Challenges in integrating digital agriculture solutions

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Abstract

The economy digital transformation started, mainly from the beginning of the XXI century, a new era in which data has become a highly valuable input, giving rise to disruptive technologies that are changing the way business chains operate. As one of the main food, fiber and agriculture-based energy world providers, Brazil is already taking advantage of this movement, and Brazilian AgTechs are expected to help changing its productive model toward a more digital and efficient direction, event considering that digital agricultural solutions still face relevant challenges that goes from financial costs for farmers to adopt their solutions to operational barriers to adopt different solutions to digitalize several steps of the agricultural life cycle. The objective of this study was to describe the Brazilian AgTechs ecosystem operating under an integrative technological context that provides solutions for distinct steps or features of the agricultural cycle. This study explored the Radar AgTech 2024 database, selecting, from the set of 1,969 AgTechs, 195 of them classified as on-farm companies classified as (i) platforms for systems, solutions and data integration; (ii) farm management systems providers; and (iii) telemetry and automation providers. By segmenting the agricultural life cycle in 10 steps or features, it was assessed, through information extracted from AgTechs' websites, the information Score (IS) that account for the degree of complexity of their solutions considering the number of features they can attend and assessed it using frequency analysis and similarity binary comparison. The findings showed a positive correlation between Gross Domestic Product (GDP) and the number of higher-level teaching institutions with the number of integrative AgTechs (80% and 75%, respectively). São Paulo state (with 28), and the southeast region as well (with 38), concentrate most AgTechs with an integrative profile. From the set of agricultural steps and features covered by them, their frequency in the referred solutions resides individually between ~10% and ~55%. Beyond that, the joint set of features covered by each AgTech showed a median (50%) IS of 3 (out of 10), *reaching 5 at 75% percentile. A coupled comparison of similarities also floated between a minimum of 8% (between financial management solutions and water and irrigation management solutions) and a maximum of 45% (between financial management solutions and crop cycle planning solutions). In summary, In Brazil, wealthier regions and those having more higher-educational institutions concentrate most integrative AgTechs. In terms of solutions complexity, wealthier states with a higher number of higher-level teaching institutions tend to have AgTechs which could attend more steps and features of the agricultural life cycle. The technological focus of Brazilian integrative AgTechs concentrates on financial management and monitoring, while water management and irrigation figures as the least addressed one. Nonetheless, the integrative context is still sub explored and heterogenous, an average similarity of 26%. Thus, users still need to seek for similar companies and compare if the set of features covered by their solutions can attend the technological demand.*

Keywords.
smart farming, agricultural cycle steps, digitalization, decision support system

Introduction

Since the beginning of the century, and mainly during last decade, the economy digital transformation has been boosted worldwide in all sectors, starting a new era in which data has become a highly valuable input. Such transformation has given rise to disruptive technologies that are changing the way business chains operate, enabling even small teams to compete with big corporations in the running for technological advances. In the so called Agriculture 4.0 era, its development is ruled by interrelated drivers spread over technological, political and social pillars, and the rate of success of emerging technologies are as high as the attainment of these factors, mainly the existence of rural connectivity, rural youth participation, government pressures for innovation, information disclosure mechanisms to inform about such technologies and ecosystem representativeness for the democratization of this movement (Silveira et al., 2026).

The Brazilian agribusiness is also under the digital transformation, what is expected to be a relevant improvement to maintain the country as one of the main food, fiber and agriculture-based energy world providers. To reach this objective, the Brazilian AgTechs have the mission of helping to change its productive model from a conventional and analogic reality toward a more digitalized, efficient and sustainable direction. However, to establish their business plan and develop feasible solutions, they frequently face challenges related to fulfilling regulatory issues, access to financing and infrastructure and finding skilled human resources (Sakuda et al., 2025; Silveira et al., 2025). Such issues pressure their development model and force them to focus on developing very specific and focused solutions (Tyrychtr and Vostrovsky, 2017), although the agricultural cycle is formed by several steps and features that, without being adequately covered by digital solutions, could result, on the one hand, in a lower cost-benefit perception by farmers when adopting single but very specific solutions. On the other hand, the adoption of several solutions could lead (i) to financial costs increase to access a set of technologies able to digitalize some or all the agricultural cycle steps and features or; (ii) to operational barriers reasoned by the lack of integration between solutions that, summed up with farmers low digital literacy, would likely to prevent them from extracting benefit in favor of their operation (Silveira et al., 2025).

The patents registration can be a proxy for understanding trends in AgTechs development. In the United States (US), that is still a relevant innovation pole, the patents registration shows that information systems, which include organized systems of interrelated components, which is more related to information integration, are present in only 0.27% of recently registered patents, whereas automation, control and robotics related patents, responsible for specific tasks, are responsible for 7.9% of them, and the representativeness difference between these kinds of application can be assumed as both a trend for new solutions but also an insight for unexplored potential (Cano et al., 2025).

From the exposed contextualization, the objective of this study was to describe the Brazilian AgTechs ecosystem operating under an integrative technological context that provides solutions for distinct steps or features of the agricultural cycle.

Methodology

The analysis employed the Radar AgTech 2024 survey database (Sakuda et al., 2025) as the primary source of information about the Brazilian existing AgTechs. Built following a methodology for data collection, curation, classification and comparison to previous versions, this publication is an effort to map the agribusiness startups ecosystem and brings several segmentations regarding their organization along the Brazilian territory. For example, there are subsets of startups acting before-farm, on-farm and post-farm, by location, by kind of investment, social criteria (e.g., its members gender) and so on.

The analysis began by subsetting, from the complete set of 1,969 AgTechs, 195 classified as on-farm (i) platforms for systems, solutions and data integration; (ii) farm management systems providers; and (iii) telemetry and automation providers. This classification is already determined and was adopted due to their potential to subsidize decisions using data from several sources, thus acting as an integration proxy. By focusing exclusively on agriculture, this study intended to complement with a new segmentation by assessing a set of crop cycle features or steps that AgTechs solutions can handle. Thus, the scope of the assumed crop cycle features comprises:

- Crop cycle planning (CCP): Technologies that support decision before soil preparation or planting to improve system efficiency in subsequent steps.
- Soil preparation, planting and mechanization (SPM): Technologies for soil preparation and planting (or sowing), merged with mechanized process often adopted in such steps.
- Water management and irrigation (WMI): Technologies to improve designing, implementation or operation of irrigation systems.
- Soil fertility management (SFM): Technologies responsible for increasing soil nutrition efficiency, as is the case for precision agriculture solutions.
- Phytosanitary management (PSM): Solutions to improve disease and pest control using digital technologies.
- Harvesting (HAR): Solutions to increase the harvest efficiency, being it digital solutions to collect data with more precision or to improve the machinery control.
- Monitoring (MON): Continuous monitoring features. Comprises both meteorological and remote sensing data collection, for example.
- Field notebook (FDN): Technologies which enable farmers and field operators to generate digital annotations of field work for further assessment.
- Human resources management (HRM): Technologies for any nature of team management.
- Financial management (FIM): Solutions for any nature of financial management.

This list was arbitrarily defined and can be reduced or expanded for better understanding of concepts or to change the detail degree. As an example, during the survey, mechanized solutions were often linked to soil preparation or planting/sowing steps, so they were merged. For the purposes of this work, this list was assumed as a representation of agricultural life cycle steps.

The data collection was conducted on the AgTechs informed websites. After excluding misclassified AgTechs and those with inactive websites, a sample size of 88 active companies was retained and enabled to create a binary representation of the agricultural steps and features covered by their solutions, summing up the positive response as an Integration Score (IS).

The dataset was assessed following a descriptive analysis for: (i) the AgTechs spatial distribution; (ii) the occurrence of each single feature; (iii) the generated IS; and (iv) the combined sets of features. Further, the Jaccard similarity index (Han et al., 2012) was employed to assess the synergy of coupled features to identify if they follow the same development dynamics, i.e., if they are commonly provided (or skipped) together. The Jaccard similarity index is represented by

$$J(A,B) = \frac{|A \cap B|}{|A \cup B|} = \frac{|A \cap B|}{|A| + |B| - |A \cap B|} \quad (1)$$

where $J(A,B)$ is the Jaccard similarity index, which varied between 0 and 1, A is the distribution of the first coupled feature and B is the distribution of the second coupled feature.

Results and Discussion

AgTechs Development Poles

Companies with an integrative profile are more frequent in more developed regions by taking advantage of a more affordable fostering environment, access to better infrastructure and qualified customers which are more likely to absorb their solutions. The results showed that, in Brazil, the southeast region leads the integrative AgTechs hosting ranking, especially the São Paulo state, with almost two times more companies than the second one. It is followed by the south region, mainly by Rio Grande do Sul and Paraná states, both with relevant production that also demands innovative solutions to attend variable (in size and organization) productive systems. In third place, the central-west region concentrates less than half of the proportion of AgTechs compared to the previous regions, despite its economy being almost entirely based on agribusiness, while the northeast and north regions account for only 4 and 1 companies, respectively (Fig. 1.a and Fig. 1.b).

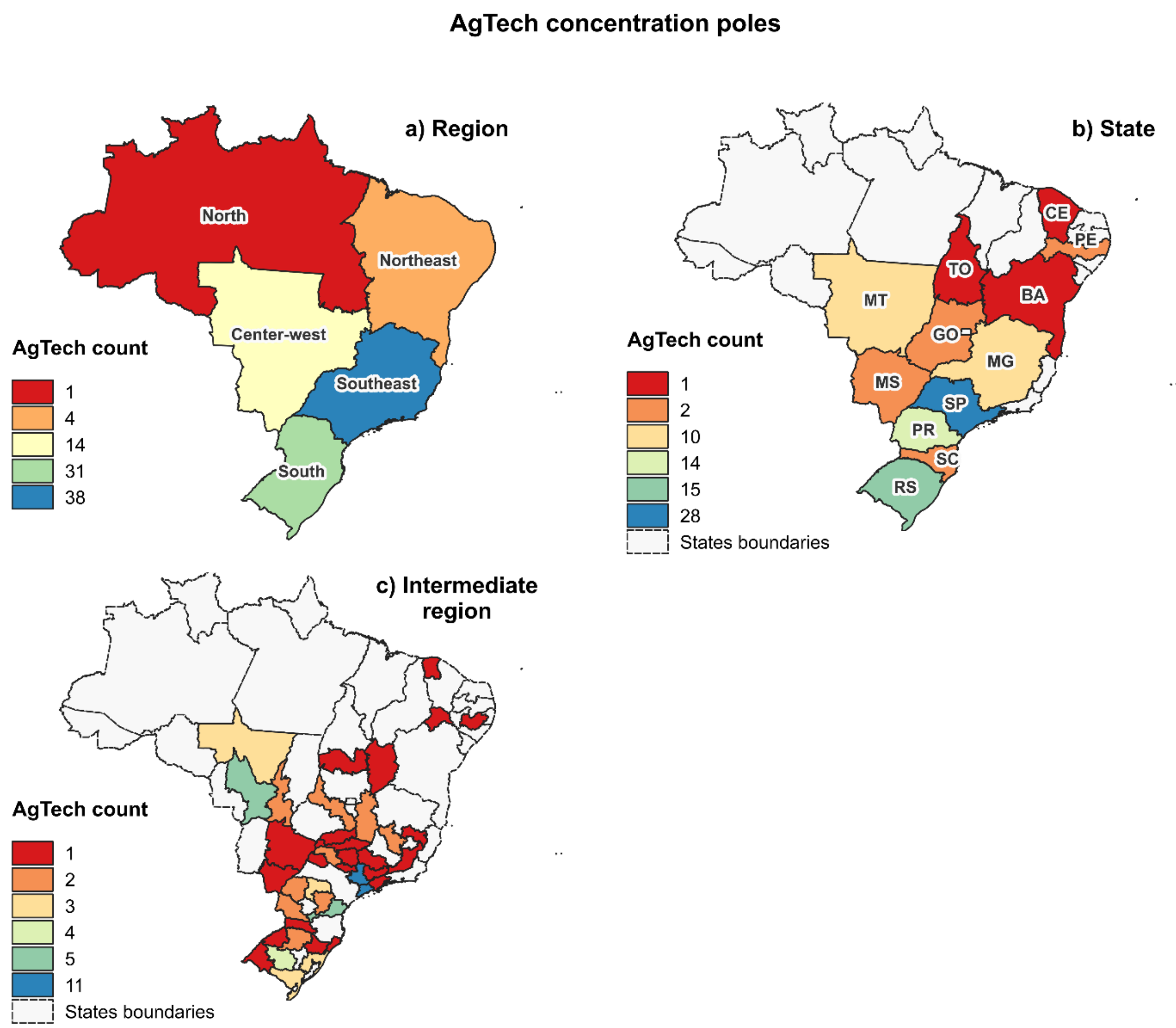

Fig. 1 AgTechs hosting poles in intermediary regions (a), state (b) and region scales (c)

São Paulo state, which is itself responsible for about 30% of national Gross Domestic Product (GDP) (IBGE, 2026), has the highest potential to boost public investments in research, development and innovation. It represents an economical factor driving the higher concentration of AgTechs (Sakuda et al., 2025). Beyond that, the availability of public universities with high quality teaching and research is also an infrastructural factor that serves as a source of highly skilled human resources and scientific advances. Thus, these factors complement each other in fostering innovation ecosystems. The intermediary region scale (Fig. 1.c) showed the existence of strong correlations between the availability of AgTechs against (i) their annual GDP (2023) ($r_{pearson} = 80\%$) and (ii) the number of public teaching institutions ($r_{pearson} = 75\%$) (Table 1).

Table 1. Integrative AgTechs concentration in intermediate regions and correspondent educational and economic indicators through the number of public higher education institutions and annual Gross Domestic Product (GDP).

Intermediate region	State	Region	No. Agtechs	No. Public Teaching Institutions	GDP 2023 (million R$)
São Paulo	SP	Southeast	11	35	1,871,856
Campinas	SP	Southeast	11	20	650,390
Curitiba	PR	South	05	04	267,576
Cuiabá	MT	Center-west	05	03	101,748
Santa Maria	RS	South	04	02	31,518
Londrina	PR	South	03	08	93,741
Pelotas	RS	South	03	04	48,046
Porto Alegre	RS	South	03	03	288,004
Sinop	MT	Center-west	03	01	83,601
Belo Horizonte	MG	Southeast	02	10	347,433
Goiânia	GO	Center-west	02	06	177,633
São José do Rio Preto	SP	Southeast	02	06	87,268
Cascavel	PR	South	02	04	125,500
Maringá	PR	South	02	03	99,739
Ponta Grossa	PR	South	02	01	64,022
Patos de Minas	MG	Southeast	02	01	45,557
Rondonópolis	MT	Center-west	02	01	42,828
Passo Fundo	RS	South	02	00	81,221
São José dos Campos	SP	Southeast	01	12	193,582
Caruaru	PE	Northeast	01	09	45,614
Ribeirão Preto	SP	Southeast	01	08	156,748
Petrolina	PE	Northeast	01	08	21,575
Araraquara	SP	Southeast	01	06	70,582
Pouso Alegre	MG	Southeast	01	03	81,139
Juíz de Fora	MG	Southeast	01	03	73,275
Varginha	MG	Southeast	01	03	66,175
Araçatuba	SP	Southeast	01	03	39,629
Campo Grande	MS	Center-west	01	02	102,053
Dourados	MS	Center-west	01	02	68,540
Uberaba	MG	Southeast	01	02	60,692
Caxias do Sul	RS	South	01	01	92,429
Chapecó	SC	South	01	01	79,925
Uberlândia	MG	Southeast	01	01	78,416
Barreiras	BA	Northeast	01	01	47,206
Ijuí	RS	South	01	01	42,150
Sobral	CE	Northeast	01	01	25,920
Governador Valadares	MG	Southeast	01	01	18,614
Uruguaiana	RS	South	01	01	18,003
Gurupi	TO	North	01	01	13,027
Criciúma	SC	South	01	00	52,177
Total	-	-	88	182	5,955,152 (~55% of national GDP)

Considering Brazil's continental size and high variability of both environmental conditions and productive systems configuration, companies based in one region should be aware of such differences when designing their solutions to success at scaling to different regions. On one hand, companies based on more developed regions are potentially able to adapt and evolve their solutions to attend this kind of demand. On the other hand, economic and logistical barriers can take place and harm solutions exportation, especially considering technologies which depend on frequent field work or highly skilled tasks. For example, this could be the case for (i) maintenance of precision irrigation systems controlled by specific chips/equipment, which eventually should be replaced by trained technicians; (ii) the operation of advanced UAV-based processes and techniques or; (iii) the adoption of human resources management systems designed for a specific corporative organization which in turn could have low overlap with different production systems. So, fostering the development of AgTechs in other areas would also be desirable as an alternative for the concentration of a few companies in specific regions that would take too much time to attend remote regions. Considering the whole spectrum of AgTechs, not only those with an integrative profile, it is possible to note that this movement is already in progress, and even though São Paulo still has the highest AgTechs concentration, it felt about 10% from 2019 to 2024, even with an increase in the total number of companies (Sakuda et al., 2025).

Technological Focus and Integration for Agricultural Digitalization

From planning to harvest, the agricultural cycle depends on several steps, each related to management decisions that in turn represent opportunities for AgTechs to develop solutions aiming at efficiency improvements. Nonetheless, in most cases, the integrative AgTechs ecosystem is not mature enough to provide solutions regarding all the features considered in this work. Financial management (FIM) and monitoring (MON) are the most explored features, covered by at least half of solutions, whereas water management and irrigation (WMI) is the least explored one (Fig. 2).

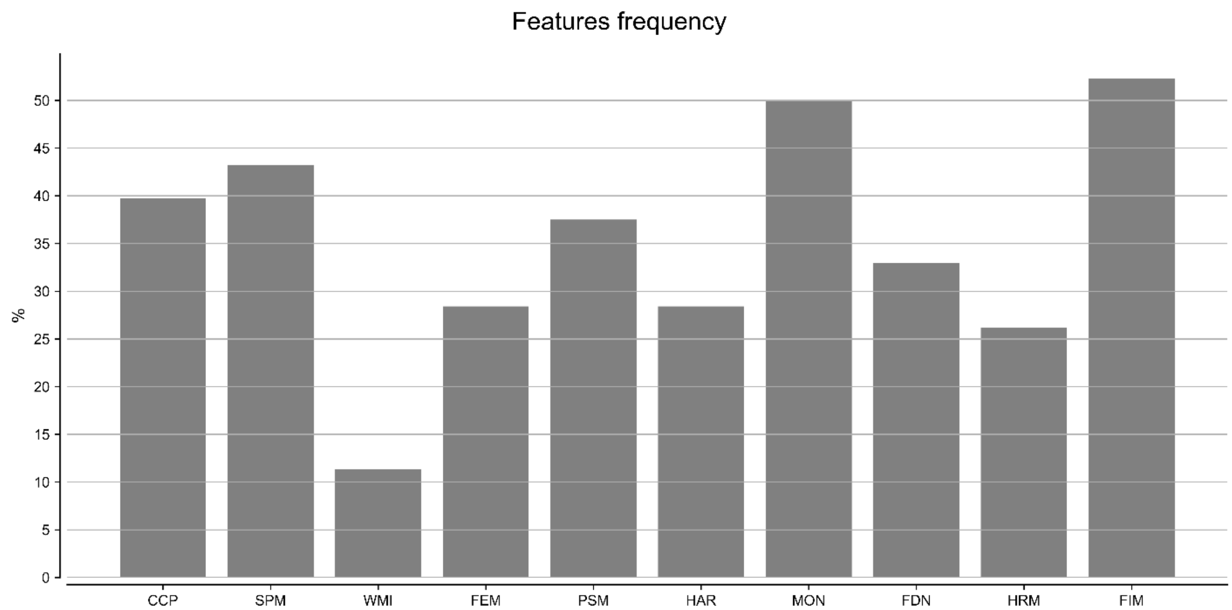

Fig. 2 Frequency of features addressed by integrative AgTechs

The AgTechs' integrative property, IS, means the coverage of agricultural steps or features in an integrative manner. Nonetheless, differences in features coverage frequencies (Fig. 2) also reflect differences in the synergy between them. From 88 assessed AgTechs, only 3 attend all the 10 features (one hosted in São Paulo and two in Mato Grosso), whereas 50% (median) cover a maximum of 3 features in their solution, reaching up to 5 at 75% percentile.

The aggregation of socio-economic indicators (Table 1) on a state scale showed Mato Grosso (MT) with the highest average IS (5.3), immediately followed by Tocantins (TO), Bahia (BA) and Pernambuco (PE), all with an average IS of 4.0, although they also presented less hosted companies (maximum of 2) than MT (10). Thus, it permitted assume MT as having more mature integrative AgTechs able to supply farmers with more complex solutions. The average IS in São Paulo (SP), in turn, puts it in the 4th position (out of 9), but considering the number of hosted AgTechs (28), it is possible to consider it as having a more dynamic development environment, with some of them still in the initial steps whereas there are others already reaching an $IS = 10$. In the south region, Santa Catarina (SC) is apart from its neighbors, Paraná (PR) and Rio Grande do Sul (RS), and present the lowest average and maximum IS in the dataset (1.5 and 2.0, respectively), meaning that there is an opportunity for outside companies to reach for customers in that state or to evolve the locally existing ones considering its regional agricultural characteristics and priorities (Cano et al., 2026; Iakovidis et al., 2025). While the average IS didn't correlate with the number of public teaching institutions ($r_{pearson} = 2{,}92\%$) and GDP ($r_{pearson} = -0.59\%$), the maximum IS showed that wealthier states ($r_{pearson} = 61{,}62\%$) and states with a higher number of higher education structures ($r_{pearson} = 62,66\%$) are related to the existence of AgTechs with more complex solutions regarding the number of covered agricultural cycle steps or features.

Table 2. AgTechs Integration Score (IS) in state scale. Values in parenthesis rank the state on each statistic parameter.

State	Region	No. AgTechs	No. Public Teaching Institutions	GDP 2023 (million R$)	Integration Score (IS)	
					Average	Maximum
SP	Southeast	28	90	3,070,055	(4) 3.4	(1) 10
MG	Southeast	10	24	771,301	(7) 2.9	(3) 05
PR	South	14	20	650,578	(5) 3.1	(3) 05
RS	South	15	12	601,371	(3) 3.5	(2) 06
MT	Center-west	10	5	228,177	(1) 5.3	(1) 10
GO	Center-west	2	6	177,633	(6) 3.0	(3) 05
MS	Center-west	2	4	170,593	(3) 3.5	(3) 05
SC	South	2	1	132,102	(9) 1.5	(5) 02
PE	Northeast	2	17	67,189	(2) 4.0	(2) 06
BA	Northeast	1	1	47,206	(2) 4.0	(4) 04
CE	Northeast	1	1	25,920	(8) 2.0	(5) 02
TO	North	1	1	13,027	(2) 4.0	(4) 04

The degree of similarity that measures the AgTechs development dynamic related to commonly explored (or skipped) features (Table 3) showed that all coupled features reached a similarity Jaccard index below 50%, with the highest values for crop cycle and planning and financial management features (CCP-FIM) ($j = 45\%$) and for phytosanitary management and monitoring features (PSM-MON) ($j = 43\%$), while the lowest values accounted for water management and irrigation and financial management features (WMI-FIM) ($j = 8\%$), for crop cycle and planning and water management and irrigation features (CCP-WMI) ($j = 12\%$) and for phytosanitary management and human resource management (PSM-HRM) ($j = 12\%$). On average, the Jaccard similarity index (j) reached 26%, meaning that the set of features covered by AgTechs classified as integrative is still highly variable. By increasing the set of integrated features provided by AgTechs' solutions, barriers like the perception of value or the costs related to broader agricultural cycle digitalization (Sakuda et al., 2025) would be more likely to be overcome. Zhai et al. (2020) stated that complexity enhancement to attend the whole agricultural life cycle is a challenge still to be addressed by AgTechs solutions.

Table 3. Similarity Index (Jaccard) for integrative AgTechs solutions. Higher values indicate that coupled features are directly correlated and more likely to be offered (or absent) together. Bold values indicate the highest (+) and lowest (-) similarity between coupled features on each column.

Feature	CCP	SPM	WMI	FEM	PSM	HAR	MON	FDN	HRM	FIM
CCP	1.00									
SPM	0.35	1.00								
WMI	**(-) 0.12**	**(-) 0.20**	1.00							
FEM	0.22	0.26	**(+) 0.21**	1.00						
PSM	0.36	0.31	0.16	0.26	1.00					
HAR	0.30	0.34	0.13	0.22	0.38	1.00				
MON	0.34	0.32	0.10	**(+) 0.33**	**(+) 0.43**	0.30	1.00			
FDN	0.33	0.29	0.11	0.23	0.24	**(+) 0.38**	**(+) 0.38**	1.00		
HRM	0.23	0.27	0.18	0.23	**(-) 0.12**	**(-) 0.14**	**(-) 0.18**	**(-) 0.30**	1.00	
FIM	**(+) 0.45**	**(+) 0.35**	**(-) 0.08**	**(-) 0.13**	0.22	0.27	0.27	**(+) 0.36**	0.25	1.00

The still low average IS and similarity of agricultural steps and features covered by AgTechs reflect the still incipient development of integrative solutions, as also observed in Cano et al. (2025) for the US. Furthermore, it also represents an opportunity for both AgTechs, government and funding agencies to invest in integrative solutions centered not only on available technologies, but also in the agricultural life cycle steps, where the interface between them would also be an issue to be addressed in the development strategy.

Studies like Dibbern et al. (2024), Cano et al. (2026), Silveira et al. (2025) and Silveira et al. (2026) explore farmers' perception and adoption of digital agricultural technologies and the innovation environment that incentives the AgTechs rise and development. Here, this work assessed existing technologies in terms of their complexity toward the digitalization of different steps of the agricultural cycle, assuming it as an outcome of all interrelations (Silveira et al., 2026) needed to be fulfilled in favor of the development of Agriculture 4.0.

Conclusions

In Brazil, integrative AgTechs are not majority of the proposed solutions. Despite that, affordable economic and educational conditions define their development environment, and regions under such conditions, which offer both universities and economic prominence, tend to concentrate most of them. In state scale, São Paulo (SP) leads the ranking, followed by Rio Grande do Sul (RS), Paraná (PR), Mato Grosso (MT) and Minas Gerais (MG). In a broader regional scale, southeast and south regions lead by hosting more than 30 AgTechs each, being followed by center-west region, with 14. Northeast and north regions, in their turn, account for only 4 and 1 hosted integrative AgTechs and still need more incentives to develop an innovative environment.

In terms of solutions complexity, wealthier states with a higher number of higher-level teaching institutions also tend to have AgTechs which could attend more steps and features of the agricultural life cycle.

The technological focus addressed by Brazilian integrative AgTechs concentrates on financial management and monitoring features, while water management and irrigation figures as the least addressed one. Nonetheless, the integrative context is still sub explored and heterogenous, with an average similarity of 26%, a minimum of 8% (between financial management solutions and water and irrigation management solutions) and reaching a maximum of 45% (between financial management solutions and crop cycle planning solutions), meaning that users still need to seek for similar companies and compare if the set of features covered by their solutions are capable of attending the technological demand.

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References

Cano, P. B., Carcedo, A. J. P., Hernandez, C. M., Gomez, F. M., Gimenez, V. D., Kyveryga, P. M. et al. (2025). Trends in agricultural technology: A review of US patents. *Precision Agriculture*, 26(4), 59. https://doi.org/10.1007/s11119-025-10257-x

Cano, P., Mandrini, G., Buckmaster, D., Arnall, B., Carroll, M., Sharda, A., et al. (2026). Farmer perspectives on digital agriculture in the US Midwest. *Agronomy Journal*, 118(1), e70268. https://doi.org/10.1002/agj2.70268.

Han, J., Kamber, M., & Pei, J. (2012). Getting to Know Your Data. In Han, J., Kamber, M., & Pei, J (Ed.), *Data Mining: Concepts and Techniques (Third Edition)* (pp. 39–82). Waltan, MA: Morgan Kaufmann. https://doi.org/10.1016/B978-0-12-381479-1.00002-2.

Iakovidis, D., Gadanakis, Y., Campos-Gonzalez, J., Park, J. (2025). Optimising decision support tools for the agricultural sector. *Environment, Development and Sustainability*, 27(10), 25043–25067. https://doi.org/10.1007/s10668-024-04743-x.

IBGE (2026). Produto Interno Bruto dos Municípios. Instituto Brasileiro de Geografia e Estatística. https://www.ibge.gov.br/estatisticas/economicas/contas-nacionais/9088-produto-interno-bruto-dos-municipios.html. Last accessed 15 June 2026.

Sakuda, L. O., Favarin, A. M., Jábali, P. P. C. (2025). *Radar Agtech Brasil 2024: Mapeamento de Startups, Ambientes de Inovação e Investidores do Ecossistema Agro Brasileiro*. Brasília and São Paulo: Embrapa, SP Ventures e Homo Ludens.

Silveira, F., Corrêa, R. G. F., Baierle, I. C., Landaverde, R., Barbedo, J. G. A. (2025). Behavioral profile of farmers in the adoption of agriculture 4.0 technologies in the agri-food system: A case study in Brazil. *Frontiers in Sustainable Food Systems*, 9.

https://doi.org/10.3389/fsufs.2025.1624753.

Silveira, F., Smania, G. S., Landaverde, R., Osiro, L., Bolfe, É. L., Romani, L. A. S., et al. (2026). Exploring the drivers of responsible scaling of Agriculture 4.0 technologies for transformative impact in the modern agri-food ecosystem: An ISM-based analysis. *Agricultural Systems*, 231, 104508. https://doi.org/10.1016/j.agsy.2025.104508.

Tyrychtr, J., Vostrovsky, V. (2017). The current state of the issue of information needs and dispositions among small Czech farms. *Agricultural Economics (Zemědělská Ekonomika)*, 63(4), 164–174. https://doi.org/10.17221/321/2015-AGRICECON.

Zhai, Z., Martínez, J. F., Beltran, V., Martínez, N. L. (2020). Decision support systems for agriculture 4.0: Survey and challenges. *Computers and Electronics in Agriculture*, 170, 105256. https://doi.org/10.1016/j.compag.2020.105256.