

POLICY BRIEF

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Transforming Family Farming: Advancing Inclusive Digitalization in the Amazon

Empowering Rural Communities through Technology and Participation

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KEY MESSAGES

- The climate crisis threatens the stability of Brazil's agri-food systems—putting global food security at risk. As a major food producer, Brazil must urgently adopt locally tailored technologies that boost resilience to climate change and improve conditions for family farmers in vulnerable rural areas
- The ageing rural population in Brazil and Latin America is closely linked to declining agricultural productivity and worsening socio-economic conditions. As young people migrate to urban areas seeking better opportunities, the rural labor force weakens. While older farmers bring valuable experience, limited long-term planning often restricts the adoption of new technologies.
- The agroecological production model faces major barriers to widespread adoption in Brazil. The country's vast cultural diversity demands tailored technologies adapted to local realities. Meanwhile, the entrenched large-scale model—relying heavily on chemical inputs and machinery—remains dominant agricultural, making the shift to alternatives difficult.
- Digital tools for farmer advisory services are rapidly expanding. Yet, they often neglect local realities and the specific needs of small-scale family farmers, focusing instead on the demands of international markets for large-scale, standardized, low-cost production to feed global value chains.
- The results of the Inclusive Digital Tools (ATDT) project in Brazil suggest that participatory approaches can be an effective way to adapt digital technologies, helping farmers access knowledge and make better decisions. The co-creation of technical knowledge is important to accelerate the dissemination of more efficient and resilient production techniques.

The Agroecological TRANSITIONS' Inclusive Digital Tools Project (ATDT) in Brazil was developed to address critical challenges faced by smallholder farmers in the Amazon region, including limited access to tailored knowledge, low productivity, and vulnerability to climate change. The project focused on creating participatory solutions that combine agroecological principles, knowledge co-creation, and digital technologies to support sustainable livestock production. Implemented in the municipalities of Novo Repartimento, Pacajá, and Anapu in Pará state, ATDT aimed to develop a user-friendly digital tool to facilitate the dissemination of agroecological practices among family farmers and extension agents, empowering local communities and fostering climate-resilient agriculture.

The climate emergency in the context of low productivity & limited technological absorption capacity

Climate change represents a growing risk to the stability of Brazil's agri-food systems. Increases in temperature, irregular rainfall, prolonged droughts, and extreme weather events are already straining agricultural productivity. Climate projections estimate temperature rises between 1°C and 5.5°C, shifts in precipitation ranging from +5% to -50%, and a higher frequency of extreme events by the end of the century. Compounded by the territorial and socio-economic diversity of Brazil's rural areas, these impacts intensify vulnerabilities and pose direct threats to national food supply and security (Tanure, Domingues and Magalhães, 2023).

Regarding family farming, climate change is undermining the production and livelihoods of millions of smallholder farmers. Events such as

prolonged droughts, heavy rainfall, and rising global temperatures directly affect crop yields and production stability. These phenomena reduce water availability and impact rain-dependent crops, such as cassava and beans, which are crucial for food security in rural communities. Furthermore, increased evaporation and irregular rainfall can further hinder soil water retention, which is essential for sustainable agricultural production (EMBRAPA, 2024).

However, the risks to agricultural productivity extend beyond subsistence crops and family farming. Key commodities integrated into global value chains—such as soy, corn, and wheat—as well as sectors critical to Brazil’s domestic industry, like dairy production, are also highly exposed to climate impacts. To underscore the urgency of the climate crisis in the Brazilian context, the following figure presents pessimistic projections for the productivity of major crops central to family farming (EMBRAPA, 2024).

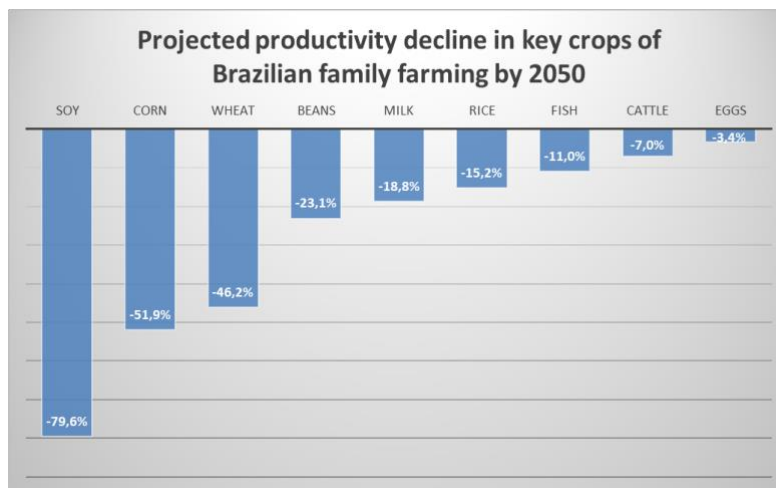


Figure 1 Projected productivity decline in key crops of Brazilian family farming by 2025.

Source: EMBRAPA, based on data from Brazil’s Fourth National Communication to the United Nations Framework Convention on Climate Change (UNFCCC).

Family farmers are among the most vulnerable to climate change, largely due to limited access to productive technologies such as fertilizers, pest and disease control, soil management, and technical assistance. This lack of resources increases their exposure to climate variability, particularly temperature shifts and irregular rainfall, compared to farmers operating under conventional, high-input production models. The impacts are expected to be especially severe in Brazil’s North and Northeast regions, where rising temperatures and declining rainfall pose a significant threat to subsistence farming (Tanure, Domingues and Magalhães, 2023).

Deforestation is a key driver of climate change and is closely tied to Brazil’s prevailing economic growth model, particularly in the Amazon biome. Land conversion for pasture was the leading cause of deforestation in the region between 1985 and 2023. Over this period, pastureland expanded by more than 363%—from approximately 12.7 million to 59 million hectares—an increase of 46.3 million hectares in less than four decades. By 2023, pastures covered 14% of the entire Amazon (MAPBIOMAS, 2024).

In addition to environmental pressures such as deforestation, structural socio-demographic changes are also reshaping rural landscapes and threatening the long-term sustainability of agriculture in the Amazon and beyond. The ageing rural population reduces the labor force and threatens Brazil’s food sovereignty by impacting agricultural productivity and socio-economic conditions. While older farmers bring valuable experience, they often have shorter planning horizons, which can limit the adoption of new technologies. The migration of young people to urban centers in search of better education and employment further weakens family farming. Across Brazil and Latin America, youth participation in agriculture has sharply declined, largely due to greater job opportunities in cities (Fochezatto and Vogt, 2019).

The state of Pará, where the Inclusive Digital Tools (ATDT) project was implemented, has a relatively high proportion of young family farmers¹ compared to the national average. According to the 2017² Brazilian agricultural census, 18% of family farmers in Pará were under 35 years old—nearly double the national average of 10.7%. In contrast, Mato Grosso, another region where project activities took place, had only 8% of family farmers under 35 years old (IBGE, 2017).

¹ In Brazil, family farming is defined as farming operations where the property has a maximum of four fiscal modules (a land unit corresponding to the minimum area required for its economic viability), predominantly uses family labor in the economic activities of the property, derives a minimum percentage (as defined by the executive branch) of income from these activities, and is managed by the farmer or in partnership with their family (Law No. 11,326, 2006).

² Agricultural censuses in Brazil are conducted, on average, every ten years. The most recent one was carried out in 2017.

While Pará shows encouraging signs of youth presence in agriculture, other structural barriers—such as low levels of formal education—continue to limit the broader adoption of technologies and innovation among family farmers. Low education levels among rural populations in Brazil are closely linked to the challenges **farmers** face in adopting technologies that could enhance yields and resilience. Approximately 32% of over 5 million agricultural establishments are managed by producers with only basic literacy, and 14% have never attended school. Among family farmers—who make up 77% of this total (over 3.8 million)—these figures are even higher: 41.7% have only basic literacy, and 18% have never attended school. This means about 2.3 million family farmers have limited reading and comprehension skills (IBGE, 2017).

In addition, nearly 80% of the more than 5 million agricultural establishments in Brazil receive no technical assistance. In the context of family farming, the situation is similar, as 81.8% of the 3.8 million establishments classified as family farming have no access to any form of technical assistance (IBGE, 2017).

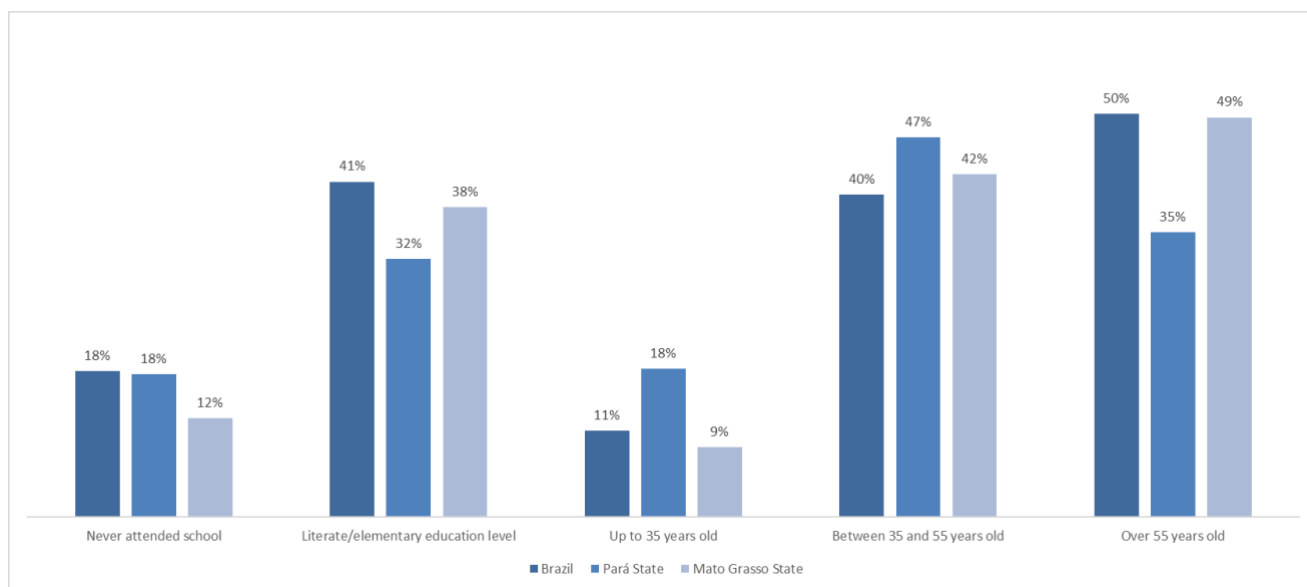


Figure 2 Educational and age profile of family farming in Brazil

Source: Agricultural Census IBGE (2017).

Agroecology in the Brazilian Socioeconomic Context

The extreme inequality observed in Brazil’s rural areas is a direct outcome of the country’s agricultural modernization and rural development model over the past five decades. Built on three pillars—subsidized credit, technological innovation research, and top-down extension services focused on disseminating the Green Revolution’s technological package—and supported by abundant natural resources and extensive arable land, this strategy significantly boosted the productivity of key crops like soy, sugarcane, and cattle (Barros, 2014). It also generated important socio-economic gains, including a steady reduction in food prices from the 1970s to the 2000s (averaging a 5% annual decrease between 1975 and 2007), inflation control in the 1990s, and improved food security. These achievements helped income redistribution programs succeed, as lower food prices allowed beneficiary families to spend more on other goods, fueling broader economic growth (Barros, 2014; Martins, 2014).

However, this rural development model has been exclusionary, marginalizing small-scale farmers who, lacking legal land tenure, were denied access to government-subsidized rural credit and extension services tailored to their socioeconomic and cultural profiles. This group, which today represents a large share of Brazil’s nearly 4 million family farming establishments, struggles to achieve satisfactory productivity levels—either due to incompatibility with large-scale production models or because sociocultural barriers hinder the assimilation and adoption of knowledge and new technologies (Buainain *et al.*, 2013; Lauce and Filho, 2023).

The production model based on intensive use of chemical inputs, mechanization, business management practices, and integration into international commodity markets has become so entrenched that it is widely perceived as the only viable farming approach—commonly referred to as the “hegemonic model” or “conventional agriculture.”

Alternative models, such as agroecology, small-scale production, and crops linked to short supply chains with sociocultural importance, have been relegated to “niche markets” (Buainain *et al.*, 2013).

Efforts to reverse this exclusionary process began in the 1980s. From the start, policymakers, academia, and civil society seeking a new development model—and consequently rural extension services better aligned with the real needs and socioeconomic profiles of small-scale farmers—have viewed agroecology as a promising alternative to promote more sustainable and equitable development in disadvantaged rural communities (Lisita, 2005; Laluze and Filho, 2023).

The agroecology approach demanded a reformulation of Brazil’s rural extension services, which had previously centered on disseminating the Green Revolution’s technological package. This shift required two key pillars: training extension agents to develop critical thinking beyond technical skills and adopting participatory planning methods with local communities to better connect agents and farmers—integrating local realities and sociocultural factors into the adaptation of technologies suited to specific contexts (Lisita, 2005; Gonçalves and Lima, 2022).

However, the reformulation of rural extension services in Brazil has yet to succeed. According to Laluze and Filho (2023), key challenges include difficulties in generating knowledge and developing technologies that effectively integrate institutional science with the tacit, traditional knowledge held within rural communities. Additionally, the deeply entrenched hegemonic agricultural and livestock production model in Brazilian collective thinking presents significant barriers to designing and implementing a pedagogical policy that fully embraces agroecology as the dominant technical and productive framework.

Digital technologies to foster agroecological transition: reality or utopia?

The advancement of digital technologies has sparked growing discussion about their potential to accelerate the agroecological transition. Increasingly, academic research highlights the role of these tools in helping rural producers improve productivity and enhance the resilience of their production systems against climate change (Maurel and Huyghe, 2017; Lioutas and Charatsari, 2020; Simelton and McCampbell, 2021; Schnebelin, 2022).

The discussion around digital technologies stems from their recent benefits to agriculture and livestock. Precision agriculture includes a range of tools—from simple devices like mobile phones and integrated management systems to advanced solutions such as machinery sensors, remote sensing, animal tracking, augmented reality, artificial intelligence, machine learning, and blockchain. These technologies generate large volumes of data that feed intelligence platforms for monitoring crop areas, deforestation, resource use efficiency, animal weight, weather forecasts, production forecasts, and pest and disease control. Such applications improve resource efficiency and support better decision-making for farmers (Barnes *et al.*, 2019; Klerkx, Jakku and Labarthe, 2019).

Proponents of digital technologies argue that, just as these tools have driven efficiency gains in large-scale production, they could also offer significant benefits to small-scale and diversified farming systems. However, to realize these benefits, digital solutions must be carefully adapted to the specific needs, aspirations, and resources of these farmers (Bellon-Maurel *et al.*, 2022).

Conversely, Hilbeck *et al.* (2022) and Kato, Delgado and Romano, (2022) argue that most digital technologies are designed with a focus on standardization and systematization to boost efficiency in industrial-scale production. This approach conflicts with agroecological principles, which emphasize local complexities, natural characteristics, diversification, and short value chains. The standardized design of current digital tools limits the flexible, context-specific solutions necessary for territorial development and agroecological practices.

Despite differing perspectives, much of this debate remains theoretical and lacks robust field-based evidence (Lajoie-O’Malley *et al.*, 2020). One effort to generate concrete insights on using digital technologies to enhance rural advisory services globally is the study conducted by the Global Forum for Rural Advisory Services (GFRAS).

The study found that while some digital advisory services have achieved strong engagement and user retention, these cases are exceptions. In Latin America, 80 services were evaluated, with most having fewer than 5,000 active users. The private sector (both for-profit and non-profit) dominates, providing 60% of services; the public sector accounts for 28%, and public-private partnerships (PPPs) make up 12%. In Southeast Asia, 16 services in Indonesia were assessed, six of which have over 50,000 users, reflecting high digital penetration and population size. In English-speaking African countries, some services have reached over a million users, though many still face scaling

challenges. Francophone African countries reported the most services, but with fewer than 2,000 active users each (Larsen *et al.*, 2023).

In their policy brief, Laurens *et al.* (2023) suggest that a key reason for low adoption rates is the lack of a compelling value proposition for end users—whether farmers or extension agents. Many digital tools are built on business models that prioritize data collection, offering services in exchange for user-provided information. This often results in products designed more for gathering data than for delivering tangible benefits. Consequently, users may struggle to understand the tool’s relevance or usability, leading to low engagement and abandonment after a single use.

A New Approach to Digital Tools: Co-creation and Collaborative Learning in Rural Contexts

A New Channel for Disseminating Co-Generated Knowledge with Farmers and Extension Agents

As described by Laurens *et al.* (2023), the ATDT project adopted a co-participatory approach from the outset, involving extension agents, farmers, and livestock producers from the region. These local actors contributed to identifying the technical and functional requirements of the digital tool and played an active role in validating its early development. They were introduced to the minimum viable product (MVP) and invited to provide feedback and suggestions, which were incorporated into subsequent versions of the tool.

Building on this participatory foundation, the resulting tool—Solis—was designed not only to be accessible, but also to foster engagement and knowledge exchange among family farmers.

Solis replicates social media dynamics to encourage two-way interaction between extension agents and farmers, promoting co-creation and sharing of knowledge on locally relevant practices of production. It uses strategies such as simplified access (no email required to register) and a user experience inspired by popular platforms.

Participatory workshops revealed that even older farmers with limited formal education commonly use social media apps like Instagram, TikTok, and YouTube (Laurens *et al.*, 2023). Grounded in smallholder farmers’ daily realities, prior knowledge, and challenges, Solis facilitates access to technical content and practices that—although already available—have not been widely disseminated or adapted to the context of family farming.

The technical content shared through Solis focuses on production practices adapted to local contexts, some of which result from the co-generation of knowledge consolidated in the Sustainability Curriculum for Livestock Chains³. All videos posted on the platform undergo technical review by extension agents and specialists in livestock and agroecology from Solidaridad, ensuring the reliability and relevance of the information.

By drawing on the familiarity of social media interfaces, Solis is not limited to younger users. Its intuitive navigation increases the likelihood of adoption by older farmers as well. A key factor behind its use is the farmers’ ability to relate to the content—not only because it is technically relevant and locally adapted, but also because it is often produced and shared by people they know, such as neighbors, family members, or friends. These elements help foster greater acceptance of Solis, even among those who face greater barriers to using digital tools.

Compared to traditional social media platforms, Solis offers a distinct value proposition by centralizing exclusively technical content. This material is carefully reviewed and curated, ensuring a level of reliability and relevance that surpasses what is typically found on open platforms.

In November 2024, a new version of Solis was launched, which incorporated enhancements based on the contributions of farmers and extension agents involved in co-creation workshops and other project activities. As of April 2025, the platform had already registered over 238 unique users and 182 videos.

The ATDT Project also focused on strengthening the capacities of local actors. An agroecological expert was hired as an extension agent to provide continuous technical advice and insights to farmers and project staff throughout the ATDT timeframe. Field days demonstrating practices such as rotational grazing and silvopastoral systems were

³ The "Sustainability curriculum for livestock production" was also developed within the context of the ATDT and consolidates the learnings from a co-creation process aimed at adapting agroecological practices for livestock production in the region where the project was implemented. It involved the direct participation of farming families from the area between the municipalities of Novo Repartimento and Anapu, as well as extension agents providing rural technical assistance to producers and livestock farmers in the territory. The full publication can be accessed at: <https://hdl.handle.net/10568/168329> (Oliveira *et al.*, 2024)

also conducted. Within these activities, farmers, extension agents, and experts shared knowledge and practical experience to adapt generic agroecological practices into locally relevant ones, considering production systems, sociocultural habits, and local biodiversity.

Videos were produced during the visits for publication on Solis, featuring farmer testimonials on the benefits of improved practices and agroecology experts explaining effective implementation. Key moments from training sessions were recorded and edited into concise, easy-to-understand content “pills” available on Solis. This approach ensures that farmers unable to attend field days can still access critical insights through engaging audiovisual content tailored to the local farming community.

The Solis Ambassadors Initiative

To support Solis deployment, the project launched an innovative Ambassador Program, engaging young farmers as champions of the app and agroecological practices within their communities. Seven Ambassadors were selected—five farmers and two extension staff—tasked with promoting agroecological practices and facilitating Solis’ development and scaling. The Ambassadors participated in a training trip to São Paulo, where they deepened their understanding of ecological agricultural practices and acquired skills in scriptwriting, video production, and social media editing.

The group of young people, known as Solis Ambassadors, actively promotes Solis and agroecological practices within their communities through the app and other social media platforms. For example, Irivelton Tavares⁴, one of the Ambassadors, runs a YouTube channel featuring videos of his daily life on the farm. As of mid-2025, his channel has nearly 16,000 subscribers and 380 videos.

Leveraging their firsthand experience with the Solis app, the Ambassadors have become credible advocates, demonstrating the tangible benefits of agroecological farming techniques. They have developed a strong sense of responsibility in supporting Solis’s improvement, shown through detailed user experience reviews and ongoing feedback.

The Solis Ambassadors also serve as a focus group for the app’s continuous improvement. Regular meetings between developers, young farmers, and technicians help identify usability enhancements and resolve issues. Given the poor internet connectivity in the project area, this collaboration with local users has been crucial to ensure the tool functions effectively and remains appealing to its target audience.

The active involvement of farmers and extension agents in both the digital tool’s development and knowledge production results in technical content tailored to local realities. By addressing factors such as plant species adapted to soil and climate, resource limitations, and availability of inputs, equipment, and labor, the productive technologies disseminated through the Inclusive Digital Tools Project are more readily adopted by farmers in the region.

Feedback from local stakeholders—including small businesses, public agencies, academia, and producer organizations—who participated in ATDT outreach workshops⁵ indicates strong support for engaging young farmers as creators of technical content. This approach seeks to address youth migration to urban centers by fostering appreciation for rural culture and, importantly, by presenting viable options for sustaining family farms. It also encourages the use of digital platforms to seek and share knowledge and experiences, opening new opportunities for their families’ productive activities.

In addition to promoting broader adoption of the tool, the Solis Ambassadors Initiative may provide new incentives for young people to remain engaged in rural activities. It fosters the exchange of experiences and knowledge between them and other stakeholders, offering opportunities to take a leading role in disseminating technologies adapted to their realities.

Scalability Potential

The model developed by Solidaridad integrates digital resources, social media dynamics, and in-person engagement to enable continuous co-creation and the scaling of agroecological practices. Scaling pathways combine online and offline components across community, local, and regional levels. At the community level, the Ambassadors Program fosters local leadership, empowering ambassadors to activate the digital learning

⁴ Irivelton Tavares' YouTube channel <https://www.youtube.com/@iriveltontavares>

⁵ For more details on these outreach events, see the [Sustainability Curriculum for Livestock Production](#).

community by creating and sharing content and onboarding peers and family members. To extend Solis beyond the community, Solidaridad adopted two additional strategies: a conventional partner engagement approach, offering Solis as a cost-effective solution to local institutions working with smallholder farmers, and broad outreach to individual farmers through digital campaigns, targeted paid social media, radio advertisements, and billboards.

Policy Recommendations

To enable initiatives like the Inclusive Digital Tools Project to scale effectively and support the sustainability of family farming in the Brazilian Amazon, it is crucial to design and implement policies that foster inclusive digitalisation. The following recommendations aim to guide policymakers in creating an enabling environment for the adoption of digital technologies by family farmers:

Strengthen Digital Infrastructure in Rural Areas

- Expand internet access and improve connectivity across rural Amazonian communities.
- Provide incentives to establish community internet networks affordable to smallholders farmers.

Support Digital Training for Farmers and Extension Agents

- Implement training and technical assistance programs that incorporate the use of digital technologies.
- Promote initiatives that empower rural youth in adopting and disseminating digital solutions.

Promote Co-Creation and Adaptation of Digital Technologies to Family Farming Contexts

- Encourage research and development based on participatory methodologies to ensure digital solutions meet local needs.
- Foster partnerships among public agencies, the private sector, and civil society organisations to amplify the reach and impact of these technologies.

Integrate Digital Solutions into Public Policies for Technical Assistance and Rural Extension (ATER)

- Incorporate digital tools into rural extension service policies, ensuring alignment and integration with existing programs.
- Encourage the formation of collaborative networks between extension agents and producers to facilitate the sharing of technical knowledge.

Conclusions

Inclusive digitalization represents a strategic opportunity to address the longstanding challenges faced by family farming in Brazil, particularly in the Amazon region. By facilitating access to information, strengthening knowledge networks, and expanding farmers' economic opportunities, digital solutions co-created with local communities can accelerate the agroecological transition and enhance the sector's climate resilience.

The adoption of participatory methodologies to adapt digital and productive technologies to the realities of family farmers in Brazil has proven to be an effective strategy to increase productivity in underdeveloped agri-food systems and to combat drivers of climate change, such as deforestation, irrational use of chemical inputs, and water resource depletion.

To expand these positive impacts, policymakers, research institutions, and the private sector must collaborate in formulating robust public policies focused on the digital inclusion of rural populations. Investments in infrastructure, training, and accessible digital tools not only strengthen family farming but also promote a more equitable and sustainable rural development model.

Further reading

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The Agroecological Transitions for Building Resilient, Inclusive, Agricultural and Food Systems (TRANSITIONS) Program aims to enable agroecological transitions. The TRANSITIONS Inclusive Digital Tools (ATDT) project aims to support the use of digital resources and citizen science to empower farmers to co-create, adapt, and innovate practices for climate-resilient and low-emission agroecological outcomes at large scales.

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