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Mapping and Advances of Agtechs in Brazil

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Abstract: This research aimed to map Agtechs in Brazil and describe their areas of operation. It analyzed data from the Agtech Startups Brazil Censuses of 2016 and 2018, employing an explanatory bibliographic research methodology. It was noted that Agtechs, despite representing only 4% of the market, are strongly linked to the agribusiness sector, which accounts for about 25.5% of Brazil's GDP. The largest concentration of startups is found in São Paulo, followed by Minas Gerais and Paraná, and the areas of operation that experienced the most growth were those involving information and communication technologies. It was concluded that Agtechs have the potential to transform the agricultural sector, contributing to improvements in productivity and a reduction in environmental and social costs associated with the production process. These results can guide future research and public policies aimed at the agricultural sector and technological innovation.

Key words: agriculture 4.0, agribusiness, Brazilian landscape, information technologies
JEL codes: M210, O32, O33

1. Introduction

According to Rodrigues (2006), the country holds 22% of the world's arable land and applies high technology in the field, facts that make Brazilian agribusiness a modern and efficient sector, placing Brazil in a status of "world's breadbasket".

Innovation in this field spans the entire food chain, from retail applications to plant genetics. Businesses can modify and/or utilize genes to boost productivity, enhance soil quality, shield crops from pests and drought stress, and more. In order to develop biobased inputs or enhance grafts, they also employ biotechnology. Robots are created "to serve as the hands and eyes of a producer". Additionally, they keep track of and gather pertinent data from the outcomes attained during the procedure (Waltz, 2017).

Through these tools, the context of agriculture 4.0 is created, which uses methods also employed in industry 4.0, integrating and automating precision agriculture and livestock, agricultural robotics, and big data and AI models. Such technologies contribute to increased productivity, efficiency in the use of inputs, reduction of labor costs, improvement of quality and work safety, and reduction of environmental impacts (Massruhá & Leite, 2017).

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There are various definitions of the concept of Startup, however, the expression is usually used to describe early-stage businesses that use innovation as a stimulant to grow and solve market pains. It consists of a repeatable business model (capable of delivering the same product in a potentially unlimited way) and scalable (constant growth without compromising its business model) in a scenario free of guarantees and stabilities (Gitahy, 2010).

Agtechs, although they represent only 4% of the market, are associated with the agribusiness sector, responsible for about 25.5% of the Brazilian GDP (CIEB, 2022).

Innovation in this sector encompasses all the processes of the food chain, from plant genetics to retail applications. Companies have the ability to alter and/or use genes to increase yield, improve soil quality, protect crops from pests and water stress, among others. They also use biotechnology to improve grafts or create biobased inputs. They develop robots "to serve as the eyes and hands of a producer". And, throughout the process, they store and collect relevant information from the results achieved (Waltz, 2017).

According to Dutia (2014), the importance of Agtechs is related to the potential to transform the agricultural sector through improvements in productivity along with a reduction in environmental and social costs associated with the production process.

Thus, this research aims to map Agtechs in the Brazilian scenario and describe the areas of operation.

2. Methodology

The project will be conducted through the use of data obtained from bibliographic reviews, which encompass academic papers, websites of public and private institutions, journals, among other productions found in the literature on entrepreneurship and innovation.

Particularly, data and analyses of information from the Agtech Startups Brazil Censuses, found on specific websites of the Agtech segment, such as: https://www.startagro.agr.br/1o-censo-agtech-startups-brasil-confira-resultados-e-analises/ and https://www.agtechgarage.com/censo/, will be addressed.

This research will be conducted through the use of data obtained from bibliographic reviews, which encompass academic papers, websites of public and private institutions, journals, among other productions existing in the literature on entrepreneurship and innovation. The analysis will be carried out in an explanatory manner (Gil, 2008).

Explanatory study, according to Gil (2008), seeks to pinpoint the elements that influence or determine the occurrence of events. Stated differently, it enhances comprehension of the reality under examination with the intention of illuminating the rationale, the why behind things.

The literature analysis will be carried out in an explanatory manner, which, according to Gil (2008), explanatory research aims to identify the factors that determine or contribute to the occurrence of phenomena. In other words, it deepens the understanding of the reality to be analyzed with the goal of bringing to light the reason, the why of things.

It is important to emphasize that the choice of bibliographic research is directly linked to its objective, since, according to Manzo (1971), the bibliographic review explores new fields of science beyond the already known, with the goal of achieving new knowledge and areas of research not fully sedimented.

Thus, through these data, analysis will be carried out both quantitatively and qualitatively. Qualitative is understood as the quality of an entity, that is, it is expressed in words to describe its value to an object, individual, and state. Quantitative, on the other hand, is understood as data analyses based on numbers, that is, estimated in quantity. Furthermore, after reading the research related to the theme of Agtechs, they were used as the basis for the production of results and discussion, contemplating the objective of this research.

3. Theoretical Framework

According to a recent article, startups are defined as business models that are repeatable and scalable, meaning they are capable of delivering the same product in potentially unlimited quantities, with constant growth, without changing their business model, and under conditions of extreme uncertainty due to a lack of guarantees of approval or market stability (Gitahy, 2010).

In their study, Arruda (2014) identified that Brazilian startups with less than one year of existence have a 25% mortality rate. This aligns with Jones (2012), who argues that case studies are useful when the conditions of the research involve exploring new or emerging phenomena within a real-life context.

Maletta (2013) argues that the Brazilian internet-era entrepreneur fundamentally differs from traditional entrepreneurs. On average, they are men (75%) around 30 years old, residing in the Southeast-South axis, with a high level of education (66% with a complete higher education or higher education in progress), belonging to social classes A and B.

In the realm of Agtechs, Bambini (2019) demonstrates the activity of this segment across all Brazilian regions. Despite regional differences, there are resources, knowledge, and technology with agricultural applications throughout the country.

There are approximately 1,600 startups focused on agribusiness, at various stages of maturity and with different development needs, according to Radar Agtech (2022).

According to the second census by Agtech Garage (2019), the development of Agtechs is concentrated in specific areas in Brazil: 46% are in São Paulo, 16% in the State of Minas Gerais, 12% in Paraná, 8% in Rio Grande do Sul, and 6% in Santa Catarina. Other states, crucial to agribusiness, have little representation in the creation and operation of startups.

Moreover, Radar Agtech (2022) points out that the main areas of operation of these startups are, respectively, “Innovative foods and food trends”, “Rural Management System”, “Integrated system platform”, and “Marketplaces and platforms for product negotiation”. These segments will be discussed and analyzed throughout the research, along with others of lesser representation but equally important.

Silveira, Farina & Santos (2023) explored the high-tech startup ecosystem in the agribusiness sector, emphasizing the importance of connections, innovative products, and services. Using an exploratory qualitative methodology and bibliographic design, the authors compiled data from various sources, including the Brazilian Startup Association and reports from the Global Entrepreneurship Monitor. According to the findings, São Paulo, which is home to 26% of Brazil’s AgTechs, is a key component of the nation’s entrepreneurial and inventive ecosystem. High-tech goods and services were produced by agribusiness startups, fostering beneficial relationships between many ecosystem participants, including businesses, governmental agencies, and academic institutions. The conclusion highlighted the relevance of AgTechs in transforming the agricultural sector through technological innovation and the creation of collaboration networks.

Romani et al. (2020) addressed the modernization of Brazilian agribusiness through the adoption of digital technologies, highlighting the role of research and development institutions and AgTechs in this process. The methodology consisted of presenting and analyzing the TechStart Agro Digital Acceleration Program, a joint initiative of Embrapa Informática Agropecuária and the Venture Hub accelerator. The collected data revealed that the 11 startups graduated from the program demonstrated significant improvement and growth, effectively contributing to solving real problems in Brazilian agriculture. The main results indicated that technological acceleration and continuous post-program support were fundamental to the success of these startups, adding value to the country's agricultural sector. The conclusions reinforced the importance of collaboration among research institutions, technology companies, and the agricultural sector for the digital transformation of agriculture in Brazil, highlighting the potential of AgTechs to promote significant innovations in the field.

In the study conducted by Almeida (2022), the impact of the AgTech Valley Innovation Ecosystem on the development of Agtech startups was investigated, with a particular focus on the Piracicaba-SP region. The methodological approach adopted was quantitative, through the application of an online structured questionnaire, aimed at collecting responses from individuals actively engaged in the AgTech Valley ecosystem. The analysis of the collected data was performed using descriptive statistics techniques, with the aid of the SPSS software. The results obtained point to the relevance of the various components of the ecosystem, including public policies, funding, entrepreneurial culture, support systems, and human capital, which are fundamental for the development of agtechs in the ideation, operation, traction, and scaling phases. The study concludes by emphasizing the importance of a robust and well-structured innovation ecosystem for the success of startups in the agricultural technology segment.

4. Results and Discussion

Data from the first and second Agtech companies Brazil Censuses (Agtech Garage, 2016, 2018) were used to map the locations of agribusiness companies. 75 agro startups took part in the first census, while 184 were examined in the second.

Of these, 50% were located in the state of São Paulo, but when compared with the second census, São Paulo accounted for 46%, still being considered the region with the most Agtech startups. Notably, the State of São Paulo hosts a network of internationally renowned academic and research institutions and an informational park formed by intensive industrial and service sectors. As a result of systematic state and federal investments over decades, this system demonstrates its excellence by being responsible for a large part of Brazilian scientific production (Quadros et al., 2000).

Thus, observing Table 1, the second state that shows the development of Agtechs is Minas Gerais, representing 18% in the 2016 census and 16% in the 2018 census. It can also be noted that the state of Paraná experienced an increase from 2016 to 2018, moving from 9% to 12%.

Moreover, the 2018 census not only presented the regions where they are distributed but also identified their locations, with 35% of agribusiness startups having their own headquarters, while 21% are in incubators, 15% in coworking spaces, 13% do not have a headquarters, 9% in technology parks, and 7% in company-sponsored hubs. This indicates that just over a quarter of the startups opt for their own headquarters, which may be related to their market representation. However, for those without their own location, the most advantageous options are incubators or hubs, which play a role in fostering innovative businesses and aiding in their development. This

option may be limited due to the region where the Agtech is located, as some states lack technological poles that stimulate innovation. This is why the state of São Paulo has the most Agtechs due to its opportunities. The higher concentration in these regions is explained by the presence of technology parks and innovation hubs, as well as the number of universities and research institutes, leading to more innovations and better ways to disseminate technology and deliver it to the place of use (Firetti, Oliveira, Bonacelli, 2016).

Table 1 Distribution of Agtechs by State

STATES	1ST AGTECH CENSUS 2016 (%)	2ND AGTECH CENSUS 2018 (%)	AGTECH RADAR 2019 (%)	AGTECH RADAR 2020/21 (%)	AGTECH RADAR 2022 (%)	AGTECH RADAR 2023 (%)
São Paulo	50.0	46.0	52.5	48.1	43.2	47.0
Minas Gerais	18.0	16.0	8.8	9.1	8.6	9.0
Paraná	9.0	12.0	9.1	9.6	9.3	10.3
Rio Grande do Sul	7.0	8.0	7.9	7.9	9.9	7.8
Santa Catarina	8.0	6.0	6.2	7.7	6.8	7.5
Goiás	-	4.0	1.9	1.9	1.8	1.9
Mato Grosso	-	2.0	1.6	1.9	2.0	2.1
Piauí	-	1.0	0.2	0.3	0.2	0.3
Rio de Janeiro	-	-	3.6	4.0	3.6	4.1
Mato Grosso do Sul	-	-	1.5	1.1	1.1	0.9
Distrito Federal	-	-	1.2	1.1	1.0	1.2
Bahia	-	-	-	-	1.1	1.6
Espírito Santo	-	-	0.8	1.3	1.4	1.3
Pernambuco	-	-	0.7	0.7	1.0	1.0
Ceará	-	-	0.6	0.8	1.0	1.0
Rio Grande do Norte	-	-	0.3	0.6	0.3	0.4
Tocantins	-	-	0.4	0.5	1.0	0.5
Paraíba	-	-	0.4	0.4	0.3	0.4
Amazonas	-	-	0.4	0.3	1.2	0.2
Others	8.0	6.0	0.6	0.6	-	-

Source: Author based on Agtech Garage (2016, 2018)

Furthermore, in addition to data from the Agtech Garage censuses, information provided by the Radar Agtech, which aims to map startups in the Brazilian agricultural sector for the years 2019, 2020, 2021, 2022, and 2023, was also analyzed. This identified the existence of 1953 Agtechs in 2023, distributed throughout the national territory as evidenced in Table 1. As with the Agtech Garage censuses, the Radar Agtech analysis reveals that the state of São Paulo maintains its position as the one housing the largest number of startups in the agricultural sector.

However, comparing the data from the censuses and the radar, it is possible to observe a variation in the percentage of the state of Minas Gerais, showing that in the years 2019 and 2020/21, 2022, and 2023, the state experienced a decline in the growth of Agtechs. In 2018, it accounted for 18% and in the following year, it decreased to 8.8%, then in 2020/1, it increased by 0.3%, in 2022 it experienced another drop, and a slight increase in 2023, which is not significant when compared with previous years.

Thus, the information presented by the Agtech Garage censuses and the Radar Agtech highlights that the Southeast region has the most participation and growth of Agtechs in Brazil, contributing to more than half of the agro startups distributed throughout the country. The fact that Agtechs predominate in the Southeast region stands out for its developed infrastructure, providing consolidated urban centers, wide access to financial resources, and academic and geographical resources. Additionally, the consolidated entrepreneurial ecosystem in the region, with the presence of incubators, accelerators, and investors, plays a crucial role in the maturation of Agtechs. Furthermore, governmental policies and innovation incentive programs act as catalysts, attracting companies and entrepreneurs to the Southeast region.

In addition to providing information on their areas of operation, the censuses also highlight the main markets impacted in the years 2016 and 2018. When considering startups within the agribusiness sector, it is natural to focus on the crops that play a crucial role in the country's economy, as illustrated by Table 2. Brazil stands out for having a vast stock of agricultural knowledge and technologies capable of transforming resources into valuable products. Thus, the significant increase in innovative startups in the agribusiness sector can be attributed to the complexity of the challenges faced by the sector, such as the increasing demand for food, climate change, and sustainability.

Accordingly, it is observed that soybean cultivation represents the most significant markets impacted. In the period of 2016, it held a share of 49%, however, by 2018, it recorded a decrease to 46%. This trend of reduction is also observed in the markets for corn, sugarcane, and coffee, indicating a possible strategic redistribution of efforts or a search for diversification in other areas between the first and second census.

Table 2 Main Markets Reached

Markets	1st Agtech census 2016 (%)	2nd Actech census 2018 (%)
Soybean	49.00	46.00
Corn	46.00	41.00
Sugarcane	41.00	35.00
Coffee	32.00	25.00
Beef Cattle	28.00	30.00
Dairy Cattle	17.3	20.00
Citriculture	14.7	18.00
Others	33.3	19.00

Source: Author based on Agtech Garage (2016, 2018)

5. Conclusions

Throughout this research, the mapping of Agtechs in the Brazilian scenario was outlined, and their areas of operation were described. This study revealed that, although these companies represent only 4% of the market, they are strongly associated with the agribusiness sector, which accounts for about 25.5% of Brazil's GDP. This significant contribution reflects the high technology employed in the field, making Brazilian agribusiness a modern and efficient sector, elevating Brazil to the status of the “world’s breadbasket”.

Innovation in agribusiness extends through all processes of the food chain, from plant genetics to retail applications. It can be concluded that Agtechs have the potential to transform the agricultural sector, enabling improvements in productivity and a reduction in the environmental and social costs associated with the production

process.

Agriculture 4.0, which employs methods used in industry 4.0, integrates and automates precision agriculture and livestock, agricultural robotics, and big data and AI models, contributing to increased productivity, efficiency in the use of inputs, reduction of labor costs, improvement of work quality and safety, and reduction of environmental impacts.

Therefore, this research contributed to the understanding of the geographical distribution of Agtechs in Brazil and the areas of operation of these companies, providing valuable insights into the agribusiness sector and its relationship with technology. It is hoped that these results can guide future research and public policies aimed at the agricultural sector and technological innovation, in addition to encouraging the creation of new Agtechs in regions not yet explored.

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