMS”, with a limit of articles published between 2018 and 2023.

In addition, to collect data on intellectual property, patents, utility models, and industrial design records were consulted at the National Institute of Industrial Property (INPI) and on the technological innovation platforms of the Federal Institutes themselves, filed and granted by the institutions in the last five years.

SCIENTIFIC AND INTELLECTUAL PROPERTY PRODUCTION AT THE IFS

The scientific production of the Federal Institutes of the Central-West Region was analyzed based on articles published in the main scientific databases, considering the last 5 years. As shown in Graph 1, the number of publications has been increasing in all Federal Institutes in the region, with emphasis on the scientific production of IFMT, IFGoiano, and IFG. It was also observed that this scientific production is linked to partnerships with other institutions, whether through postgraduate programs or collaborative research.

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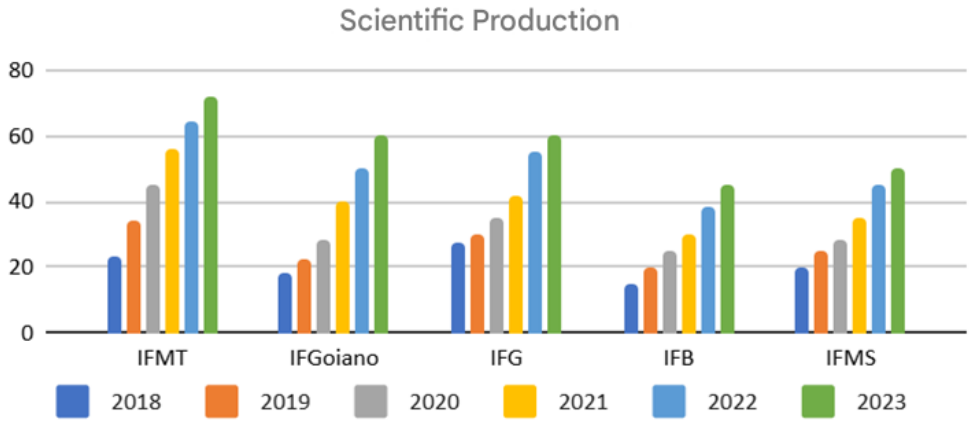
Chart 1 - Scientific Production of Federal Institutes in the Central-West Region.



Source: Prepared by the authors (2024).

The areas of greatest productivity in scientific articles of each Federal Institute are linked to the economic and productive vocations of the regions where they are located, but the number of publications in the areas of humanities and languages is significant. This increase is also the result of the consolidation of the Federal Institutes, resulting from the increase in the qualifications of researchers and the postgraduate courses offered by these institutions, as stated by Oliveira, Santos, and Lima (2020).

In addition to scientific production, the institutions have also registered patents, utility models, and industrial designs in their technological and intellectual property production. Graph 2 shows the total number of deposits and grants of industrial property for these institutions in the last five years, carried out with the INPI.

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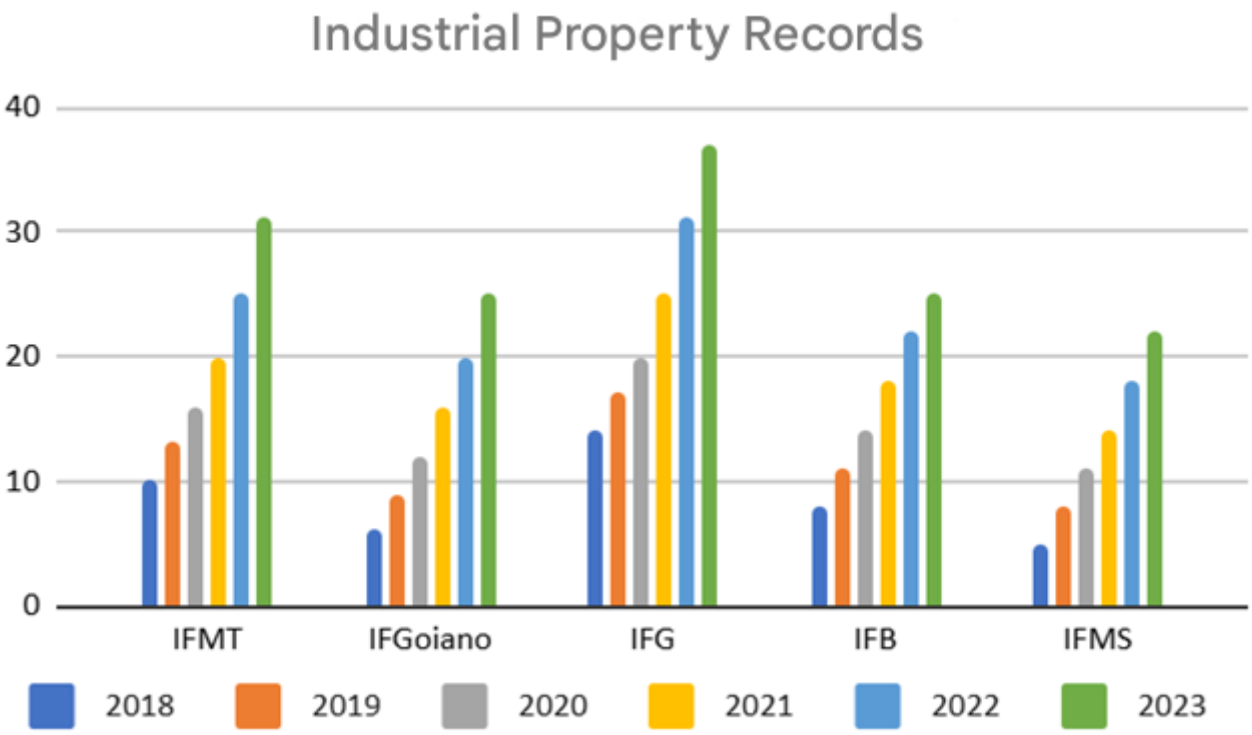
Graph 2 - Industrial Property Records of Federal Institutes in the Central-West Region.



Source: Prepared by the authors (2024).

The analysis of the production of patents, utility models, and industrial designs shows that the IFMT has been standing out, especially in terms of patents filed, with continuous growth over the last 5 years. This growth can be attributed to the fact that investments in research have been more robust in the areas of engineering and agronomy, areas where technological innovations have a strong impact on the productive sector and meet the economic vocations of the region. This information is consolidated when looking at the number of scientific publications, which are largely also related to these areas of knowledge.

Another Federal Institute in the region, the IFG, stood out during the period for the number of industrial design registrations, a fact generated by a very particular characteristic of this institution, the formation of partnerships for technological research and innovation. This led us to observe that in addition to functional innovations, the institution is also investing in aesthetic improvements and product design, which is an important component for the market and a strategic action for institutions such as the Federal Institutes.

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IFGoiano and IFB have also demonstrated significant patent production, with a growing number of innovations over the years. IFMS, although with more modest numbers, has shown a gradual increase in registered patents, reflecting a continuous investment in innovation.

Based on the surveys carried out, it was observed that IFMT has demonstrated significant performance in the Central-West Region in the generation of patents, utility models, and industrial designs, consolidating itself as one of the main centers of technology production among the institutions in the region. However, institutions such as IFG stand out for their pioneering role in formalizing public-private partnerships, agreements, and the provision of technological services, which has resulted in significant numbers of intellectual property registrations, such as utility models and industrial designs, which reflects the diversification of innovations produced and the capacity to generate solutions applicable in different productive sectors. Despite the optimism shown by the number of publications and intellectual property registrations, there is a lack of partnerships between these institutions and the productive sector, which promotes a disconnect between the demands of industry and the production of solutions from academia. Another important point to be highlighted is the low number of partnerships between the institutes for the development of research and innovation projects, which means that, even in a region with great similarity, there is little collaboration and sharing of knowledge and structures.

Another point observed in the Federal Institutes of the region is that the number of intellectual property registrations carried out in conjunction with companies and other research institutions is incipient, which demonstrates a real disconnect between research activities and local productive sectors.

FINAL CONSIDERATIONS

The analysis of scientific production and the generation of intellectual property in Federal Institutes, such as IFMT, reveals a dynamic and growing panorama in the Central-West Region, but also exposes a series of challenges to be overcome for Brazil to stand out in the global context of research and innovation. Despite efforts to strengthen the relationship between knowledge generated in academia and market needs, there are considerable gaps when compared to developed countries, especially when observing the

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production of patents and technology transfer, which are crucial indicators of the impact of scientific research on the economy and technological development.

IFMT, like other institutions in the Federal Education System, has been demonstrating a constant increase in scientific production, especially in the areas of engineering and agronomy, but its contribution to technological innovation, through intellectual property registrations, is still incipient when compared to large universities in Brazil and countries such as the United States, Germany, and Japan, which are global leaders in both research and the generation of applicable innovations. Although the growth of scientific production in Brazil is notable, the ability to convert this production into commercial innovations that generate economic and technological value remains a major challenge, evidenced by the discrepancy between the number of scientific articles published and the number of patents generated from this research.

Furthermore, a comparison between Brazilian and international universities reveals that Brazil still needs to improve the internationalization of its academic production and cooperation with industry. The interaction between universities and the private sector, which is essential for transforming scientific research into products and technologies, is an essential aspect that should be strongly encouraged. Brazilian universities need to create an environment of entities that are more collaborative with companies, in addition to facilitating the technology transfer process, to ensure that research results are not restricted to the academic environment, but have practical application in the market.

The growing production of intellectual property in Brazil, especially in Federal Institutes, is a sign that, despite the challenges, there is a movement to encourage the promotion of innovation in the country. However, Brazil needs to improve innovation management, create a culture of applied innovation, and encourage more partnerships between universities and industry, especially in emerging areas such as clean technologies, artificial intelligence, biotechnology, and materials engineering.

Finally, scientific production and intellectual property at IFMT represent not only a significant contribution to the advancement of science and technology in the Central-West Region but also a strategic potential for the country's economic and social development. For this potential to be fully exploited, it is essential to invest in the training of human resources specialized in innovation management, encourage technology transfer, and expand international cooperation, ensuring that Brazilian science becomes increasingly competitive and relevant on the global stage. The key to success will therefore be to

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strengthen the links between academia, industry, and the government sector, creating an environment more conducive to innovation and sustainable development.

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