RBGDR

THE DIGITAL DEBT IN BRAZILIAN COUNTRYSIDE: AN ANALYSIS AT NATIONAL AND REGIONAL LEVELS BASED ON 2017 AGRICULTURAL CENSUS

A DÍVIDA DIGITAL NO CAMPO BRASILEIRO: UMA ANÁLISE NACIONAL E REGIONAL A PARTIR DO CENSO AGROPECUÁRIO 2017

RBGDR

REVISTA BRASILEIRA DE GESTÃO E DESENVOLVIMENTO REGIONAL
V.20, N°1, Jan-Abr/2024 | Taubaté/SP - Brasil | ISSN 1809-239x

THE DIGITAL DEBT IN BRAZILIAN COUNTRYSIDE: AN ANALYSIS AT NATIONAL AND REGIONAL LEVELS BASED ON 2017 AGRICULTURAL CENSUS[1]

A DÍVIDA DIGITAL NO CAMPO BRASILEIRO: UMA ANÁLISE NACIONAL E REGIONAL A PARTIR DO CENSO AGROPECUÁRIO 2017

Marcio Gazolla[2] | Joacir Rufino de Aquino[3]

Received: 10/16/2023
Accepted: 02/27/2024

[1] This article is part of the results of research activities planned in the projects 'Digital food markets in Brazil: innovations, dynamics and limits of online sales of family farming food attempts in the context of the Covid-19 pandemic' funded by the National Council for Scientific and Technological Development (CNPq), through Call 04/2021 (Process 303942/2021-5) and 'Digital food markets in Brazil: dynamics, innovations and marketing challenges in family farming' financed by the National Council for Scientific and Technological Development (CNPq), Ministry of Science, Technology and Innovations (MCTI), through Call 40/2022 (Process nº 409231/2022-3).

[2] PhD in Rural Development (UFRGS).
Professor at the Federal Technological University of Paraná. Pato Branco - Paraná, Brazil.
Email: marciogazolla1@gmail.com

[3] PhD student in Geography (UFRN).
Professor at the State University of Rio Grande do Norte. Açu – RN, Brazil.
Email: joaciraquino@uern.br

ABSTRACT

This article offers an analysis of digitalization among the two types of Brazilian farming (family farming-AF and non-family farming - ANF), in different regions of the country and groups of producers, aiming to highlight the serious digital debt that persists in the sector at the beginning of the 21st century. To this end, a review of part of recent literature on the subject and unpublished data from 'special tabulations' of the 2017 Agricultural Census prepared by the IBGE team were used. The results show that internet is still absent in more than 70% of Brazilian farms and, when present, mobile connection predominates, which is not the best quality. In relative terms, family farming is the least assisted in all regions, especially the poorest farmers (PRONAF Group B). The North and Northeast regions are the ones with the worst indicators in terms of connectivity and the South has the best percentages of access. The work concludes that paying down the digital debt in the Brazilian countryside requires the State to advance public policies, as well as to strengthen joint actions with private actors and local/regional innovation ecosystems at different territorial levels. Only then will it be possible to open up new opportunities for farmers and encourage more sustainable and inclusive rural development processes.

Keywords: Family Farming. Rural Development. Digitalization. Digital Exclusion.

RESUMO

O objetivo deste artigo é analisar a digitalização nos dois tipos de agricultura brasileira (familiar - AF e não familiar - ANF), nas diferentes regiões do país e por grupos de produtores, de forma a evidenciar o tamanho, os determinantes e as consequências da grave dívida digital que ainda persiste no setor no limiar do século XXI. Para tanto, recorreu-se à revisão de parte da literatura recente sobre o tema e a dados inéditos de "tabulações especiais" do Censo Agropecuário de 2017, elaboradas pela equipe do IBGE. Os resultados evidenciam que a internet ainda está ausente em mais de 70% dos estabelecimentos agropecuários do país e, quando disponível, predomina a conexão móvel que não é a de melhor qualidade. Em termos relativos, a agricultura familiar é a menos assistida em todas as regiões brasileiras, especialmente os agricultores mais pobres (Grupo B do PRONAF). Já as regiões Norte e Nordeste são as que apresentam os piores indicadores quanto à conectividade, e a região Sul a que possui os melhores percentuais de acesso. O trabalho conclui que, para saldar a dívida digital existente no campo brasileiro, é necessário avançar nas políticas públicas de Estado, bem como fortalecer ações em conjunto com atores privados e os ecossistemas locais/regionais de inovação nos distintos níveis territoriais. Somente assim será possível abrir novas oportunidades aos agricultores e incentivar processos de desenvolvimento rural mais sustentáveis e inclusivos.

Palavras-chave: Agricultura Familiar. Desenvolvimento Rural. Digitalização. Exclusão Digital.

INTRODUCTION

Digitalization processes are spreading to various sectors of the economy and society, ranging from *big data* in corporations that capture data from users and consumers, often without permission, through online services provided by the State at various levels, to the private use of social networks by the general public. Following this trend of contemporary capitalism, international institutions, such as the World Bank and FAO (United Nations agency for Agriculture and Food), have expressed in their documents the potential of digitalization processes for: construction of new business models, the possibility of greater economic gains, access and transparency in information, increased connectivity and the ability to access online services, among others (World Bank, 2016; FAO, 2020).

Nevertheless, those institutions have repeatedly expressed concerns about what they call the 'digital divide', which is the uneven development of digitalization processes in society, which increases socioeconomic and technological disparities, especially among the most vulnerable people. Furthermore, they emphasize that in rural areas, the digital debt on a global scale is greater among the categories of smallholder farmers, as recent research has shown (Kenney; Serhan; Trystram, 2020).

In fact, the history of technological innovations development and dissemination in the countryside has been marked by inequality and exclusion. The modernization of Latin American agriculture from the 1960s onwards illustrates this – it covered only a few areas, products and farmers, leaving a large segment of family farmers as latecomers or simply excluded from access to technologies. Equally illustrative is the so-called 'precision agriculture' or 'agriculture 4.0', a current paradigm based on the computerization and digitalization of production processes, which, due to expensiveness of technologies, reaches only a small and limited segment of farmers (Sotomayor; Ramirez; Martínez, 2021).

In the case of digitalization processes underway in Brazil in agriculture and food systems, it seems that inequality and exclusion issues are also present. However, there is still little systematized evidence on the topic, since most of existing research is limited to discussing use of information and communication technologies (ICTs) in agribusiness, in areas such as biotechnology, natural resources and climate change, phytosanitary safety, technology transfer and uses of digital technologies (Bos; Owen, 2016; Massruhá; Leite, 2016; Deponti; Kirst; Machado, 2017). This fact represents an important gap in Brazilian rural studies, considering the recent expansion of this novelty during the Covid-19 pandemic, as well as its strategic potential for strengthening farmers, especially family farmers (Favareto *et al*., 2021; Gazolla; Aquino, 2021; Niederle *et al*., 2021).

In light of that, this article analyzes digitalization within two categories of Brazilian farming (family farming- AF and non-family farming- ANF), in different regions of the country and by groups of producers, aiming to shed light on the extent of the heavy digital debt that persists in Brazilian countryside at the dawn of the 21st century, its determinants and consequences. To this end, in methodological terms, we reviewed part of the recent literature on the topic as well as unpublished data from 'special tabulations' of the 2017 Agricultural Census, prepared by the Brazilian Institute of Geography and Statistics' (IBGE) team.

The article is organized into four other sections in addition to this Introduction and the Final Considerations. In the second section, the theoretical framework on digitalization in agriculture and its role for sustainable and inclusive development is presented. In the third section, the research methodology is discussed, highlighting the originality of the special tabulations used. The fourth section describes census data on digitalization along with the different types of Brazilian agricultural

establishments. The fifth section, in turn, seeks to explain and discuss why there is a digital debt in Brazilian countryside and what opportunities are obstructed by this problem, aiming to urge rural development processes.

AGRICULTURE, DIGITALIZATION AND SUSTAINABLE AND INCLUSIVE RURAL DEVELOPMENT

Sustainable development is a multidimensional process through which the necessary conditions are created for individuals to achieve social and economic well-being and substantive freedoms, preserving and regenerating environmental resources and ecosystem services in a long-term perspective (Abramovay, 2010; Sachs, 2011). In this sense, sustainable development should be pursued by both public and private organizations and its current foundations lie in the societal paradigm of the Sustainable Development Goals (SDGs) as recommended by the United Nations, many of which have important implications for rural spaces, such as sustainable agriculture and social inclusion (UNDP, 2022).

When development is conceptualized taking into account social inclusion, both private actions and public policies are necessary in a society or social group so that to enhance social actors' capabilities and freedoms to 'be and do' (Sen, 2000). That said, in the specific case of this work, the term inclusive development aims to account for the inclusion of social subjects who remain on the periphery of rural digitalization processes.

Several studies by international organizations place digitalization[1] as an irreversible process, considering its dynamics in the current knowledge society, and as something necessary to achieve sustainable development. These studies recognize the advances that digitalization can generate, making it possible to lower transaction costs, support economic growth, create new businesses and make information quickly available in productive and technological activities. At the same time, as mentioned in the previous section, documents from international organizations recognize the huge gap in access to digital technologies separating different social groups, especially the most vulnerable, what can

1 According to Niederle *et al.* (2021), the term 'digitalization' is used to describe sociotechnical processes that involve the use of digital technologies in restructuring social and institutional contexts. This definition is important because, in Brazilian literature on digital transformation, it is common to also find the term *digitização* to refer to these processes, taking digitalização as restricted to the conversion of analog data into digital data, what in English is expressed as *'digitization'.*

increase socioeconomic inequalities (World Bank, 2016; CEPAL, 2020; FAO, 2020; OECD, 2019).

Therefore, one of the challenges for social inclusion would be expanding access to internet, given that just over half of world's population (54%) has access to this technology and the rest remains aside from the so-called 'digital economy' (World Bank, 2016; FAO, 2020). Obviously, these generic data are much more contrasting in developing countries, such as Brazil and other Latin American nations, where social and economic disparities are more pronounced for poor and low-income population groups.

Regarding agriculture and rural spaces, Rolandi *et al*. (2021), when reviewing literature on digitalization within the European Union, highlight its impacts on four domains: economic, environmental, governance and social. As regards the economic domain, digitalization influences: production processes, affecting organization, work processes and management activities; value chains, affecting the sequence of business activities (marketing, sales and services); and, markets, changing the exchange of goods and services and defining prices. In the environmental domain, the authors identified impacts on animal welfare; ecosystem services such as pollination and clean air; natural resources used as assets and raw materials; and risk management and prevention of environmental accidents.

As to the governance domain, two effects of digitalization appear: functionality of bureaucratic and legal procedures, allowing greater speed and equity in conditions of access to legal/normative information and administrative instruments. In the social domain, the authors reinforce the following points: individual effects, which refer to people: access, chance and conditions to expand social interactions; effects on fundamental labor rights and rules, among others.

The Inter-American Institute for Agricultural Cooperation (IICA) has also sought to characterize the novelty of digitalization in rural areas, considering some of its particularities. The first aspect refers to what the organization calls 'food systems', rather than 'agriculture' or 'rural', stating that: "digital transformation is the main opportunity for changes in food systems" (IICA, 2021, p 5). Furthermore, it highlights that digitalization will transform food systems in five directions: ensuring access to healthy and nutritious food; supporting the adoption of sustainable consumption; generating sustainable production; promoting equitable livelihoods and creating resilience in the face of vulnerabilities and tensions that surround producers.

Some of these effects of digitalization have been observed by experienced researchers, corroborating the arguments of Rolandi *et al*. (2021). This is the case of Reardon *et al*. (2021), who assert that the digitalization of food systems was accelerated by Covid-19 pandemic and that it will have four main consequences: a) acceleration of the entry of e-commerce into value chains; b) integration by retailers of e-commerce into their supply chains; c) proliferation of new delivery intermediaries, copivoting new e-commerce businesses in food supply chains; and d) incorporation of e-commerce and delivery by small and medium-sized retail and food service companies as strategic mechanisms in their business plans.

In this sense, it becomes clear that, besides including people in the digitalization processes by promoting access to new technologies, it is necessary to build other human and cognitive capabilities that are fundamental to overcoming the digital divide that most seriously affects the poorest. Such capabilities range from knowing how to navigate the internet, access platforms and content, handle electronic devices, databases and software, to technical knowledge in ICTs, safe browsing, data protection, to critical sense in relation to fake news and internet scams – all of which are essential skills for the safe inclusion of people in the 'new digital world' (Deponti; Kirst; Machado, 2017; Kenney; Serhan; Trystram, 2020).

What is disturbing in the Brazilian and of other Latin American countries cases is that the State has hardly acted to bring solutions and public policies focused on tackling the problem. The only visible initiative here is a plan for digitalizing technical assistance and rural extension services (ATER), but which has not yet gained momentum in Brazilian states, where few experiences and services are already operating within this new paradigm. For some authors, this strategy will not succeed unless it takes into account the different cognitive and technological capabilities of the social actors involved in rural development processes (Torero, 2013; FIDA, 2021).

In any case, there have been ongoing debates on the topic and new proposals have been launched for society. Buainain, Cavalcante and Consoline (2021), for example, in a work recently published by the Economic Commission for Latin America and the Caribbean (CEPAL), argue for the paradigm of agriculture 4.0 and agritechs (startups) as the main paths towards digitalization. However, these two technological movements are founded on the deepening of processes initiated in the modernization of agriculture, lacking collective concern about the possible risks of digitalization and the achievement of the Sustainable Development Goals (SDGs).

It should be noted that a major risk of digitalization regards to the crystallization and deepening of the already mentioned digital debt. As facets of this phenomenon, FAO (2021) lists increase in rural inequalities, deepening of asymmetric power relations, increase in labor productivity and automation/use of artificial intelligence/robots. Such factors can generate technological unemployment, since digitalization can be used in 40 to 60% of jobs, violation of rights, trafficking and illicit use of data from system users, etc.

Therefore, the issue of digitalization clearly entails both opportunities and risks for the promotion of sustainable and inclusive rural development – it can, then, aggravate social inequalities instead of alleviating them. But in Brazil, as highlighted above, so far, little is known about the real size of the digital debt regarding different types of farmers, especially those who constitute the large family farming segment. There is also a lack of evidence on the causes and consequences of digital exclusion, as well as on the challenges of scientifically addressing the problem and seeking solutions for it. Based on this scenario, the next sections present and discuss new data from the 2017 Agricultural Census that can help fill some of these gaps.

METHODOLOGY: DELIMITING THE TYPES OF BRAZILIAN FARMERS AND THE RESEARCH VARIABLES

The secondary data used here to measure the level of digitalization in Brazilian agriculture comes from the last Agricultural Census carried out by the Brazilian Institute of Geography and Statistics (IBGE) in 2017/2018, but whose reference date is September 30, 2017. This Census, which incorporated the legal principles of Law No. 11,326/2006[2*] (regulated by Decree No. 9,064/2017), classified rural establishments as either 'family farming' or 'non-family farming'.

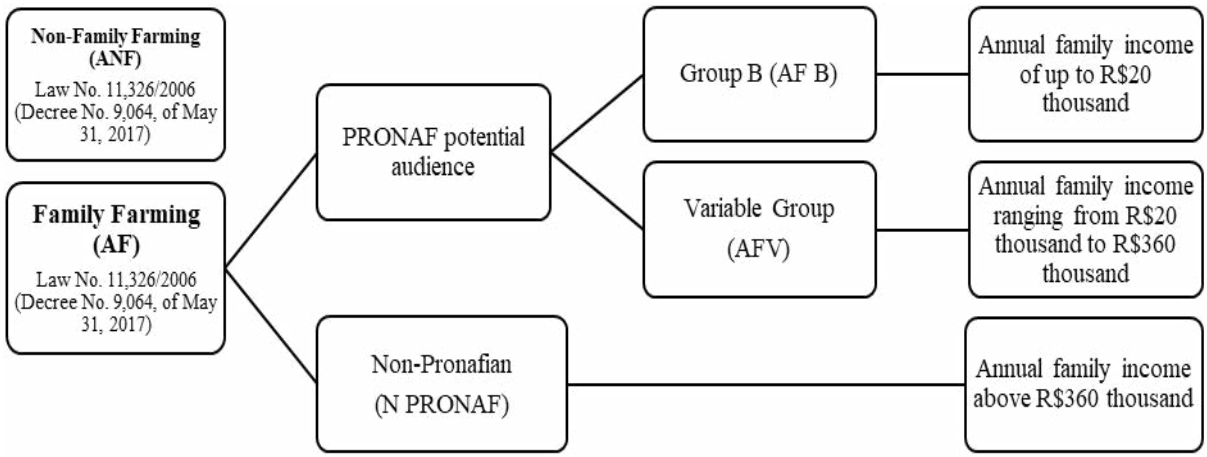
The family farmer (AF) category includes those producers who: i) hold, in any capacity, an area of up to four fiscal modules; ii) have at least half of its workforce for production and income generation formed by family members; iii) obtain at least half of their family income from economic activities in their farm or rural enterprise; and iv) run their farm or rural enterprise strictly with their family (Del Grossi, 2019; IBGE/SIDRA, 2019). By exclusion, establishments that did not simultaneously meet these cited criteria were considered non-family farms (ANF); these are production units with more than four fiscal modules, operated predominantly by salaried workers and directed by administrators or forepersons.

2 * Brazilian law that sets the guidelines for formulation of the national policy for family farming and rural family enterprises.

Once family farmers were identified according to the legal criteria listed above, IBGE also classified that category based on whether it fits into the potential audience of the National Program for Strengthening Family Farming (PRONAF). Figure 1, below, shows that this methodological option made it possible to split the AF category into three groups: B (AF B), Variable (AF V) and non-Pronafians (N PRONAF).[3]

According to the Central Bank norms in force in 2017/2018, family farmers in PRONAF B were those with a gross annual family income of up to R$20,000 (hereinafter referred to as 'disadvantaged AF). Those in Group V (AF V) were farmers whose earnings were intermediate, ranging from a gross annual income of R$20 thousand to R$360 thousand. Non-Pronafians, or capitalized farmers (N PRONAF), were defined as those who exceeded the annual gross family income included in PRONAF, at the time stipulated at R$ 360 thousand (Del Grossi, 2019).

Figure 1 | Classification of rural establishments in Brazil based on Law 11,326 and the PRONAF potential audience typology – 2017



Source: Elaborated by the authors based on IBGE/SIDRA (2019) and Del Grossi (2019).

These classifications adopted by IBGE, which were taken as references in the research, served as the basis for the final results of the 2017 Agricultural Census published on IBGE's Automatic Recovery System (SIDRA). On this platform, however, there is only one table regarding

3 The PRONAF was created in 1996 and, over time, became the main public policy for productive support for Brazilian family farming. The program's target audience, from the 1999/2000 harvest, was divided into groups, from the poorest to the most capitalized according to their levels of annual gross monetary income. This typology became popular within the scope of public rural development policies and, as a novelty, was incorporated by IBGE into the 2006 and 2017 agricultural census database, allowing progress in the study of the characteristics of the different types of family farmers in the country (Aquino; Gazolla; Schneider, 2018; Del Grossi, 2019).

digitalization,[4] which comprises establishments in general and does not allow viewing the previously described typologies. To circumvent this limit, we asked IBGE's team in Rio de Janeiro to create a 'special tabulation' containing the aforementioned information, which they promptly fulfilled, allowing for the database used here to be organized.

In general terms, the unpublished stratified data from the 'special tabulation' relate to information on the existence of telephone and email, internet access and type of internet connection in rural establishments. Furthermore, these cited data were organized into tables and disaggregated to the entire national territory and the five macro-regions of the country, in addition to the two types of agriculture (family and non-family) and groups of family farmers (group B, Variable and Non-Pronafian) as illustrated in Figure 1. This methodological procedure, as will be seen later, widens the range of vision on the socioeconomic heterogeneity of national agriculture and on the regional specificities of the uneven digitalization process.

RURAL DIGITALIZATION AND DIGITAL DEBT OVERVIEW BY TYPE OF AGRICULTURE IN BRAZIL AND REGIONS

Access to the internet and ICTs in agricultural establishments in Brazil

Census statistics reveal that the number of agricultural establishments in Brazil showed significant growth from the beginning of the 20th century until the mid-1980s. After a sharp drop in the 1990s, the indicator stabilized at a level above five million units. The country stands out in the South American scenario, holding almost half of the region's agricultural properties. Part of these farms is formed by the employer sector, though the absolute majority is operated by thousands of self-employed farming families (Aquino; Gazolla; Schneider, 2018).

In Table 1, we can observe the data referring to the number of farms of the 'two Brazilian agricultures' – non-family farming (ANF) and family farming (AF). ANF covers 1,175,916 units, 23.18% of the whole universe of farms registered in Brazil. The AF segment records a significantly higher number – 3,897,408 establishments, comprising 76.82% of existing farms.

4 This is Table 6962 - Number of agricultural establishments and Area of agricultural establishments, per producer who has DAP (Declaration of Suitability for PRONAF), use of limestone and/or other soil pH correctors, telephone, e-mail and internet and total area groups. Available at: < https://sidra.ibge.gov.br/tabela/6962 >.

The numerical superiority of Brazilian family farming, however, must be viewed with caution, since a marked inequality prevails within the segment (Aquino; Gazolla; Schneider, 2018). In fact, as shown in Table 1, disadvantaged AF (AF B) constitute most of rural establishments. The intermediate (AF V) and capitalized (N PRONAF) groups, in turn, are less representative, although they account for most of the wealth generated by family farming.

Table 1 | Distribution of types of farmers in Brazil – 2017

Type of Farmer	Number	%
Non-Family (ANF)	1,175,916	23.18
Family (AF)	3,897,408	76.82
Group B (AF B)	2,732,790	53.87
Group V (AF V)	1,138,885	22.45
Not PRONAF (N PRONAF)	25,733	0.51
TOTAL	5,073,324	100.00

Source: 2017 Agricultural Census (IBGE/SIDRA, 2019). Authors' elaboration.

The socioeconomic differentiation found among Brazilian rural establishments is defined by multiple factors. Among these factors, access to digital technologies stands out. In this sense, data in Table 2 demonstrate that 71.81% of the farms lack access to the internet, unveiling the so-called digital exclusion of rural people from the world wide web. It is true that data presented by Cunha, Conceição and Schneider (2022), from the 2019 National Household Sample Survey (PNAD), are a little more encouraging, showing that 55.6% of rural households would have internet access.[5] Anyway, IBGE's census figures point to a large contingent of farmers who are excluded from access to the world wide web. This situation is aggravated among AFs – 74.28% out of them lack access to the internet, compared to ANF, of which 63.63% lack access.

Within AF groups, the situation is more critical in the so-called Group B (AF B), as almost 80% of this category of farmers lack access to the network, compared to their peers in family farming (AF V and N PRONAF), which present better access rates. The low access to the internet by disadvantaged households

5 It is worth mentioning that the Agricultural Census data refer to the base year of 2017, while the cited PNAD data refers to 2019. There may have been an improvement in internet access in these two years and in relation to the two surveys. This is what PNAD data demonstrate in relation to the Agricultural Census – that internet access increased in Brazil, generally, and in all five macro-regions. It should also be considered that the Census and PNAD have distinct methodologies: the first is a census survey of the entire population and works with the notion of rural establishment; the second uses sampling and is carried out based on the concept of (rural) household.

is worrying, since digital exclusion adds to so many other productive deficiencies and social vulnerabilities they already face, such as, for example, reduced land areas, restricted access to machines, low education, low access to technical assistance and extension (ATER) and rural credit, among other structural limitations as some studies have pointed out (Aquino *et al.*, 2014; Aquino; Gazolla; Schneider, 2016, 2018).

Table 2 | Internet access and type of connection in agricultural establishments, by type of farmer and family farming group, Brazil - 2017

Type of Farmer	Number	Internet access			
		Yes	%	No	%
Total	**5,073,324**	**1,430,156**	**28.19**	**3,643,168**	**71.81**
ANF	1,175,916	427,671	36.37	748,245	63.63
AF	3,897,408	1,002,485	25.72	2,894,923	74.28
AF B	2,732,790	560,224	20.50	2,172,566	79.50
AF V	1,138,885	426,035	37.41	712,850	62.59
N PRONAF	25,733	16,226	63.06	9,507	36.94

Type of Farmer	Type of internet access (*)						
	Internet access	Broadband	%	Dialed by line	%	Mobile	%
Total	**1,430,156**	**659,767**	**46.13**	**19,532**	**1.37**	**909,381**	**63.59**
ANF	427,671	202,298	47.30	6,051	1.41	274,444	64.17
AF	1,002,485	457,469	45.63	13,481	1.34	634,937	63.34
AF B	560,224	223,480	39.89	7,006	1.25	378,021	67.48
AF V	426,035	222,776	52.29	6,196	1.45	249,078	58.46
N PRONAF	16,226	11,213	69.11	279	1.72	7,838	48.31

Source: 2017 Agricultural Census (IBGE, 2019 – special tabulation). Authors' elaboration.

(*) The percentages of types of internet access are greater than 100% because a portion of respondents declared more than one type of access to the world wide web.

In the second part of Table 2, showing the 28.19% of Brazilian farmers who have access to the internet by type of connection, mobile internet connection makes up 63.59% and broadband, 46.13%. Dial-up technology comprises just 1.37% of connections, given its lag as a connective technology. This means that cell phones are the most used connectivity technology in rural establishments, due to the possibility of capturing signal in remote locations and being carried during the different farming activities, something highlighted in the ICT Households survey (Silva, 2022).

Regarding farming categories, among AF, 63.34% of internet access is made through mobile devices, a percentage quite close to that observed among ANF. Considering the family farming segment, the highest levels of broadband internet access are found in the AF V and N PRONAF groups. AF B's farmers show a more precarious profile, having limited access to broadband networks and communicating mainly via mobile devices. In any case, data in Table 2 inform that some disadvantaged farmers are also able to access better quality internet, while most of them are still using slow connection technologies.

The preceding discussion is strengthened in Table 3, which shows data regarding the existence of telephone and e-mail as ICTs in Brazilian farms. Census information shows that the telephone is an ICT widely accessed by farmers in 62.97% of the farms. This number is well below that recently reported by the ICT Household Survey, in which 83% of rural households use their cell phones as a connectivity device (Silva, 2022).

Table 3 | Existence of telephone and email in agricultural establishments, by type of farmer and family farming group, Brazil – 2017

Type of Farmer	Number	Existence of telephone					
		Yes	%	No	%	Uninformed	%
Total	**5,073,324**	**3,194,862**	**62.97**	**1,878,179**	**37.02**	**283**	**0.01**
ANF	1,175,916	852,898	72.53	322,972	27.47	46	0.00
AF	3,897,408	2,341,964	60.09	1,555,207	39.90	237	0.01
AF B	2,732,790	1,441,561	52.75	1,290,993	47.24	236	0.01
AF V	1,138,885	876,750	76.98	262,134	23.02	1	0.00
N PRONAF	25,733	23,653	91.92	2,080	8.08	0	0.00
Type of Farmer	**Existence of email**						
	Number	**Yes**	**%**	**No**	**%**	**Uninformed**	**%**
Total	**5,073,324**	**246,795**	**4.86**	**4,826,190**	**95.13**	**339**	**0.01**
ANF	1,175,916	142,595	12.13	1,033,259	87.87	62	0.01
AF	3,897,408	104,200	2.67	3,792,931	97.32	277	0.01
AF B	2,732,790	39,923	1.46	2,692,590	98.53	277	0.01
AF V	1,138,885	59,672	5.24	1,079,213	94.76	0	0.00
N PRONAF	25,733	4,605	17.90	21,128	82.10	0	0.00

Source: 2017 Agricultural Census (IBGE, 2019 – special tabulation). Authors' elaboration.

Regarding farming categories, AF establishments that have a telephone are less representative (60.09%) compared to ANF (72.53%). Group B has the lowest access rates (52.75%), revealing that this is yet another socio-technical deficiency in this segment of family farming. As to the use of e-mail by the farms, its presence is low throughout Brazilian agriculture, making up less than 5% of agricultural establishments. In ANF, the use of e-mail seems to be a bit more widespread, as 12.13% use the technology, compared to 2.67% in AF. Among AF groups, that of non-Pronafians uses this technology the most (17.90%) and AF's Group B uses it the least (1.46%).

Therefore, digitalization processes are clearly still incipient in Brazilian countryside. Access to ICTs is precarious and unevenly distributed among farmers. Although the situation affects all groups of producers, the problem is aggravated among the large group of disadvantaged households. These initial findings corroborate the results of research carried out in Brazil and other countries, which interpret this process of exclusion as one facet of the digital divide (Buainain; Cavalcante; Consoline, 2021; FAO, 2020; Kenney; Serhan; Trystram, 2020). Of course, the colors in this picture take on different intensities when considering the specificities of Brazilian regions.

ACCESS TO THE INTERNET AND ICTS IN AGRICULTURAL ESTABLISHMENTS IN BRAZILIAN REGIONS

Brazil's farmers are dispersed throughout the national territory. Table 4 shows that most of (46%) the more than 5.0 million Brazilian farms are located in the Northeast, followed by the Southeast and the South. The smallest contingents are registered in the Center-West and North. Looking at data based on the classification adopted in Figure 1, ANF appears as more representative in the regions with modernized agriculture, with emphasis on the center-western, southeastern and southern regions. Even so, the predominant segment in every region is that of AF, following the national trend.

It should be noted that the highest percentages of disadvantaged farmers (AF B) are located in the northeastern and northern regions. But they are also present in the agrarian structure of the other regions, what exposes the internal inequalities that characterize the national family farming sector (Aquino; Gazolla; Schneider, 2018). The AF V and N PRONAF groups, in turn, are more significant in the South and Southeast. This differentiation will also be manifested in regional digitalization indicators, as mentioned at the end of the previous subsection.

Table 4 | Distribution and relative participation of types of farmers in the agrarian structure of Brazilian regions - 2017

Type of Agriculture	North	%	Northeast	%	Southeast	%	South	%	C.-West	%
Non-Family (ANF)	100,038	17.23	483,873	20.83	280,470	28.93	187,547	21.98	123,988	35.70
Family (AF)	480,575	82.77	1,838,846	79.17	688,945	71.07	665,767	78.02	223,275	64.30
Group B (AF B)	319,575	55.04	1,640,708	70.64	401,723	41.44	254,157	29.78	116,627	33.58
Group V (AF V)	159,729	27.51	196,509	8.46	280,820	28.97	398,128	46.66	103,699	29.86
N PRONAF	1,271	0.22	1,629	0.07	6,402	0.66	13,482	1.58	2,949	0.85
TOTAL	580,613	100.0	2,322,719	100.0	969,415	100.0	853,314	100.0	347,263	100.0

Source: 2017 Agricultural Census (IBGE/SIDRA, 2019). Authors' elaboration.

In fact, it is possible to observe in Table 5 that the North out of the five regions of the country is the one most devoid of access to world wide web, since 84.31% of farms in this area lack access. PNAD data, organized by Cunha, Conceição and Schneider (2022), also demonstrate this reality, albeit with better indices, showing that internet access in rural households in the region is 38.4%. Between the two farming categories, AF is the one that most lacks access (85.96% of farms), with the worst situation being seen in the AF B group, whose absolute majority (88.63%) lacks access to the internet.

As regards to the type of internet access, mobile predominates, with 69.56%, ranking second nationally, in terms of the percentage of use of this type of connection (behind only the southeastern region), followed by broadband (33.92%). Mobile internet and broadband make up the highest percentage of access in both AF and ANF. Among AF groups, mobile internet is the type most accessed by Group B (78.12%) and broadband by N PRONAF and AF V, with Group B being the one that uses the latter type of connection least (23. 96%).

Table 5 | Internet access and type of connection of agricultural establishments, by type of farmer and family farming group, North region, 2017

Type of Farmer	Number	Internet access			
		Yes	%	No	%
Total	**580,613**	**91,080**	**15.69**	**489,533**	**84.31**
ANF	100,038	23,593	23.58	76,445	76.42
AF	480,575	67,487	14.04	413,088	85.96
AF B	319,575	36,328	11.37	283,247	88.63
AF V	159,729	30,753	19.25	128,976	80.75
N PRONAF	1,271	406	31.94	865	68.06

Type of Farmer	Type of internet access (*)						
	Internet access	Broadband	%	Dialed by line	%	Mobile	%
Total	**91,080**	**30,896**	**33.92**	**1,450**	**1.59**	**63,357**	**69.56**
ANF	23,593	9,188	38.94	374	1.59	15,562	65.96
AF	67,487	21,708	32.17	1,076	1.59	47,795	70.82
AF B	36,328	8,706	23.96	612	1.68	28,379	78.12
AF V	30,753	12,803	41.63	460	1.50	19,179	62.36
N PRONAF	406	199	49.01	4	0.99	237	58.37

Source: 2017 Agricultural Census (IBGE, 2019 – special tabulation). Authors' elaboration.

(*) The percentages of types of internet access are greater than 100% because a portion of respondents declared more than one type of access to the world wide web.

Next, Table 6 presents data on telephone and email access by category of farm in the northern region. Lack of access to the telephone appears as the highest among the five regions of the country, accounting for more than half of the farms (55.29%). The family farming category, generally, has the least access to telephone (57.86%), although, of the establishments that have this technology, AF N PRONAF is the one that access it most (70.50%). As regards the other AF groups, among those that lack access to a telephone, the AF B segment predominates (62.83%).

Regarding the existence of e-mail, only 2.05% of farms in the northern region reported using it, with ANF segment being the one that makes most use of this technology (6.53%). As for the AF groups, N PRONAF is the one that most uses email (9.52%) and the biggest exclusion is again in Group B, as less than 1.0% of this group of farmer make use of e-mail in their farms (0.69%).

Table 6 | Existence of telephone and email in agricultural establishments, by type of farmer and family farming group, North region, 2017

Type of Farmer	Number	Existence of telephone					
		Yes	%	No	%	Uninformed	%
Total	**580,613**	**259,558**	**44.70**	**321.014**	**55.29**	**41**	**0.01**
ANF	100,038	57,089	57.07	42,944	42.93	5	0.00
AF	480,575	202,469	42.13	278,070	57.86	36	0.01
AF B	319,575	118,763	37.16	200,777	62.83	35	0.01
AF V	159,729	82,810	51.84	76,918	48.16	1	0.00
N PRONAF	1,271	896	70.50	375	29.50	0	0.00
Type of Farmer	**Number**	**Existence of email**					
		Yes	%	No	%	Uninformed	%
Total	**580,613**	**11,924**	**2.05**	**568,638**	**97.94**	**51**	**0.01**
ANF	100,038	6,529	6.53	93,501	93.47	8	0.01
AF	480,575	5,395	1.12	475,137	98.87	43	0.01
AF B	319,575	2,209	0.69	317,323	99.30	43	0.01
AF V	159,729	3,065	1.92	156,664	98.08	0	0.00
N PRONAF	1,271	121	9.52	1,150	90.48	0	0.00

Source: 2017 Agricultural Census (IBGE, 2019 – special tabulation). Authors' elaboration.

Another region showing very precarious digitalization indicators is the Northeast. Indeed, data in Table 7 shows that this region is the second most excluded in terms of internet access, as 78.23% of its farms lacks a connection. In their research, Cunha, Conceição and Schneider (2022) found that 50.9% of rural households in the Northeast had access to the internet in 2019, a figure slightly higher than that of the Census, but, even so, the region still ranks as the second worst position regarding internet access nationally.

Furthermore, Table 7 also shows an aggravated situation in the case of family farming (AF), 80.18% of which lack access to the internet. As regards AF groups, Group B appears as the most excluded, with 81.30% of the farms lacking access to internet. Considering the type of connection and the universe of farmers, 61.92% out of them declared that they had mobile internet and 45.74% that they had broadband access. Among AF, the type of mobile connection exceeds 60%, with Group B using less broadband technology (44.26%) compared to other farmers.

Table 7 | Internet access and type of connection of agricultural establishments, by type of farmer and family farming group, Northeast region, 2017

Type of Farmer	Number	Internet access			
		Yes	%	No	%
Total	**2,322,719**	**505,726**	**21.77**	**1,816,993**	**78.23**
ANF	483,873	141,191	29.18	342,682	70.82
AF	1,838,846	364,535	19.82	1,474,311	80.18
AF B	1,640,708	306,894	18.70	1,333,814	81.30
AF V	196,509	56,977	28.99	139,532	71.01
N PRONAF	1,629	664	40.76	965	59.24

Type of Farmer	Type of internet access (*)						
	Internet access	Broadband	%	Dialed by line	%	Mobile	%
Total	**505,726**	**231,324**	**45.74**	**5,506**	**1.09**	**313,138**	**61.92**
ANF	141,191	68,308	48.38	1,583	1.12	85,871	60.82
AF	364,535	163,016	44.72	3,923	1.08	227,267	62.34
AF B	306,894	135,844	44.26	3,296	1.07	191,737	62.48
AF V	56,977	26,828	47.09	621	1.09	35,120	61.64
N PRONAF	664	344	51.81	6	0.90	410	61.75

Source: 2017 Agricultural Census (IBGE, 2019 – special tabulation). Authors' elaboration.

(*) The percentages of types of internet access are greater than 100% because a portion of respondents declared more than one type of access to the world wide web.

The existence of telephone lines in rural establishments in the Northeast is also quite limited. As illustrated in Table 8, the region is the second-to-last in access to telephone lines (48.11%), only better than the previously highlighted North region. Most of family farms do not have a telephone line (50.80%), with ANF group showing a relatively better level of access (62.11%). Considering AF groups access to telephone lines, group B is the one with the worst indicator (52.55 %) compared to its intermediate and capitalized peers (AF V and N PRONAF).

Regarding the use of e-mail, census data reveal that only 2.02% of farms in the northeastern region access it, with this percentage being slightly higher for the ANF category (5.40%). Within AF groups, N PRONAF is the one that uses this ICT the most (9.64%) and the disadvantaged farmers are those with the least access (0.87%).

Table 8 | Existence of telephone and email in agricultural establishments, by type of farmer and family farming group, Northeast region, 2017

Type of Farmer	Number	Existence of telephone					
		Yes	%	No	%	Not identified	%
Total	**2,322,719**	**1,205,246**	**51.89**	**1,117,418**	**48.11**	**55**	**0.00**
ANF	483,873	300,537	62.11	183,328	37.89	8	0.00
AF	1,838,846	904,709	49.20	934,090	50.80	47	0.00
AF B	1,640,708	778,491	47.45	862,170	52.55	47	0.00
AF V	196,509	124,990	63.61	71,519	36.39	0	0.00
N PRONAF	1,629	1,228	75.38	401	24.62	0	0.00
Type of Farmer	**Number**	**Existence of email**					
		Yes	%	No	%	Not identified	%
Total	**2,322,719**	**46,991**	**2.02**	**2,275,664**	**97.97**	**64**	**0.00**
ANF	483,873	26,151	5.40	457,713	94.59	9	0.00
AF	1,838,846	20,840	1.13	1,817,951	98.86	55	0.00
AF B	1,640,708	14,210	0.87	1,626,443	99.13	55	0.00
AF V	196,509	6,473	3.29	190,036	96.71	0	0.00
N PRONAF	1,629	157	9.64	1,472	90.36	0	0.00

Source: 2017 Agricultural Census (IBGE, 2019 – special tabulation). Authors' elaboration.

The Southeast presents a more favorable digitalization scenario than previous regions, even though it is far from universalization. Table 9 shows that, in this region, 63.05% of farms lack access to the internet, ranking fourth nationally in terms of lacking access. This percentage is much higher than that pointed by Cunha, Conceição and Schneider (2022), who found that 38.8% of rural households in Southeast are not connected to the internet. Lack of connection is greater among the AF category (65.75%), compared to ANF (56.42%). Within AF groups, in turn, farmers of group B are the least connected (29.10%) and the most connected are N PRONAF (52.20%) and AF V (41.22%).

In terms of types of internet access, the region ranks first in mobile use (77.74%), followed by broadband (34.80%). Considering the AF category, mobile internet (77.98%) and broadband (33.59%) are more widespread, with use of mobile network being predominant among the three groups. Broadband is more present in the N PRONAF segment (41.35%), involving farmers with higher income levels, what explains their ability to access wired internet, which provides greater data traffic, quality connection and has more expensive monthly bills for services provision by companies.

Table 9 | Internet access and type of connection of agricultural establishments, by type of farmer and family farming group, Southeast region, 2017

Type of Farmer	Number	Internet access			
		Yes	%	No	%
Total	**969,415**	**358,211**	**36.95**	**611,204**	**63.05**
ANF	280,470	122,223	43.58	158,247	56.42
AF	688,945	235,988	34.25	452,957	65.75
AF B	401,723	116,882	29.10	284,841	70.90
AF V	280,820	115,764	41.22	165,056	58.78
N PRONAF	6,402	3,342	52.20	3,060	47.80

Type of Farmer	Type of internet access (*)						
	Internet access	Broadband	%	Dialed by line	%	Mobile	%
Total	**358,211**	**124,665**	**34.80**	**4,392**	**1.23**	**278,490**	**77.74**
ANF	122,223	45,386	37.13	1,713	1.40	94,474	77.30
AF	235,988	79,279	33.59	2,679	1.14	184,016	77.98
AF B	116,882	33,911	29.01	1,373	1.17	94,253	80.64
AF V	115,764	43,986	38.00	1,253	1.08	87,265	75.38
N PRONAF	3,342	1,382	41.35	53	1.59	2,498	74.75

Source: 2017 Agricultural Census (IBGE, 2019 – special tabulation). Authors' elaboration.

(*) The percentages of types of internet access are greater than 100% because a portion of respondents declared more than one type of access to the world wide web.

Table 10 shows, complementarily, that telephone lines are a quite widespread technology in agriculture in the Southeast, as three quarters of the farms have it (75.49%), with the region ranking third in the use of this technology, behind South and Center-West. The access percentage for ANFs is 81.24%, compared to 73.14% for AFs. Among AF groups, telephone is most frequently available in AFs V and N PRONAF farms. Group B also records a significant access percentage (66.94%), although well below the average for the category in the region.

The use of e-mail, also highlighted in Table 10, occurs in only 8.77% of rural establishments in the Southeast, and the region ranks second nationally, only behind Center-West. The use of this means of digital communication is greater in the category ANF (18.52%) than in the AF (4.80%), although the AF group N PRONAF is the one that proportionally most declared using e-mail (19.87%). Exclusion related to the use of this technology is again evident in its very low presence in farms of AF B group (3.14%).

Table 10 | Existence of telephone and email in agricultural establishments, by type of farmer and family farming group, Southeast region, 2017

Type of Farmer	Number	Existence of telephone					
		Yes	%	No	%	Not identified	%
Total	**969,415**	**731,769**	**75.49**	**237,534**	**24.50**	**112**	**0.01**
ANF	280,470	227,855	81.24	52,591	18.75	24	0.01
AF	688,945	503,914	73.14	184,943	26.84	88	0.01
AF B	401,723	268,932	66.94	132,703	33.03	88	0.02
AF V	280,820	229,155	81.60	51,665	18.40	0	0.00
N PRONAF	6,402	5,827	91.02	575	8.98	0	0.00
Type of Farmer	**Number**	**Existence of email**					
		Yes	%	No	%	Not identified	%
Total	**969,415**	**85,016**	**8.77**	**884,263**	**91.22**	**136**	**0.01**
ANF	280,470	51,951	18.52	228,488	81.47	31	0.01
AF	688,945	33,065	4.80	655,775	95.19	105	0.02
AF B	401,723	12,618	3.14	389,000	96.83	105	0.03
AF V	280,820	19,175	6.83	261,645	93.17	0	0.00
N PRONAF	6,402	1,272	19.87	5,130	80.13	0	0.00

Source: 2017 Agricultural Census (IBGE, 2019 – special tabulation). Authors' elaboration.

For the South of the country, in turn, digital debt is lower in most indicators, although its existence is also observed. As shown in Table 11, the South region ranks first in terms of internet access for agricultural establishments (43.89%) and is well above the national average of 28.19%, as seen in the previous subsection. The 2019 PNAD data on rural households with internet access corroborates this position and is more encouraging, showing that 67.20% of them had access to the world wide web (Cunha; Conceição; Schneider, 2022). This access is greater among ANF (51.13%) and, especially, in the AF N PRONAF group (77.70%). However, 70.23% of the AF B group declared lacking access to the internet, a lack that also affected 51.64% of the AF intermediate segment.

Regarding the type of connection, southern rural establishments connect mainly via broadband (59.85%) and mobile (51.67%), being the only Brazilian region where the number of farms with broadband is greater than mobile connections, indicating that farmers have better access to higher speed and quality technology. This broadband connection is more frequent in family farms (60.71%) and, among them, in the N PRONAF group (81.60%).

Table 11 | Internet access and type of connection of agricultural establishments, by type of farmer and family farming group, South region, 2017

Type of Farmer	Number	Internet access			
		Yes	%	No	%
Total	**853,314**	**374,555**	**43.89**	**478,759**	**56.11**
ANF	187,547	95,886	51.13	91,661	48.87
AF	665,767	278,669	41.86	387,098	58.14
AF B	254,157	75,655	29.77	178,502	70.23
AF V	398,128	192,539	48.36	205,589	51.64
N PRONAF	13,482	10,475	77.70	3,007	22.30

Type of Farmer	Type of internet access (*)						
	Internet access	Broadband	%	Dialed by line	%	Mobile	%
Total	**374,555**	**224,154**	**59.85**	**6,709**	**1.79**	**193,547**	**51.67**
ANF	95,886	54,966	57.32	1,622	1.69	53,730	56.04
AF	278,669	169,188	60.71	5,087	1.83	139,817	50.17
AF B	75,655	36,161	47.80	1,369	1.81	46,300	61.20
AF V	192,539	124,479	64.65	3,519	1.83	89,564	46.52
N PRONAF	10,475	8,548	81.60	199	1.90	3,953	37.74

Source: 2017 Agricultural Census (IBGE, 2019 – special tabulation). Authors' elaboration.

(*) The percentages of types of internet access are greater than 100% because a portion of respondents declared more than one type of access to the world wide web.

From Table 12, we observe that the South region also comes first in terms of telephone use, accounting for 84.80% of farms and being above the national average of 62.98%. Its use is higher in AF V (89.18%) and in N PRONAF group (96.87%), in which access is nearly universal. The same level of access is not observed regarding e-mail use, as only 8.43% of surveyed southern farms use the technology in the region, which ranks third at the national level in use behind the Center-West and Southeast. In the context of AF, this lack is even greater, given that 94.62% of farmers do not use an email, with groups B and V recording the highest percentages of non-use of email.

Table 12 | Existence of telephone and email in agricultural establishments, by type of farmer and family farming group, South region, 2017

Type of Farmer	Number	Existence of telephone					
		Yes	%	No	%	Not identified	%
Total	**853,314**	**723,612**	**84.80**	**129,687**	**15.20**	**15**	**0.00**
ANF	187,547	164,091	87.49	23,456	12.51	0	0.00
AF	665,767	559,521	84.04	106,231	15.96	15	0.00
AF B	254,157	191,428	75.32	62,714	24.68	15	0.01
AF V	398,128	355,033	89.18	43,095	10.82	0	0.00
N PRONAF	13,482	13,060	96.87	422	3.13	0	0.00
Type of Farmer	**Number**	**Existence of email**					
		Yes	%	No	%	Not identified	%
Total	**853,314**	**71,931**	**8.43**	**781,366**	**91.57**	**17**	**0.00**
ANF	187,547	36,104	19.25	151,443	80.75	0	0.00
AF	665,767	35,827	5.38	629,923	94.62	17	0.00
AF B	254,157	7,786	3.06	246,354	96.93	17	0.01
AF V	398,128	25,545	6.42	372,583	93.58	0	0.00
N PRONAF	13,482	2,496	18.51	10,986	81.49	0	0.00

Source: 2017 Agricultural Census (IBGE, 2019 – special tabulation). Authors' elaboration.

In the case of the Center-West, the last of the large Brazilian regions analyzed here, we observe that the degree of digitalization is below that of the Southeast and South regions. Table 13 shows that this region ranks third in terms of farms access to internet, although 71.04% of them lack a connection. The research by Cunha, Conceição and Schneider (2022) also places Center-West in the same position, though with more encouraging connection data: 62.1% of rural households had internet in 2019. The situation is more critical for AF, in which 75.01% of the farms are disconnected. Regarding AF groups, the highest connection rate occurs in N PRONAF (45.41%) and the lowest access rate in group B, reaching only 20.98% of the farms in AF category.

As to the type of connection, establishments in the Center-West use mainly mobile connections (60.50%), followed by broadband (48.45%). In both farming categories this balance between connection data is also evident, with mobile internet being slightly more used by AF (64.58%). Within AF groups, N PRONAF stands out with the greatest access to broadband internet (55.27%), group V comes in second place and group B has the lowest access rate to this type of connection (36.21%).

Table 13 | Internet access and type of connection of agricultural establishments, by type of farmer and family farming group, Center-West region, 2017

Type of Farmer	Number	Internet access			
		Yes	%	No	%
Total	**347,263**	**100,584**	**28.96**	**246,679**	**71.04**
ANF	123,988	44,778	36.11	79,210	63.89
AF	223,275	55,806	24.99	167,469	75.01
AF B	116,627	24,465	20.98	92,162	79.02
AF V	103,699	30,002	28.93	73,697	71.07
N PRONAF	2,949	1,339	45.41	1,610	54.59

Type of Farmer	Internet access	Type of internet access (*)					
		Broadband	%	Dialed by line	%	Mobile	%
Total	**100,584**	**48,728**	**48.45**	**1,475**	**1.47**	**60,849**	**60.50**
ANF	44,778	24,450	54.60	759	1.70	24,807	55.40
AF	55,806	24,278	43.50	716	1.28	36,042	64.58
AF B	24,465	8,858	36.21	356	1.46	17,352	70.93
AF V	30,002	14,680	48.93	343	1.14	17,950	59.83
N PRONAF	1,339	740	55.27	17	1.27	740	55.27

Source: 2017 Agricultural Census (IBGE, 2019 – special tabulation). Authors' elaboration.

(*) The percentages of types of internet access are greater than 100% because a portion of respondents declared more than one type of access to the world wide web.

Table 14 complements Center-West region data regarding the existence of telephone line and e-mail in rural establishments. Generally, the region has the third best position in terms of telephone usage and is above the national average with 79.10% of farms. Its use is more widespread among ANFs (83.34%) and less frequent in family farming (76.74%). Among AF groups, the percentage of telephone availability is greater than 80% in intermediate and capitalized farms, reaching 71.98% in the group of disadvantaged farmers.

The use of e-mail in Center-West (8.91%) is higher than in the North and Northeast regions (which have around 2%) and closer to the Southeast and South regions (around 9%), although usage data is still low. Among the studied categories, AF uses this technology less and 95.91% of the farms do not have it, a situation common to the three AF groups, which reveals the weakness of this indicator within the category.

Table 14 | Existence of telephone and email in agricultural establishments, by type of farmer and family farming group, Center-West region, 2017

Type of Farmer	Number	Existence of telephone					
		Yes	%	No	%	Not identified	%
Total	**347,263**	**274,677**	**79.10**	**72,526**	**20.89**	**60**	**0.02**
ANF	123,988	103,326	83.34	20,653	16.66	9	0.01
AF	223,275	171,351	76.74	51,873	23.23	51	0.02
AF B	116,627	83,947	71.98	32,629	27.98	51	0.04
AF V	103,699	84,762	81.74	18,937	18.26	0	0.00
N PRONAF	2,949	2,642	89.59	307	10.41	0	0.00
Type of Farmer	**Number**	**Existence of email**					
		Yes	%	No	%	Not identified	%
Total	**347,263**	**30,933**	**8.91**	**316,259**	**91.07**	**71**	**0.02**
ANF	123,988	21,860	17.63	102,114	82.36	14	0.01
AF	223,275	9,073	4.06	214,145	95.91	57	0.03
AF B	116,627	3,100	2.66	113,470	97.29	57	0.05
AF V	103,699	5,414	5.22	98,285	94.78	0	0.00
N PRONAF	2,949	559	18.96	2,390	81.04	0	0.00

Source: 2017 Agricultural Census (IBGE, 2019 – special tabulation). Authors' elaboration.

In short, the unpublished data from the 'special tabulations' of the 2017 Agricultural Census exposes a heavy digital debt in the Brazilian countryside. Such debt affects the country as a whole and more strongly the North and Northeast regions. Its biggest victims are the huge contingent of family farmers, especially those pertaining to Group B of PRONAF. Such farmers, who already have their freedoms hampered by 'multiple shortages of assets', are also transformed into what can be called the 'digital excluded'. We may ask: Why does this happen in Brazilian agriculture? What opportunities and obstacles does this process of exclusion generate for farmers and their capabilities to trigger sustainable and inclusive rural development processes? This is what we will try to answer next.

DETERMINANTS AND LOCKDOWNS FOR BUILDING SUSTAINABLE AND INCLUSIVE RURAL DEVELOPMENT PROCESSES

Regarding the first question put at the end of the previous section, about 'why' there is a digital debt with such serious unequal impacts on Brazilian countryside, specialized literature has provided some explanations. For example, Cunha, Conceição and Schneider (2022), using data from PNAD, pointed out that a determining reason for lacking access to the internet is associated with high costs of services in Brazil, given that 25.3% of respondents in their research mentioned it as the main limiting factor. Added to this is the lack of interest by farmers themselves (24.1%) and the low 'digital literacy', something that happens when none of the residents in the household have knowledge of using the internet (21.4% of respondents). The authors also draw attention to a determinant related to lack of availability of internet services in rural households (19.2%), while in urban areas this was the last reason pointed, with only 0.6% of responses.

Another survey carried out in Brazil, 'TIC Domicílios' (ICT Households) of 2021 (Silva, 2022), reveals that low internet access is greater in lower income households, with access in social classes D and E being only 66% of households, while in class B it is 93% and in class A it reaches 98%. Still according to the same survey, education level appears to be a structural factor for internet access, since in households whose members only attended primary school, internet access is 71%. In households where families have higher schooling, internet access rates are 91% for secondary education and 94% for higher education. These two findings from 'TIC Domicílios' coincide with census data on disadvantaged family farmers (AF B), who show the lowest levels of both income and formal education, what reflects in the most weak digitalization indicators (Aquino *et al*., *2014*; Aquino; Gazolla; Schneider, 2016, 2018).

The cited survey also points out that, in terms of connection devices, cell phones prevail in households (99%), followed by TV (50%) and, finally, computer (36%), suggesting a certain inadequacy of the devices used for internet access, as computer is the most suitable equipment for work and management operations and for access to diverse platforms (Silva, 2022). Furthermore, Pereira and Castro (2022), studying technological inequality, based on aggregated data from the 2017 Agricultural Census (SIDRA Table 6962), highlight that near 14% of Brazilian rural establishments

do not have electricity, an essential rural infrastructure to connect electronic equipment such as computers, to charge cell phone batteries and access the internet.

Buainain, Cavalcante and Consoline (2021) complement these determinants for the low diffusion of digitalization technologies in the countryside, stating that farmers lack both monetary resources to afford the appropriate equipment for connection and knowledge about the most appropriate connection technologies. Such problems are aggravated by the lack of technical support and guidance on the use of ICTs and of access to subsidized credit lines to acquire the technologies. Furthermore, the authors mention that, to a lesser extent, the use of digital technologies is hampered because: few technologies are available for application in production; evidence on the economic benefits of digitalization in terms of financial return is lacking; information about internet providers is scarce; cost-benefit ratio of technologies is high; and farms present physical and size limitations for applying such technologies.

As for the second question raised at the end of the previous section, on the hindrances caused by digital debt and the exclusion resulting from it, the empirical evidence available in the literature is varied. It is possible to say, however, that digital divide is limiting for farmers in at least five aspects. The first limiting aspect regards farmer's need, especially after the Covid-19 pandemic, for building digital food markets for their products in addition to the physical markets they already access. To do so, they need to be able to issue invoices, make contact with suppliers, buyers and consumers, operate platforms, websites and social networks to offer their products, carry out advertising and marketing with their customers, communicate to consumers the food qualification attributes of the products, act in a cooperative manner, besides other operations that are necessary for the 'social construction of digital markets' (Cunha, 2022; Gazolla; Aquino, 2021; Niederle *et al* ., 2021).

The second limiting aspect caused by digital exclusion is related to the accessibility to productive, human, technical and administrative knowledge. This is because there are several platforms and websites that aggregate diverse knowledge and areas of knowledge, which could be accessed by farmers to seek the information they need in their production and management systems. Young people at university or technical schools who take online classes or distance learning courses (EaD) are also disadvantaged, often having to travel to urban areas to be able to follow classes without

a drop in connection or loss of internet signal. Furthermore, the very proposal for technical assistance and digital rural extension (ATER) in Brazil is hampered if no quality internet is available in rural areas so that technicians and extensionists can communicate and exchange knowledge and information with farmers (CEPAL, 2020; IFAD, 2021).

In this sense, the research carried out by Cunha (2022) among family farmers from the Rede Xique-Xique de Comercialização Solidária (a collective marketing network) in the northeastern state of Rio Grande do Norte confirms the statements above that ICTs help to aggregate various types of knowledge. In her research, the author found that 56.7% of farmers use ICTs to seek knowledge from EMATER technicians; 60% of them research products and food prices; 63.3% talk to other farmers, exchanging experiences and answering questions and 73.3% participate in training meetings or social organizations in which they participate/are members. All this movement is absent in the lives of the 'digitally excluded'.

The third aspect concerns the technological development of farms, which is hindered without internet access. This is the case of applications for monitoring the characteristics of livestock and crops; monitoring energy generation on solar panels; banking and financial services apps that would allow online transactions without the need to travel to urban spaces; use of drones to monitor specific production parameters; access to websites for rain and temperature forecasts; implementation of solutions based on the internet of things, in which several electronic devices could be controlled by cell phone, but from a stable connection; precision agriculture techniques; systems for the traceability of products and foods and the use of satellite images. In brief, all current technological developments, what has been called 'agriculture 4.0', are practically inaccessible to farmers without the internet or with low-quality internet in rural areas (FAO, 2021; Pereira; Castro, 2022).

The fourth aspect regards the observation that the lack of internet access limits reaching some of the sustainable development principles that take farmers and new digital technologies as partners. Digital technologies can be used to map animal welfare; in providing online ecosystem services tracked by drones; in imparting information on specific natural resources and places with ecological beauty that could be activated assets, for example, for tourism and leisure activities, 'consumption' of photos, online landscapes, etc.; use of real time risk management and environmental accident prevention

apps; marketing and advertising of sustainable production farms, that carry out organic agriculture and preserve environmental resources, among other purposes. Therefore, the lack of rural digitalization delays the achievement of the SDGs and the construction of healthier food systems (INFOAM, 2020; Rolandi *et al*., 2021; UNDP, 2022).

The fifth and final aspect, perhaps the most important, is that lacking access to the internet can compromise the viability of generational succession processes in production units, especially in the context of AF. In fact, although there are several explanatory factors, evidence from many studies shows that young farmers will only remain in the countryside if they have access to digitalization processes aimed at making their production systems viable in a more innovative and technological way. But the issue of digitalization goes beyond the productive aspect, it is also essential for young people to be able to: communicate with family and friends; access content and social networks; interact in culture and leisure groups; get closer to subjects, people and content in urban centers; purchase necessary consumer goods through e-commerce, among other opportunities that the internet would allow them (Kenney; Serhan; Trystram, 2020; Zanrosso, 2022).

Given the described scenario, there is an urgent need for intervention by the Brazilian State, at various levels, in order to create public policies that combat the determinants and hindrances caused by the digital debt that affects the majority of farmers in the country at the dawn of the 21st century, as indicated by the census data presented in the previous section. State intervention is strategic especially in encouraging the expansion of provision and access to quality internet services in rural areas, at prices affordable for farmers (FAO, 2021; Favareto *et al*., 2021; Pauschinger; Klauser, 2022). In this sense, there are already examples of cities that have extended wired broadband internet to rural spaces, by means of partnerships signed between city halls and so-called 'local innovation ecosystems', which involve federal universities, private internet companies, science and technology and agriculture municipal departments, etc. These are the cases of Pato Branco/PR and Antônio Prado/RS, just to name two, in which the interaction between public and private sectors managed to bring internet and telecommunications infrastructure to families. In Europe, there is also the participation of cooperatives in digitalization processes as a collaborative way of making it viable in rural spaces (Cristobal-Fransi *et al*., 2020).

In fact, the State also has other roles to play, such as universalizing access to electricity in the countryside, promoting the training of farmers to use the internet – the so-called digital literacy –, subsidizing the acquisition of technology and information equipment, among other actions (Ehlers; Huber; Finger, 2021). Finally, it is essential to expand the scope of productive and digital inclusion policies aiming to raise the socioeconomic status of family farmers, especially their most disadvantaged segment (AF B), since digital exclusion is just one further need of this group, which adds to many others they already face and which literature has documented (Aquino *et al*., 2014; Aquino; Gazolla; Schneider, 2016, 2018).

The public policies and actions proposed above are similar to those recommended by the ECLAC reports (2021) for the future of digitalization and for paying off the existing digital debt in the Brazilian countryside, on five fronts: a) development of content or platforms that allow for data exchange and dissemination; b) digital literacy and training; c) telecommunications infrastructure and coverage; d) creation of platforms and applications aiming to provide greater opportunities for farmers; and e) access to devices and equipment for connection. Whether the Brazilian State will follow these recommendations and pay off its digital debt is something to be assessed in the coming years. In any case, tackling the heavy existing digital debt is urgent, since its perpetuation could further deepen digital exclusion and socioeconomic and regional inequalities in the national territory.

FINAL CONSIDERATIONS

The objective of this article was to analyze digitalization within the two categories of Brazilian farming (family farming - AF and non-family farming - ANF), in different regions of the country and for different groups of producers, in order to disclose the huge digital debt that still persists in the sector at the dawn of the 21st century, its determinants and consequences. The analyzes were anchored in the review of part of recent literature on the topic and in unpublished data from 'special tabulation' of data from the 2017 Agricultural Census focused on digitalization indicators.

The paper showed that the internet is not present in more than 70% of agricultural establishments. Non-family farming is better served in terms of connectivity than family farming. The large Group B of family farmers, called disadvantaged farmers, is the most excluded, as almost 80% of

them lacked access to the internet in 2017. Such data confirm what has been called digital exclusion in the countryside, referred to in international literature as the 'digital divide', a term used to represent the unequal digitalization process that has deserted farmers and families in the countryside.

Regarding the five Brazilian macro-regions, it was observed that the North and Northeast are those where digitalization is most precarious, while the South has more consistent data on internet and ICT uses (telephone and e-mail). However, even in regions that concentrate more capitalized agriculture, digitalization is still below adequate levels that would allow farmers to build full freedoms and opportunities to carry out various productive, human, technological and administrative activities.

Throughout this text, several determinants for the picture portrayed based on census statistics were also listed. Furthermore, it became clear that the digital exclusion that affects most Brazilian farmers generates multiple negative consequences and obstacles to promoting more inclusive and sustainable processes of rural development.

Therefore, the heavy digital debt that plagues national agriculture, especially the family farming segment, needs to be urgently addressed. To achieve this, it is necessary for the State, at various territorial levels, to act through partnerships with the private sector and with local and regional innovation ecosystems to promote actions and public policies that support rural digitalization processes. In the meantime, in the case of the large contingent of disadvantaged family farmers, the multiple historical productive deficiencies that plague this social group must also be removed, along with the technological vulnerabilities revealed by the data from the 'special tabulations', in order to reduce socio-spatial inequalities in the countryside.

ACKNOWLEDGEMENTS

The authors would like to thank Antônio Carlos Simões Florido and the IBGE team for preparing and making available the 'special tabulations' from the 2017 Agricultural Census, which were essential for carrying out this study. Likewise, we thank CNPq for the financial support and resources made available for the research. Errors and omissions that may exist in the content presented are entirely our responsibility.

REFERENCES

ABRAMOVAY, R. Desenvolvimento sustentável: qual a estratégia para o Brasil? **Novos Estudos CEBRAP**. São Paulo, 87, p. 97-113, 2010.

AQUINO, J. R. *et al*. Dimensão e características do público potencial do Grupo B do Pronaf na Região Nordeste e no estado de Minas Gerais. In: SCHNEIDER, S.; FERREIRA, B.; ALVES, F. (Eds.). **Aspectos multidimensionais da agricultura brasileira**: diferentes visões do Censo Agropecuário 2006. Brasília: IPEA, 2014. p. 77-106.

AQUINO, J. R.; GAZOLLA, M.; SCHNEIDER, S. Dualismo no campo e desigualdades internas na agricultura familiar brasileira. **Revista de Economia e Sociologia Rural**. Piracicaba, v. 56, n. 1, p. 123-142, 2018.

AQUINO, J. R.; GAZOLLA, M.; SCHNEIDER, S. Um retrato do lago pobre da agricultura familiar no estado do Rio Grande do Sul. **Redes: Revista do Desenvolvimento Regional**. Santa Cruz do Sul-RS, v. 21, n. 3, p. 66-92, 2016.

BOS, E.; OWEN, L. Virtual reconnection: the online spaces of alternative food networks in England. **Journal of Rural Studies**. 45, p. 1-14, 2016.

BUAINAIN, A. M.; CAVALCANTE, P.; CONSOLINE, L. Brasil. In: SOTOMAYOR, O.; RAMIREZ, E.; MARTÍNEZ, H. (Coords.). **Digitalización y cambio tecnológico en las mipymes agrícolas y agroindustriales en América Latina.** Santiago: CEPAL, 2021. p. 49-88.

CEPAL. **Sistemas alimentarios y Covid-19 en América Latina y el Caribe**: digitalización de la agricultura para la transformación inclusiva de sociedades rurales. Boletín, n° 18, Santiago, FAO, 6 May 2021.

CEPAL. **Universalizar el acceso a las tecnologías digitales para enfrentar los efectos del COVID-19**. Informe especial Covid-19. n. 7, 2020.

CRISTOBAL-FRANZI, E.; MONTEGUT-SALLA, Y.; FERRER-ROSELL, B.; DARIES, N. Rural cooperatives in the digital age: An analysis of the Internet presence and degree of maturity of agri-food cooperatives' e-commerce. **Journal of Rural Studies**. 74, p. 55-66, 2020.

CUNHA, J. I. **Usos das Tecnologias de Informação de Comunicação (TICs) nos circuitos curtos de comercialização de agricultores familiares**: o caso da Rede Xique-Xique de Comercialização Solidária no Rio Grande do Norte. 2022. 246f. Disseration (Doctorate in Sociology). Universidade Federal do Rio Grande do Sul, Porto Alegre. 2022.

CUNHA, J. I.; CONCEIÇÃO, A.; SCHNEIDER, S. Conectados? Uma análise a partir da PNAD 2019. **Anais...** [Proceedings] 60º Congresso da Sociedade Brasileira de Economia, Sociologia e Administração Rural. Natal/RN, 2022.

DEL GROSSI, M. **Algoritmo para delimitação da agricultura familiar no Censo Agropecuário 2017, visando à inclusão de variável no banco de dados do censo, disponível para ampla consulta**. Brasília: FAO/SAF-MAPA/Finatec, 2019.

DEPONTI, C.; KIRST, R. B.; MACHADO, A. As inter-relações entre as TICs e a agricultura familiar. **Revista Eletrônica Competências Digitais para Agricultura Familiar**. [S.l.], 3 (1), p. 4-23, 2017.

EHLERS, Melf-Hinrich; HUBER, R.; FINGER, R. Agricultural policy in the era of digitalization. **Food Policy**. v. 100, p. 1-14, 2021.

FIDA. **Conectividade rural e inclusão digital como estratégias para a democratização da ATER**: oportunidades para o Brasil e Peru. FIDA e Grupo de Política Públicas (GPP/USP/ESALQ). Piracicaba/SP. 2021.

FAO. **The Outlook for Agriculture and Rural Development in the Americas**: a perspective on Latin America and the Caribbean 2021-2022. San Jose, C.R.: IICA. ECLAC, FAO, IICA, 2021.

FAO. The State of Agricultural Commodity Markets 2020. **Agricultural markets and sustainable development**: global value chains, smallholder farmers and digital innovations. Rome, FAO. 2020.

FAVARETO, A. *et al*. **Relatório de inclusão produtiva no Brasil rural e interiorano 2022**. São Paulo: CEBRAP, 2021.

GAZOLLA, M.; AQUINO, J. R. Reinvenção dos mercados da agricultura familiar no Brasil: a novidade dos sites e plataformas digitais de comercialização em tempos de Covid-19. **Estudos Sociedade e Agricultura**. Rio de Janeiro, v. 29, n. 2, p.427-460, jun. 2021.

IBGE. **Censo Agropecuário 2017**: existência de telefone e e-mail, acesso à internet e tipo de conexão à internet, segundo agricultura familiar e Pronafs no Brasil, regiões e UFs. Rio de Janeiro: IBGE, 2019. (Special Tabulation).

IBGE/SIDRA. **Censo Agropecuário 2017**: resultados definitivos. Rio de Janeiro: IBGE, 2019. Available at: <https://sidra.ibge.gov.br/pesquisa/censo-agropecuario/censo-agropecuario-2017>. Consulted on: 20 Jan. 2020.

IICA. **La digitalización de la agricultura como determinante para la transformación de los sistemas alimentarios**: una perspectiva desde las Américas. San José, Costa Rica: IICA, 2021.

INFOAM. **Agreoecology & digitalization**: traps and opportunities to transform the food system. Brussels: Belgium, 2020.

KENNEY, M.; SERHAN, H.; TRYSTRAM, G. **Digitalization and Platforms in Agriculture**: organizations, power asymmetry, and collective action solutions. Berkley Roundtable on the International Economy. BRIE Working Paper 2020-4, 2020.

MASSRUHÁ, S. M. F. S.; LEITE, M. A. A. Agricultura digital. **Revista Eletrônica Competências Digitais para Agricultura Familiar**. 2 (1), p. 72-88, 2016.

NIEDERLE, P. A. *et al*. Inclusão produtiva por meio de mercados alimentares digitais: desafios para a construção de estratégias cooperativas solidárias. In: NIEDERLE, P. A.; SCHNEIDER, S.; CASSOL, A. (Orgs.). **Mercados alimentares digitais: inclusão produtiva, cooperativismo e políticas públicas.** Porto Alegre: Editora da UFRGS. 2021. p. 25-66.

OECD. **Digital opportunities for trade in agriculture and food sectors**. OECD, 2019. Available at: <https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=TAD/TC/CA/WP(2018)4/FINAL&docLanguage=En>. Consulted on: 15 Feb. 2021.

PAUSCHINGER, D.; KLAUSER, F. The introduction of digital technologies into agriculture: space, materiality and the public–private interacting forms of authority and expertise. **Journal of Rural Studies**. v. 91, p. 217-227, 2022.

PEREIRA. C. N.; CASTRO, C. N. **Expansão da produção agrícola, novas tecnologias de produção, aumento de produtividade e o desnível tecnológico no meio rural**. Rio de Janeiro: IPEA. 2022. (Discussion Text nº 2765).

REARDON, T.; SWINNEN, J. **COVID-19 and resilience innovations in food supply chains**. IFPRI: International Food Policy Research Institute. Washington, July 2020. Available at: <https://www.ifpri.org/blog/covid-19-and-resilience-innovations-food-supply-chains>. Consulted on: 15 Sep. 2020.

ROLANDI, S.; BRUNORI, G.; BACCO, M.; SCOTTI, I. The digitalization of agriculture and rural areas: towards a taxonomy of the impacts. Sustainability. 13, 5172, 2021.

SACHS, I. Caminhos para o desenvolvimento sustentável. Rio de Janeiro: Garamond, 2011.

SEN, A. Development as freedom. New York: Anchor Books, 2000.

SILVA, V. H. Quatro em cada cinco usuários de internet na área rural se conectam apenas pelo celular, diz pesquisa. Portal G1. 2022. Available at: https://www.google.com/h?client=safari&rls=en&q=Quatro+em+cada+cinco+usua%CC%81rios+de+internet+na+a%CC%81rea+rural+se+conectam+apenas+pelo+celular%2C+diz+pesquisa&ie=UTF-8&oe=UTF-8. Consulted on: 12 July. 2022.

SOTOMAYOR, O.; RAMIREZ, E.; MARTÍNEZ, H. (Coords.). **Digitalización y cambio tecnológico en las mipymes agrícolas y agroindustriales en América Latina**. Santiago: CEPAL, 2021.

TORERO, M. **Farmers, markets, and the power of connectivity**. Washington DC: International Food Policy Research Institute, 2013.

UNDP. **United Nations Development Programme**. 2022. Available at: <https://www.undp.org/>. Consulted on: 15 July. 2022.

ZANROSSO, P. Internet de alta velocidade muda rotina de moradores de áreas rurais de Antônio Prado. **Jornal Pioneiro**. 2022. Available at: https://www.google.com/search?client=safari&rls=en&q=Internet+de+alta+velocidade+muda+rotina+de+moradores+de+a%CC%81reas+rurais+de+Anto%CC%82nio+Prado&ie=UTF-8&oe=UTF-8>. Consulted on: 16 Aug. 2022.

WORLD BANK. **World development report 2016**: digital dividends. Washington: World Bank, 2016.