

# THE SEEDS OF MODERNITY

Now reaching its 50-year mark, EMBRAPA seeks to reconcile different models of agricultural production and promote environmental preservation

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**A**gricultural engineer Tatiana de Sá, from the Eastern Amazon branch of EMBRAPA (the Brazilian Agricultural Research Corporation), in Belém, makes a four-hour trip nearly every month, usually by bus or car, to work with farmers in Santa Luzia do Pará, in eastern Pará State. Together, they select the best ways to grow and use three root plants—arrowroot and purple and white yams—and three fruit crops—banana, tucumã (*Astrocaryum aculeatum* palm), and peach palm. Their goal is to eliminate an old problem: losing root crop and fruit harvests due to the difficulty of selling and storing them.

Farmers from the Santa Luzia region also go to the EMBRAPA unit in Belém to talk to the Agribusiness Lab team about ways to prepare flour, pasta, bread, and biscuits with the root and fruit crops they grow. “The techniques for growing and using arrowroot were being forgotten because of the dominance of wheat, the major enemy of food sovereignty in the Amazon,” comments Sá, who was hired in 1972 by the Northern Brazil Agricultural Research Institute (IPEAN), which was later incorporated into EMBRAPA. “The residents of the Santa Luzia region were interested in planting native roots, which were being lost.”

Recognizing local knowledge and organizing production through associations and small farmer unions are precepts of agroecology, an approach that advocates agricultural diversification and the preservation of natural resources. Valued as a response to international pressure on Brazil and its rural producers, who are increasingly being asked to prevent environmental damage caused by the practice of monoculture and the intensive use of pesticides, this approach is gradually gaining ground at EMBRAPA, an institution that will have been in operation for exactly 50 years on April 26.

“Organic agriculture—an area of agroecology—was seen as a utopia 30 years ago, but today it is recognized worldwide and taught in university courses,” says agronomist Jose Antonio Azevedo Espindola, a researcher at EMBRAPA Agrobiologia, in Seropédica, Rio de Janeiro, and chairperson of the management committee for its ecologically based production systems portfolio.

The environmentally friendly agriculture proposed by the agroecology movement follows principles that are quite different from the model that has previously given direction to EMBRAPA and other agricultural research institutions in Brazil. These institutions have been guided by a high-production paradigm based on mechanization, intensive use of fertilizers and pesticides, and mass crop cultivation on extensive properties, which has greatly increased national agricultural production.

“Soybean, which previously was not found north of Paraná, today is grown in the Legal Amazon. Brazilian sparkling wines win international awards. Apples used to only come from Argentina because there were no national varieties. We went from being food importers to exporters, and today Brazil is the third largest food exporter in the world,” observes physicist Silvio Crestana, a former director and researcher at EMBRAPA Instrumentação, one of five units that FAPESP has supported in the state of São Paulo since 1991, through 927 research projects and grants totaling R\$97.9 million.

Crestana, who was the director of EMBRAPA from 2005 to 2009, believes these achievements should not overshadow the future: “We now have to think about the social and environmental impacts of agriculture, because the world and the majority of producers and consumers want it that way. It’s fundamental to rebuild EMBRAPA so that it can rise to these new challenges.”

Agronomist Irene Cardoso, from Federal University of Viçosa (UFV), in Minas Gerais, points out that “Agricultural research institutions, not just EMBRAPA, need to pay more attention to other forms of agriculture, such as family and traditional agriculture, without chemical fertilizers and without pesticides.” A former president of the Brazilian Association of Agroecology (ABA), Cardoso adds that agribusiness, to which the history of EMBRAPA is closely linked, “is not environmentally sustainable, as it causes a reduction in biodiversity and extreme emissions of greenhouse gases because of deforestation and fires.” Tatiana de Sá adds, “EMBRAPA cannot be homogeneous, because its public isn’t.”

Agronomist Celso Moretti, who has served as the president of EMBRAPA since 2019, told Pesquisa FAPESP that the country’s largest agricul-

Agricultural diversity: (top) greenhouse tomatoes in the mountainous region of Rio de Janeiro, cattle raising in the forests of São Carlos, São Paulo; (bottom, from left to right) Gala apple farming in Bento Gonçalves, Rio Grande do Sul; a bee wears a tracking device in Belém, Pará; arrowroot grown in the region of Santa Luzia do Pará, Pará; *Vanilla pompona*, a native species of vanilla, in Brasília, Federal District

tural research institution is already quite eclectic. “Our studies are developed to serve all farmers of every profile, without biases, with a focus on increasing productivity, adding value to the product, and sustainability,” he says. “We carry out research both for improving products for export—like commodities—and for domestic consumption, which pertains to most small farmers and organic and agroecological agriculture.”

**M**oretti observes that EMBRAPA has a practical problem, a failure to replace employees who have left or retired over recent years: “The last time we hired new researchers was in 2014, through a 2010 civil service exam.” Agronomist Heitor Cantarella, director of the Agronomic Institute of Campinas (IAC), voices a similar complaint. “To refresh our lines of research and plan agriculture for the next 20 years, we need to rejuvenate EMBRAPA’s research team. During the last 15 years, we lost 40% of our employees, who were not replaced because there are no civil service exams being conducted,” he says.

Cantarella recognizes the social pressure in favor of food production methods with fewer environmental impacts and lower greenhouse gas emissions. He argues that the most recent research—even if based on a conventional approach—seeks to reduce the use of pesticides, for example, by selecting varieties of plants that are naturally more resistant to pests and diseases and promoting so-called agricultural intensification, which entails producing more food with the same area of land.

However, are these concrete signs of renewal? “The technological paths of the conventional paradigm, which I call the mechanical-chemical model, are reacting to the problems of the ecological crisis through a solution that remains within the paradigm: an attempt at “greening” the path with biological solutions that, in general, are at the service of mechanics and chemistry,” says economist Francisco de Assis Costa from Federal University of Pará (see Pesquisa FAPESP issue no. 277). Cantarella observes: “Ecological agriculture will continue to increase, but it will have to co-exist with some version of ‘mechanical-chemical’ agriculture, because of the pressure to produce abundant, low-cost food and raw materials.”

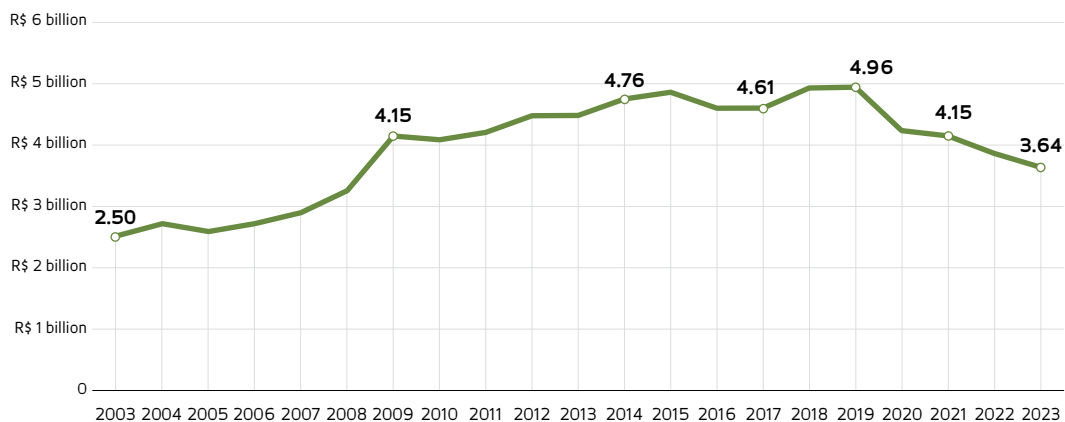
The disproportion between the size of teams allocated to the two differing approaches to research and agricultural production is another challenge. “At EMBRAPA,” says Espindola, “the percentage of researchers involved in generating technological solutions adapted for conventional agriculture is still much higher than the number dedicated to agroecology and organic production, but we’re making progress.” For Moretti, the number of researchers is not a good indicator of a research area’s relevance: “With focus and work capacity, it’s possible to deliver what’s necessary to meet the differing demands.” After doing an intensive study on grains, such as soybean, corn, or cotton, most researchers focus on other crops but also with a high-production bias.

The EMBRAPA president further observes that the teams dedicated to research on carrot and tomato production, although small, have achieved important results. In 2020, the institution launched a carrot cultivar (variety) for organic production, which is recommended for planting



## A FLUCTUATING BUDGET

The last five years have reversed the upward trend that began two decades ago (values in R\$ billion, adjusted to the IPCA [Brazilian consumer price index])



SOURCE EMBRAPA





Sorghum production in a crop-livestock-forest integration system in the Cerrado region of Maranhão

during the off-season of conventional cultivars. In turn, Tomatec is a growing system launched in 2005 that uses drip irrigation and integrated pest management.

Forestry engineer Édson Luis Bolfe, the former coordinator of Agropensa, a research division created to help EMBRAPA and its partner institutions formulate research strategies, sees a gradual improvement in agricultural production systems. “In the same way that direct planting was a novelty in the 1970s, integrated crop, livestock, and forest systems will evolve and consolidate in the coming years with greater food production and less pressure on natural resources.”

As a researcher at EMBRAPA Agricultura Digital in Campinas, São Paulo, Bolfe worked with colleagues from other institutions to develop methods for accurately mapping the boundaries, diversifi-

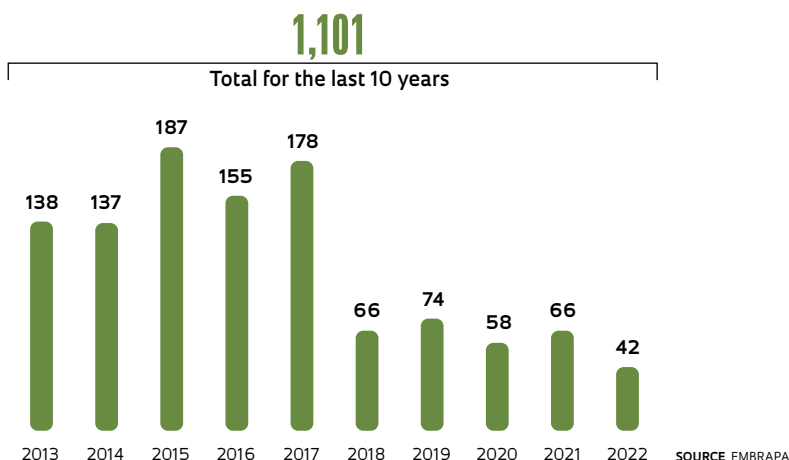
cation, expansion, contraction, or conversion of various agricultural crops by combining a variety of satellite images. Tested in municipalities in Goiás, Bahia, Maranhão, Mato Grosso, Mato Grosso do Sul, and São Paulo, the new approach maps native vegetation and differentiates plantations such as soybean, corn, cotton, and sugarcane plantations, as detailed in articles published in the journal *Remote Sensing* in 2022 and this year in the journal *Land*.

**C**urrently employing 2,201 researchers (there were 2,437 in 2013), with a budget of R\$3.6 billion for the most recent fiscal year (in current values, the budget was R\$2.5 billion in 2003), EMBRAPA is a relatively recent addition to the oldest group of national agricultural research institutions. The Instituto Agrônômico de Campinas (IAC) was created in 1887; the Luiz de Queiroz College of Agriculture (ESALQ) was launched in 1901 and later incorporated into the University of São Paulo (USP); the Agricultural School of Lavras, in Minas Gerais, began in 1908; and the Escola Superior de Agricultura e Veterinária de Viçosa, later integrated into UFV, dates back to 1920. However, no other agency has as many branches—there are seven central units, located in the Federal District, and 43 spread throughout the Brazilian states.

“EMBRAPA is one of the big projects of the past military government, and had a strong influence from the United States,” says historian Jefferson Sanches, a basic education and college entrance exam teacher in the public and private school systems of Vinhedo and Jundiáí, in the state of São Paulo. He observes that for the military government, the production model based on monoculture on large properties and bank loans with interest below inflation was a way of occupying

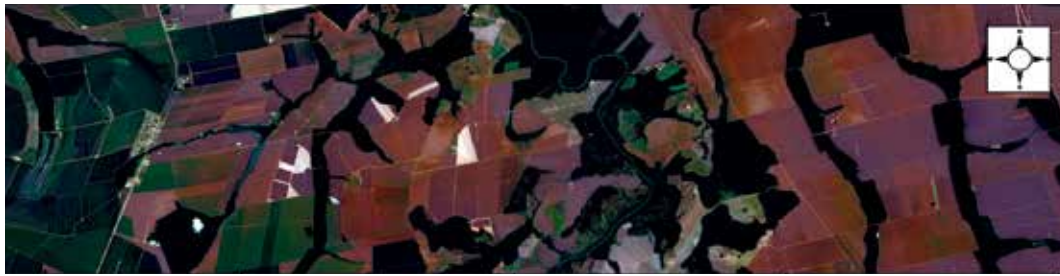
## INNOVATION IN THE FIELD

As of 2018, the count includes only market-ready technologies



# PLANTATIONS WITH PRECISE BOUNDARIES

Method using satellite image analysis facilitates the mapping of rural areas



Landsat images and maps from MapBiomass and the Department of National Transportation Infrastructure (DNIT) show the distribution of native vegetation, agriculture, and livestock in Sorriso, Mato Grosso



- Highways
- Urban areas
- Water bodies
- Native vegetation
- Cotton
- Bean
- Corn
- Other rainfed crops
- Cultivated pastures
- Sugarcane
- Irrigated crops

the Midwest, undermining the concept that agrarian concentration was an obstacle to economic development and a way to put off agrarian reform.

In a November 2022 article in *Revista de História*, Sanches describes how EMBRAPA was formed through connections between the Brazilian government and American philanthropic organizations, including the Rockefeller and Ford foundations, which turned to promoting increased food production after their contributions to funding research on global health issues. He writes that EMBRAPA's creation was inspired by prior efforts funded by US institutions, such as expanding the production of rice in the Philippines, wheat in Mexico, and potatoes in Peru. In this way, the Green Revolution, a strategy to increase productivity in the agricultural field that began in the US in the 1960s, went global, encouraging the consumption of seeds, fertilizers, and equipment produced by American companies.

EMBRAPA assumed the functions of the Agricultural Research Department of the Ministry of Agriculture, with the mission of consolidating scientific investigations and coordinating between state-owned companies, many of which had been deactivated over the previous years. One of its initial priorities was to implement commercial agriculture in the central region of Brazil, which at that time was mostly untouched Cerrado (wooded savanna). Sanches explains that the development of new techniques gave science-based reinforcement to the occupation being led by shrewd farmers in the states of Rio Grande do Sul and Santa Catarina, who had purchased land at low prices.

Methods of correcting soil acidity with limestone, directly planting the soil (without tilling, to avoid loss of nutrients), and the use of nitrogen-fixing bacteria became common. Sanches notes that the initial research that led to expanded agricultural production in this region was a doctoral thesis by Serbian scholar Nikolai Pulchritudoff, presented in 1971 at the University of California at Davis in the United States. His study described the mineral deficiencies of the Cerrado and the ways they could be successfully ameliorated.

Sanches characterizes the creation of EMBRAPA as a sign of what he calls the "modernization of permanence," an expression based on the concept of conservative modernization, created by the American sociologist Barrington Moore Jr. (1913–2005). "It was a reorganization of agricultural production without changing the land base, drawing on a narrative based on science and technology, according to which modernization would be the only path, and naturally beneficial," he comments. In the book *A modernização dolorosa* (The painful modernization) (Zahar, 1982),





# ENCOURAGING THE USE OF DIGITAL TECHNOLOGIES IN THE FIELD

Connectivity projects promote the use of apps among small and medium-sized rural producers

FAPESP is set to make a public announcement this month regarding a multidisciplinary research and innovation project named Science Center for Development in Digital Agriculture (CCD/AD/SemeAR), headquartered at EMBRAPA Digital Agriculture, in Campinas. Its purpose will be to expand the use of digital technologies and internet connectivity among small and medium-sized rural producers throughout Brazil.

“Complex projects like SemeAR often require adjustments in funding models,” said FAPESP Science Director Luiz Eugênio Mello. “In this case, we requested that the project include something similar to a PMO (project management officer) and we dedicated several months to planning and structuring the project to increase its chances of success,” he explained.

“One of our goals is to put rural producers in direct contact with the market, without

intermediaries,” adds Carlos Américo Pacheco, director-president of FAPESP’s Technical-Administrative Board. “This project should have a big impact on improving rural incomes.”

Five pilot areas will be monitored in the state of São Paulo, one in Minas Gerais State, and one in each of the other four regions of the country (North, Northeast, Midwest, and South). Work has already begun in two municipalities in cooperation with the association of producers, city halls, and businesses. The first is Caconde, a key coffee-producing municipality in São Paulo with approximately 20,000 residents on the east side of the state; the other is São Miguel Arcanjo, to the south, a major supplier of fruits and vegetables with approximately 33,000 inhabitants.

“Digital technology is already on the minds of many producers,” observes Sílvia Massruhá, CCD-AR/SemeAR coordinator.



EMBRAPA Digital Agriculture's climate monitoring system in Campinas

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She says researchers will find companies, or develop apps, to solve the demands of farmers and expand the connectivity of small and medium-sized rural producers. A 2021 survey by the Ministry of Agriculture and ESALQ/USP indicated that only 23% of the country's rural area has internet access. “Every modern production chain demands digital technology tools,” she says. The project has the participation of approximately 40 researchers, including other EMBRAPA units, the Center for Telecommunications Research and Development (CPQD), the IAC, the Institute of Agricultural Economics, the National Institute of Telecommunications, ESALQ, and UFV

agronomist José Graziano da Silva emphasizes that this process increased wealth concentration, income disparities, the rural exodus, and the exploitation of the agricultural workforce.

**T**he Cerrado has become one of Brazil's principal agricultural granaries, currently responsible for providing 86% the country's cotton production, 50% of its soybean, 43% of its bean, and 34% of its beef production. Agriculture has grown stronger. However, as a negative consequence of employing the high-production paradigm, it is estimated that 45% of the area previously covered by native vegetation has been occupied by agriculture, with losses to biodiversity and possibly worse: the risk that rivers with headwaters in the Midwest—and that flow to other regions of the country—will run dry (see *interview with Mercedes Bustamante in Pesquisa FAPESP issue no. 324*).

In 1996, EMBRAPA launched “light pork,” with less fat, already in its third generation, and has since introduced grapes and other fruit varieties to be grown along the banks of the São Francis-

co River. It participated, together with other research institutions, in the development of most of Brazil's 140 coffee cultivars and created methods for cultivation amid forests in Rondônia State. The company's institutional website portfolio lists 1,106 products or technologies, including beef production with lower carbon dioxide and methane emissions, the gases principally responsible for global warming.

During its 50 years, EMBRAPA has developed 72 cultivars of orange, 53 of peach, 44 varieties of grape, 24 of cupuaçu, 22 types of banana and passion fruit, and 10 cultivars of pineapple and melon. Including other fruit types, a total of 419 new varieties have been developed by EMBRAPA. One of its most recent innovations, announced in October, is a new variety of a typical Cerrado fruit, the pequi, without inconvenient thorns.

As a basis for future research, EMBRAPA's gene banks contain approximately 300,000 samples of 1,096 species of cereals, fruits, root plants, palm trees, and others, in addition to 115,000 samples of animal semen and 70,000 microorganisms. ■

The full *Pesquisa FAPESP* dossier on EMBRAPA and the projects and articles consulted for this article are listed in the online version.

Genetically modified, herbicide-tolerant sugarcane seedlings