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Trend of Technologies 4.0 in Brazil - what does the demand about the Public Selection MCTI/FINEP/FNDCT Grant to Innovation 04/2020 tell us?

Tendência das tecnologias 4.0 no Brasil - o que nos diz a demanda sobre a Seleção Pública MCTI/FINEP/FNDCT Subvenção Econômica à Inovação 04/2020?

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ABSTRACT - Industry 4.0 is characterized by the use of big data & analytics, autonomous robots, simulation tools, horizontal and vertical systems integration, IoT, cloud computing, additive manufacturing, augmented reality and cyber security, what was transposed to agribusiness as Agriculture 4.0 or Agro 4.0. The Brazilian government has been implementing initiatives to promote this segment, the most recent being the Public Selection Technologies 4.0, to support the themes Agro 4.0, Smart Cities, Industry 4.0 and Health 4.0. The objective of this study is to characterize and evaluate the demand for supporting innovation in Brazilian companies through this notice, with emphasis on Agro 4.0. The demand was analyzed addressing the number of projects and values in relation to the size of the companies, the occurrence of key/enabling technologies, distribution by State and Region, technological partnerships with STIs and the narrowing of the selection process. The terms highlighted in the tag cloud were qualitatively analyzed and categorized. The results indicate that the country is on the threshold of a new technological revolution in the field, with strong indications towards the wide adoption of technologies that characterize Industry 4.0 and Agro 4.0. The existence of a large contingent of well-evaluated projects in all thematic lines that will not be able to receive a grant points to the need to continue fostering innovation in segment 4.0.

Key words: Industry 4.0. Agriculture 4.0. Digital Agriculture. Technologies 4.0. Innovation.

RESUMO - Indústria 4.0 caracteriza-se pela utilização de *big data & analytics*, robôs autônomos, ferramentas de simulação, integração horizontal e vertical de sistemas, IoT, computação em nuvem, manufatura aditiva, realidade aumentada e *cyber security*, o que foi transposto para o agronegócio como Agricultura 4.0 ou Agro 4.0. O governo brasileiro vem implementando iniciativas de fomento a esse segmento, sendo a mais recente a Seleção Pública Tecnologias 4.0, para apoio aos temas Agro 4.0, Cidades Inteligentes, Indústria 4.0 e Saúde 4.0. O objetivo deste estudo é caracterizar e avaliar a demanda para o apoio à inovação nas empresas brasileiras através desse edital, com ênfase no Agro 4.0. As informações utilizadas se originam de sistemas e documentos Finep e pesquisa bibliográfica. Foi aplicada a técnica de nuvem de palavras sobre conteúdo de campo não confidencial de cada proposta do tema Agro 4.0. A demanda foi analisada abordando número de projetos e valores frente a porte das empresas, ocorrência de tecnologias habilitadoras, distribuição por Estado e Região, parcerias tecnológicas com ICTs e afunilamento do processo seletivo. Foram analisados qualitativamente e categorizados os termos em destaque na nuvem de palavras. Os resultados apontam que o País está no limiar de nova revolução tecnológica no campo, havendo fortes indícios no sentido da adoção ampla das tecnologias caracterizadoras da Indústria 4.0 e do Agro 4.0. A existência do grande contingente de projetos bem avaliados em todas as linhas temáticas que não poderão receber subvenção aponta a necessidade de continuidade do fomento à inovação no segmento 4.0.

Palavras-chave: Indústria 4.0. Agricultura 4.0. Agricultura digital. Tecnologias 4.0. Inovação.

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INTRODUCTION

The Fourth Industrial Revolution is seen by Schwab (2017) as a global phenomenon with a wide scope, beginning at the turn of the 20th century to the 21st with the expansion of the use of digital technologies, especially the internet and mobile devices connected to it, more powerful and less expensive sensors, artificial intelligence and machine learning, carrying Industry 4.0 at its core and dynamically interacting with the frontier areas of biotechnology, nanotechnology, renewable energy and materials and quantum computing. In turn, the concept of Industry 4.0 developed in 2011. Originally it was the title of a German government project focusing on the application of digital technology to the manufacturing industry and based on six principles: interoperability, virtualization, decentralization, real-time capabilities, a service-oriented approach and modularity. This project was introduced to the public at the Hanover Fair in 2011, with its final report presented publicly in the 2013 edition of the same event, and unfolded in a research agenda still ongoing (BMBF, 2020). Over the following years some technological concepts were established as necessary to characterize Industry 4.0 highlighting big data & analytics, autonomous robots, simulation tools, horizontal and vertical integration of systems, internet of things, cloud computing, additive manufacturing, augmented reality and cyber security (ERBOZ, 2017).

The technological concepts of the Fourth Industrial Revolution and Industry 4.0 are gradually being transposed to agricultural activities and Brazil stands out worldwide in this transition. Massruhá and Leite (2017) work on the concept of Agriculture 4.0 or digital agriculture, already introducing the term Agro 4.0 that has recently become popular and characterized by the use of high performance computational methods, sensor network, machine-to-machine (M2M) communication, connectivity among mobile devices, cloud computing and analytical methods and solutions to process large volumes of data and build systems to support decision making. They also highlight the potential of Agro 4.0 to increase productivity and efficiency rates in the use of inputs, reduce labor costs, improve the quality of work and the safety of rural workers and reduce environmental impacts. And they define the scope of Agro 4.0 as covering precision agriculture and livestock, automation and agricultural robotics, with an emphasis on the use of big data and the Internet of Things.

In the context of these new megatrends, the Brazilian federal government has implemented policies and initiatives to encourage Research, Development and Innovation (RD&I), especially from 2016, with the publication by the then Ministry of Science, Technology, Innovations and Communications (MCTIC) of the National Strategy for Science, Technology and Innovation (ENCTI) 2016-2022, which recognized as global technological priorities the new production processes (in the typical context of Industry 4.0), the digital society and economy, technological convergence and a set of key enabling technologies that included industrial biotechnology, advanced materials, photonics, micro and nanoelectronics, nanotechnology and advanced manufacturing technologies (MCTIC, 2016).

The National Internet of Things Plan, instituted by Ruling No. 9,854/2019, presented an interministerial approach to the technological topics of IoT and M2M (BRASIL, 2019) - unfolding on four fronts: Cities, Health, Agriculture (Rural Areas) and Industries. One of its best known discussion forums is the Agro 4.0 Chamber, created in August 2019 by means of a technical cooperation agreement between the then MCTIC and the Ministry of Agriculture, Livestock and Supply (MAPA); this Chamber continues to function, bringing together several government agencies and social organizations, having influenced the design of programs and actions to foster innovation in its technological topics (EMBRAPA, 2019; MCTI, 2020).

The development agencies foreseen in the ENCTI have managed to develop promising initiatives in topics of Industry and Agro 4.0 with emphasis on: BNDES (Brazilian National Bank for Economic and Social Development), with the Machines 4.0 Finame financing line (BNDES, 2020a) and IoT Pilots BNDES selection (BNDES, 2020b); CNPq (Brazilian National Counsel of Technological and Scientific Development), with the Mercosul Science and Technology Award editions 2018, topic Industry 4.0 (EBC, 2019) and 2020, topic Artificial Intelligence (CNPQ, 2020) and Finep (Brazilian government Financial Supporter of Studies and Projects) with the programs Finep IoT (FINEP, 2020a), FINEP Inovacred 4.0 (FINEP, 2020b) and Public Selection MCTI/FINEP/FNDCT - Economic Subsidy to Innovation - 04/2020 - Technologies 4.0 (FINEP, 2020c), hereinafter referred to as Public Selection Technologies 4.0, on which the present work is focused.

The Public Selection Technologies 4.0 was jointly conceived by MCTI and Finep to support, by means of the Economic Subsidy instrument, the development of innovative products, processes and/or services in four thematic lines that correspond to the four fronts of the National Internet of Things Plan, called Agro 4.0, Smart Cities, Industry 4.0 and Health 4.0, permeated by enabling technologies that are typical of the context of the Fourth Industrial Revolution. With regard to Agriculture 4.0 (Agro 4.0), this official notice proposed the development of new or significantly improved products, including its prototyping and demonstration in an operational environment, for

the transition from agricultural/agriculture and livestock production to a fourth generation model and the concept of Agro 4.0 was developed as a production model in which enabling technologies, integrated and connected by means of software, systems and equipment, increase agricultural productivity in relation to the third generation model – this one characterized by agricultural mechanization and partial automation of its production processes. This Public Selection was launched in June 2020, having already defined, at the time of writing this article, the preliminary results of the project's merit assessment stage.

The objective of this study is to characterize and evaluate the demand for supporting innovation in Brazilian companies by means of Public Selection Technologies 4.0 with an emphasis on the Agro 4.0 topic, thus seeking to highlight, within this topic, technological trends and needs of the national agribusiness.

MATERIALS AND METHODS

The execution of Public Selection Technologies 4.0 took place exclusively in electronic media, without the receipt of documents in physical media, due to the effects of the SARS-CoV-2 (COVID-19) Coronavirus pandemic on face-to-face work throughout 2020, both at Finep, MCTI and the companies participating in the event. This Selection official notice provided for the evaluation of proposals in two stages: qualification and merit. The information used for presentation of this work results comes primarily from the records of the proposal submission systems and the qualification and merit assessment process, the results of which were publicly available in their nonconfidential content until the preliminary result of the merit assessment stage, before the respective appeals (limit of the scope of this article), by means of the Finep website (FINEP, 2020c). And they are also based on internal documents, of restricted access, on their fraction of publishable content (FINEP, 2020d).

The coordination of the Public Selection Technologies 4.0 prepared the information mentioned in order to obtain different views on the Brazilian companies' demand for the economic subsidy instrument for the topics and enabling technologies supportable in the event, which are presented in the Results and Discussion section of this paper, complying with the confidentiality inherent to each proposal and participating company. Given this article objective, starting from the Public Selection general results, we try to focus on the results of the Agro 4.0 topic.

On the demand of the Public Selection Technologies 4.0, exclusively on the Agro 4.0 topic, consisting of 279 proposals received on this topic, the tag cloud technique (LAMANTIA, 2006) was also applied on the content of the only nonconfidential field of each proposal, called "Publishable Summary". The content of the publishable abstracts contained in the 279 proposals was aggregated into a file (rporiginal.txt) and the exclusion of 501 words without semantic relevance or for characterizing the demand (e.g., prepositions, conjunctions, articles, pronouns, connectors, company and product names) was determined, which were registered in their own file (rpex.txt). In order to improve the informational quality of the tag cloud, a set of specific compound expressions was considered as a single entry in the file rporiginal.txt – e.g. artificial intelligence was recorded as artificial_ intelligence (a single entry). For some words, the plural and singular records were considered as a single plural entry (e.g., system/systems). With these files determined, a Python language program was written (ROSSUM, 2014) to perform the word exclusion and join operations automatically from the original base file (which has about 39 thousand words and manual extraction is not possible). A processed text file (rpfinal.txt) was generated and, from it, the free online service WordClouds was used (https:// www.wordclouds.com/) to generate the tag cloud image used in this work.

RESULTS AND DISCUSSION

At the end of its proposal submission period, on August 6, 2020, the Public Selection Technologies 4.0 captured 1190 proposals, which represented a request to the National Fund for Scientific and Technological Development (FNDCT) of about BRL 1.72 billion, with a total financial contribution equivalent to BRL 674 million being offered by the participating companies. This demand was equivalent to about 34 times the resources available for the event, which were distributed by topic as described in Table 1.

Opening the demand for a thematic line, as can be verified in Table 2, Industry 4.0 prevailed both in the number of proposals submitted and in the amounts demanded from the FNDCT, followed by Agro 4.0. In Agro 4.0 it is observed that the demand for resources was about 29 times higher than the amount available for this topic, of BRL 15 million. And the potential leverage of private resources for RD&I, represented by the counterpart offered, reached BRL 168 million, approximately 39% of the demand for economic subsidy in the thematic line.

As for the size of the demanding companies, the group consisting of micro and small-size companies and small companies predominated, which held 57.8% of the demand in requested amounts and 74.1% of the demand

Table 1 - Distribution of nonreimbursable FNDCT resources provided by thematic line

Topic	Description	Maximum Provision Foreseen
Agro 4.0	Development of new or significantly improved products, including their prototyping and demonstration in an operational environment, for the transition from agricultural/ agriculture and livestock production to a fourth generation model.	BRL 15,000,000.00
Smart Cities	Development of new or significantly improved products or processes, including their prototyping and demonstration in an operational environment, to improve urban infrastructure.	BRL 5,000,000.00
Industry 4.0	Development of new or significantly improved products or processes, including their prototyping and demonstration in an operational environment, to improve manufacturing environments.	BRL 15,000,000.00
Health 4.0	Development of new or significantly improved products, including their prototyping and demonstration in an operational environment, to expand access to quality health care in Brazil.	BRL 15,000,000.00
	TOTAL	BRL 50,000,000.00

Table 2 - Distribution of demand for nonreimbursable resources from the FNDCT, an offer of financial compensation and number of projects by thematic line (basis: proposals received by Finep within the statutory deadline, until August 6, 2020)

Topic	Amounts requested from FNDCT (BRL)	Amounts offered in financial consideration (BRL)	Total proposal amounts (BRL)	Amount of projects	Participation of the topic on the Total Public Selection (%)	
					Amounts requested	Amount of projects
Agro 4.0	428,449,846.00	168,095,276.00	596,545,122.00	279	24.9%	23.4%
Smart Cities	303,947,004.00	102,129,841.00	406,076,845.00	245	17.7%	20.6%
Industry 4.0	636,274,452.00	309,101,599.00	945,376,051.00	403	37.0%	33.9%
Health 4.0	351,335,484.00	94,474,636.00	445,810,120.00	263	20.4%	22.1%
Totals	1,720,006,786.00	673,801,352.00	2,393,808,138.00	1,190	100.0%	100.0%

in the number of projects, as shown in Table 3. However, due to the limitations on the amount that can be requested according to the company size, contained in the official notice, the average ticket per proposal was the lowest in this group of companies, at around BRL 1.1 million, jumping to BRL 2.2 million in the medium-sized companies.

Considering only the Agro 4.0 topic, the participation of micro- and small-size companies was even greater: 61% of the amounts requested and 79% of the projects received, which was reflected in lower participation in the medium to large companies' demand, as shown in Table 4. The average values requested per proposal were noticeably higher for all sizes of companies than those calculated on the set of all topics, indicating a forecast or need for larger scale investments in the agribusiness panorama when it comes to the transition to a Technologies 4.0 scenario.

The proposals submitted to the Public Selection Technologies 4.0, in addition to the thematic structuring, needed to indicate the use of one or more enabling technology typical of the context of Industry 4.0, in a predefined relationship in the official notice: energy storage, edge computing, fog computing, cloud computing, machine-to-machine communication, advanced 5G communications, digital twins, geolocation, georeferencing, intelligent instrumentation/sensor, artificial intelligence, internet of things, additive manufacturing, predictive maintenance, advanced materials, nanotechnology, augmented reality, virtual reality and mixed reality and advanced robotics.

Table 3 - Distribution of the demand for nonreimbursable resources from the FNDCT, number of projects and their average value according to the demanding companies' sizes (basis: proposals received by Finep within the statutory deadline, until August 6, 2020)

Size*	Amounts requested from FNDCT (BRL)	Amount of projects	Average amounts requested per proposal (BRL)	Participation by size on the total of the Public Selection (%)	
				Amounts requested	Amount of projects
Micro to small businesses	994,364,365.00	882	1,127,397.24	57.8%	74.1%
Medium enterprise	407,731,880.00	181	2,252,662.32	23.7%	15.2%
Medium-large to large companies	317,910,540.00	127	2,503,232.60	18.5%	10.7%
Totals	1,720,006,785.00	1,190	1,445,383.85	100.0%	100.0%

* Size defined by range of Gross Operating Revenue (GOR): micro to small companies, GOR up to BRL 16,000,000.00/year; medium-size business, GOR from BRL 16,000,000.01 to BRL 90,000,000.00/year; medium-large to large company, GOR from BRL 90,000,000.00/year

Table 4 - Distribution of the demand for nonreimbursable resources from the FNDCT, number of projects and their average value according to the demanding companies' sizes for the Agro 4.0 topic (basis: proposals received by Finep within the statutory deadline, until August 6, 2020)

Size*	Amounts requested from FNDCT (BRL)	Amount of projects	Average amounts requested per proposal (BRL)	Participation by size on the total of the Agro 4.0 topic (%)	
				Amounts requested	Amount of projects
Micro to small businesses	262,493,659.36	221	1,187,754.11	61.3%	79.2%
Medium enterprise	90,060,432.44	38	2,370,011.38	21.0%	13.6%
Medium-large to large companies	75,895,754.20	20	3,794,787.71	17.7%	7.2%
Totals	428,449,846.00	279	1,535,662.53	100.0%	100.0%

* Size defined by range of Gross Operating Revenue (GOR): micro to small companies, GOR up to BRL 16,000,000.00/year; medium-size business, GOR from BRL 16,000,000.01 to BRL 90,000,000.00/year; medium-large to large company, GOR from BRL 90,000,000.00/year

According to the companies' self-declaration, the occurrence of these enabling technologies occurred as shown in Figure 1. It is observed that all these technologies were represented at the event with great emphasis on: artificial intelligence, present in 736 of the 1190 proposals presented (61.8%); cloud computing, present in 667 of the proposals (56.1%) and internet of things, present in 651 of the proposals (54.7%). Among the less frequent ones were nanotechnology and energy storage, both absent from 95% of the proposals presented. There were no noticeable changes in this distribution considering only the Agro 4.0 topic.

The profile in total demand by Region of the Country, shown in Table 5, shows some similarity with the results shown in the Innovation Survey – PINTEC 2017 (IBGE, 2020). Demand was concentrated in the country's South and Southeast Regions, which together accounted for 85.6% of the requested values and 83.1% in the number of projects – at PINTEC 2017 *(id.)*, in these Regions, 90.1% of national expenditures were on internal research and development (R&D) activities, considering a number of innovative companies that represented 89.4% of the national total. The country's North, Northeast and Center-West Regions, together, reached 14.4% of the requested values and 16.9% in the number of projects – at PINTEC 2017 *(ibid.)*, in these Regions, 9.9% of national expenditures were on internal R&D activities, for 10.6% of the national total of innovative companies. As for the average requested per project, it was higher in the South Region, with BRL 1.5 million/project, followed, in decreasing order, by the Southeast, Center-West, North and Northeast Regions.

Exclusively for the Agro 4.0 topic, the demand by Region of the Country showed significant differences in relation to the multi-thematic distribution, as shown in Table 6. Although the South and Southeast Regions predominate,

Figure 1 - Self-declaration by companies demanding the use of enabling Technologies 4.0 in their projects, according to the number of proposals in which each technology is mentioned (basis: proposals received by FINEP in the statutory deadline, until August 6, 2020)

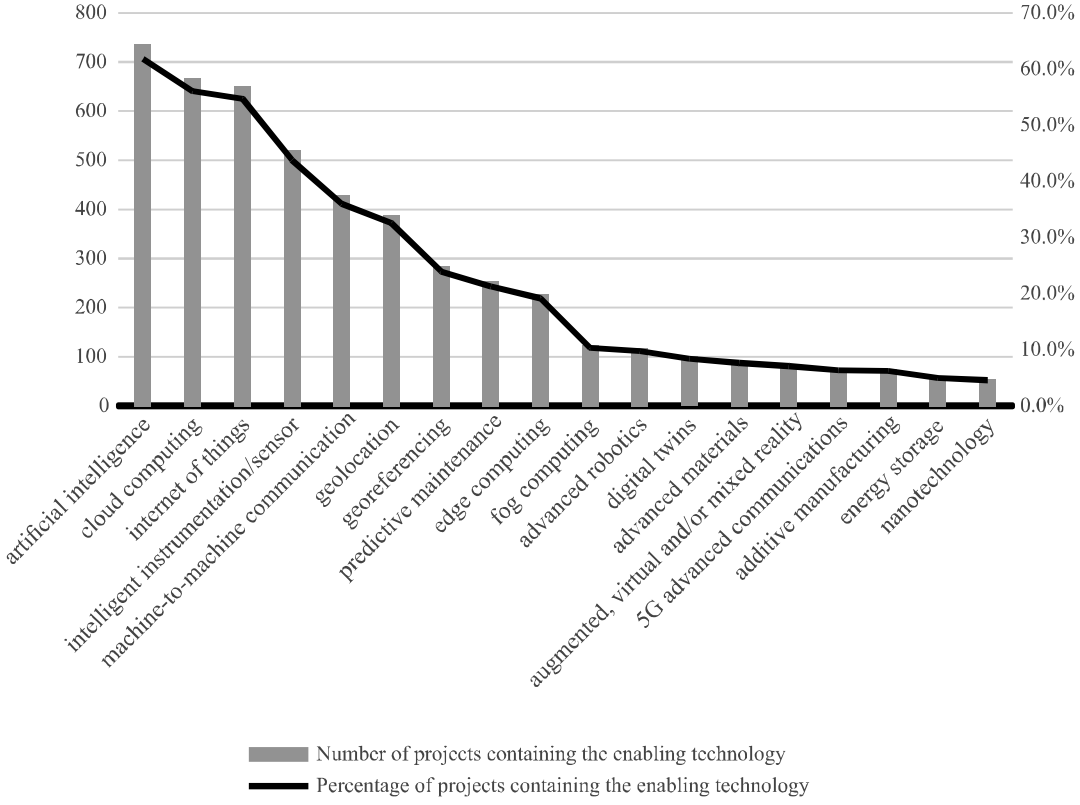

Table 5 - Distribution of demand for nonreimbursable resources from the FNDCT, number of projects and their average value according to the Region of origin of the applicant companies (basis: proposals received by FINEP within the statutory deadline, until August 6, 2020)

Country Region	Amounts requested from FNDCT (BRLx1000)	Amount of projects	Average amounts requested per proposal (BRLx1000)	Participation by size on the total of the Public Selection (%)	
				Amounts requested	Amount of projects
North	13,132	11	1,193.82	0.8%	0.9%
Northeast	112,811	102	1,105.99	6.6%	8.6%
Center-West	120,960	88	1,374.55	7.0%	7.4%
South	574,375	383	1,499.67	33.4%	32.2%
Southeast	898,729	606	1,483.05	52.3%	50.9%
Totals	1,720,007	1,190	1,445.38	100.0%	100.0%

the Center-West has considerably higher demand than in the general distribution, about 9% of the total of Agro 4.0 in requested amounts and 11% in the number of projects, showing the importance of agribusiness in this Region and the consequent increase in demand for investment in innovation. At the same time, the demand in the North Region is greater and less in the Northeast in relation to the multi-thematic distribution. The average ticket for projects is higher in the North Region, although this should be put into perspective due to the low number of projects (4), followed by the Southeast Region, which mainly reflects the concentration of companies with the largest size in this

Region. Regarding the regional distribution of demand in Agro 4.0, it can also be observed that the performance of the North, Northeast and Center-West Regions further outperformed the results of PINTEC 2017 *(ibid.)*: the number of projects from these Regions represented 18.6% of the official notice demand against the aforementioned 10.6% of the national total of innovative companies that spent on internal R&D activities in the same geographic area. And the amounts requested from the FNDCT by companies in these Regions amounted to 15.5% of the national demand in Agro 4.0 against the aforementioned expenditures on internal R&D activities in 2017, reaching only 9.9% of the national total.

As shown in Figure 2, in the distribution of demand per country state, it appears that companies based in 22 states and the Federal District participated in the event, and Acre, Amapá, Maranhão and Rondônia were not represented. The state of São Paulo alone concentrated 34.2% of the demand in amounts requested for economic subsidy. Therefore it was the state responsible for the predominance of the Southeast in this Public Selection. The States of the South Region (Rio Grande do Sul, Santa Catarina and Paraná) correspond to 33.4% of the demand in values. The states of Mato Grosso, Bahia, Espírito Santo, Ceará, Mato Grosso do Sul, Rio Grande do Norte, Paraíba, Pará, Amazonas, Piauí, Sergipe, Roraima and Tocantins did not reach, together, 10% of the total demand from the FNDCT.

In the case of Agro 4.0, as shown in Figure 3, the distribution of demand per country state takes on very different features. It appears that companies with headquarters in only 19 states and the Federal District participated in the process, and, besides Acre, Amapá, Maranhão and Rondônia, also Paraíba, Roraima and Sergipe were not represented. São Paulo continues to lead the demand with 38.5% of the amounts requested for economic subsidy. Companies from Paraná, Rio Grande do Sul and Minas Gerais make up a second block with a 34.4% participation in the event. And Santa Catarina, Mato Grosso, Rio de Janeiro and Goiás form, behind the others, a third block, with 16.7% of the demand in amounts. The Brazilian Federal District and the states of Rio Grande do Norte, Mato Grosso do Sul, Bahia, Ceará, Pará, Pernambuco, Espírito Santo, Amazonas, Piauí and Tocantins together accounted for only 10.1% of the demand from the FNDCT in Agro 4.0.

Technological partnerships with Scientific and Technological Institutions (ICTs) were encouraged in the Public Selection Technologies 4.0, positively influencing the criterion 3 grade of the merit analysis, which would measure technical capacity, technological infrastructure, adequacy of technological partnerships and the history of innovation institutions participating in each proposal. The participating ICTs entered the proposals as the subsidized companies' services providers. In the 1190 proposals received, 135 different ICTs participated in 465 of them, in different proportions according to the thematic line, as shown in Table 7. The Agro 4.0 topic stood out as the one with the highest percentage of proposals foreseen in partnership with ICTs, about 42%, which was also reflected in the quality of the partnerships, which represented the most active institutions in research in agribusiness and in Technology 4.0 applications for it. These partnerships have the potential to allow demanding companies to access a richer set of knowledge and technologies, as innovation in the digital age often requires skills that go beyond traditional strengths. By engaging with external actors such as ICTs, companies can access complementary skills, stimulate creativity and channel R&D efforts to areas that would not be explored without partnerships (PAUNOV and PLANES-SATORRA, 2019).

Table 6 - Distribution of the demand for nonreimbursable resources from the FNDCT, number of projects and their average value according to the applicant companies' Region of origin, only for the Agro 4.0 topic (basis: proposals received by Finep within the statutory deadline, until August 6, 2020)

Country Region	Amounts requested from FNDCT (BRLx1000)	Amount of projects	Average amounts requested per proposal (BRLx1000)	Participation by size on the total of the Agro 4.0 topic (%)	
				Amounts requested	Amount of projects
North	6,716	4	1,679	1.6%	1.4%
Northeast	20,502	18	1,139	4.8%	6.5%
Center-West	39,143	30	1,305	9.1%	10.8%
South	146,995	93	1,581	34.3%	33.3%
Southeast	215,094	134	1,605	50.2%	48.0%
Totals	428,449	279	1,536	100.0%	100.0%

Figure 2 - Amounts requested from FNDCT by the applicant companies' state of origin (basis: proposals received by Finep within the statutory deadline, until August 6, 2020)

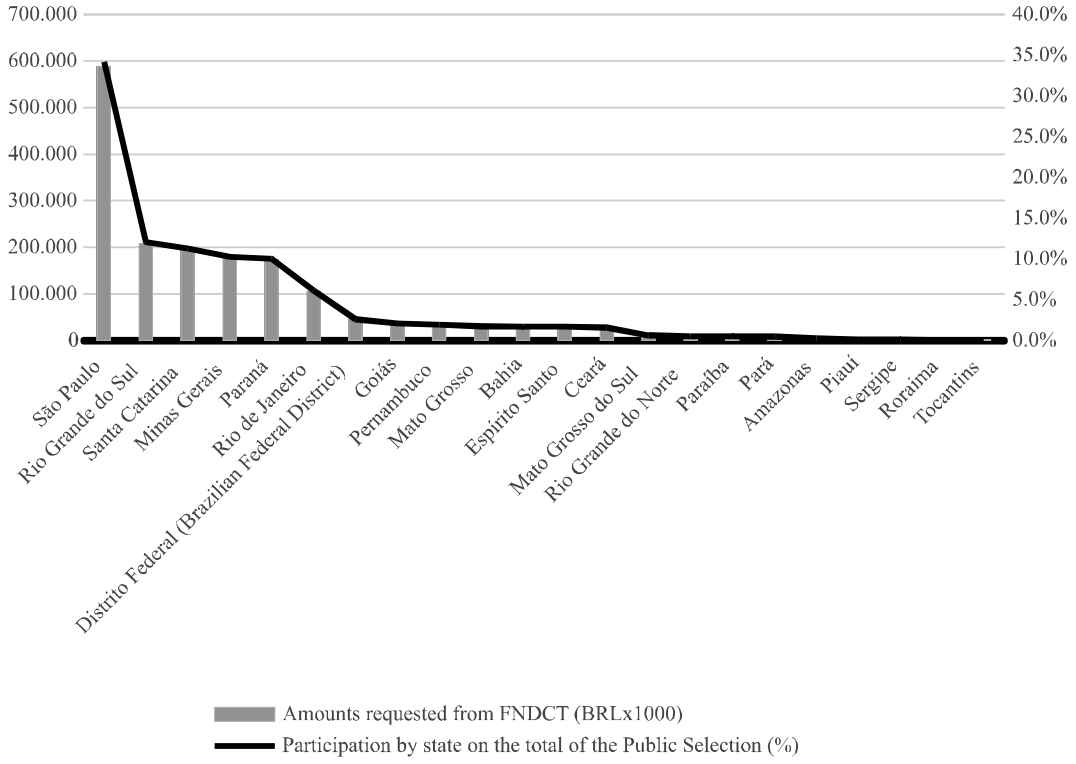

Figure 3 - Amounts requested from FNDCT by the applicant companies' state of origin only for the Agro 4.0 topic (basis: proposals received by Finep within the statutory deadline, until August 6, 2020)

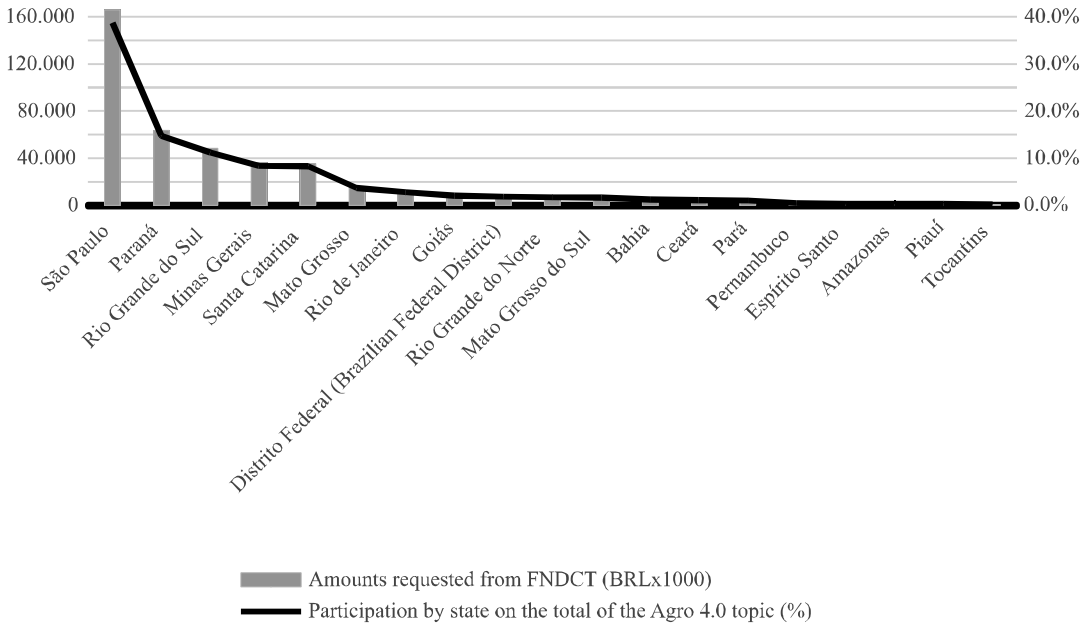

Table 7 - ICTs participation according to the thematic line (on the total number of proposals received by Finep in the statutory deadline, until August 6, 2020)

Topic	Amount of projects	Number of projects with technological partnership with ICTs	Percentage of proposals submitted with partnership with ICTs
Agro 4.0	279	117	41.9%
Smart Cities	245	102	41.6%
Industry 4.0	403	138	34.2%
Health 4.0	263	108	41.1%
Totals	1,190	465	39.1%

The initial demand was submitted to a first screening, called habilitation, in which formal and adherence requirements of the proposals presented were verified. After the appeals of this stage, the number of proposals in the event was reduced from the initial 1190 to 704 qualified and the demand of appeals to the FNDCT decreased from the initial BRL 1.72 billion to around BRL 1 billion. Afterwards, the merit assessment of the qualified proposals was carried out, the preliminary result of which (before the appeals) already points to a qualified demand of 294 projects that met the minimum requirements of the official notice criteria, in the total amount of BRL 451 million requested from the FNDCT. The distribution of demand along the process among the thematic lines is shown in Table 8. It is observed that, for Agro 4.0, even after the preliminary result of the merit analysis, the qualified demand to the FNDCT is still nine times greater than the expected availability of resources for subsidy, which leads to high competition among the classified projects ranked by weighted average of the evaluation criteria grades.

Application of the tag cloud technique to the "Publishable Summary" field, of a non-confidential nature, to the proposal forms presented in the Agro 4.0 topic produced the diagram shown in Figure 4. In it we can observe the great prominence of terms that reflect the projects development object such as systems, platforms, information, data, technologies, development, monitoring, analysis, equipment, sensors, solution/ solutions, software, traceability and machine/machines. Agribusiness concerns are also reflected in the tag cloud such as productivity, production, environment, quality, safety, sustainable, sustainability, application, control, market, reduction, cost/costs, management, Brazil, efficiency, decisions, process/processes, operations, product/products, usage, performance, optimization and accuracy. Enabling technologies also emerge such as artificial intelligence, algorithms, cloud, real time, IoT, images, automation, tools, smart and intelligence. Agribusiness practices and techniques mix, highlighting terms such as agriculture, precision agriculture, agricultural, farmer, management, plants, energy, animal, livestock, industry, crops, nutrients, food, feeding, storage, processing, pests and pesticides. All of this makes up the portrait of contemporary Brazilian agribusiness.

Table 8 - Distribution of demand for nonreimbursable resources from the FNDCT and number of projects by thematic line, according to the selection process stage

Topic	Initial demand		Demand after the qualification stage and respective appeals		Demand after the merit analysis stage; a preliminary result	
	Amounts requested from FNDCT (BRL)	Amount of projects	Amounts requested from FNDCT (BRL)	Amount of projects	Amounts requested from FNDCT (BRL)	Amount of projects
Agro 4.0	428,449,846.00	279	242,450,561.82	154	135,739,198.93	83
Smart Cities	303,947,004.00	245	158,422,506.16	139	51,101,252.37	37
Industry 4.0	636,274,452.00	403	403,105,409.78	237	154,134,893.18	95
Health 4.0	351,335,484.00	263	229,724,200.44	174	110,060,552.24	79
Totals	1,720,006,786.00	1,190	1,033,702,678.20	704	451,035,896.72	294

Figure 4 - Tag cloud about the content of the "Publishable Summary" field of the proposals received by Finep within the statutory deadline, until August 6, 2020, in the Agro 4.0 topic

CONCLUSIONS

1. In just a few decades, Brazil has become a country of great relevance in the world trade of agricultural products and foods such as soy, sugar and meat. According to the Atlas of Economic Complexity (HARVARD, 2020), 4.6% of world exports of agricultural products in 2018 had Brazil as their country of origin. In addition, the Brazilian economy performance depends, to a large extent, on the agribusiness segment – here understood as all economic activities related to the supply of agricultural inputs, machinery and equipment, agricultural production itself, agribusiness, including the food industry, as well as transport activities and marketing of primary and processed agricultural products – which also has an increasing importance in the national energy matrix, especially due to the production and domestic market of ethanol and cogeneration from biomass in the sugar and alcohol sector;
2. The vertiginous evolution of Brazilian agricultural production was mainly due to the development and adoption of innovative technologies in the different agribusiness chains. It is the result of a diversified ecosystem with companies, universities, research centers, financing institutions, regulatory bodies, technical assistance, among other links. As shown in this article, Brazil is on the threshold of a new technological revolution in the field, now due to the application of digital technologies, which has the potential to raise its agricultural productivity to the highest level in the world, in conjunction with socio-environmental sustainability. The establishment of technological partnerships with ICTs, which reached 42% of the projects on the Agro 4.0 topic of the Public Selection Technologies 4.0, characterizes the RD&I ecosystem strength in the national agribusiness;
3. The study of the demand arising from this Public Selection provides strong evidence that the country is moving towards the widespread adoption of technologies

that characterize Industry 4.0 and in a very representative way in agribusiness or Agro 4.0. This official notice rules did not allow the same company to participate in more than one proposal whether as executor or co-executor. Therefore, the 1190 proposals presented relate to more than 1190 companies with the intention of developing innovations in the 4.0 context, including more than 279 companies in Agro 4.0. The dimension of this universe, for a new technological frontier, is especially relevant, including in economic terms, as this demand also meant the precommitment of about BRL 674 million in return, or private investment;

4. The participation of micro and small companies, with about three quarters of the total number of projects and 57% of the amount requested from the FNDCT in the set of thematic lines - despite the limitations of the amount requested imposed on them by the rules of the official notice - demonstrates its relevance in the Technologies 4.0 scenario and indicates the importance of developing its own instruments to adequately support these efforts considering its size and lesser investment capacity. This was even more true in Agro 4.0, with this range of companies demanding 79% in project numbers and 61% in values. For Agriculture, the participation of the country regions outside the South-Southeast axis must also be highlighted, significantly above the usual distribution of investments in RD&I measured by PINTEC;

5. The qualified demand volume after the Public Selection Technologies 4.0 merit analysis still exceeded the resources availability on a large scale, which indicates that the use of the economic subsidy instrument, in addition to its high attractiveness already mentioned, is justified by the great competition which allows its use only for the most noble RD&I efforts. At the same time, the existence of a large contingent of well-evaluated projects in all thematic lines that will not be able to receive support by grant, due to the budget limitations of this official notice, points to the need to carefully plan the continuity of fostering innovation in the 4.0 segment, either by means of new rounds of economic subsidy and/or by means of credit instruments with rates lower than those of the market, nonrefundable support to ICTs in cooperative projects with companies, direct investment in startups and technology-based companies, technology awards and innovation and new forms of support that may be conceived.

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