THE INSTITUTE OF Development Leadership Dialogue

SOAS University of London

EMBRAPA'S TROPICAL REVOLUTION:

HOW STATE-LED AGRICULTURAL RESEARCH & INNOVATION HELPED BRAZIL BECOME AN AGRICULTURAL SUPERPOWER

In the 1970s Brazil was struggling with chronic food insecurity but today it is an export-oriented global agricultural powerhouse. The agriculture sector has been one of the main islands of success in a country that has seen de-industrialisation and declines in productivity and output across other sectors in the economy.

One of the decisive factors in Brazil's 'tropical revolution' has been the country's state-owned agricultural research and development agency – Embrapa – which has been successful in fostering innovation and effectively diffusing advanced home-grown technologies to Brazilian farmers. Embrapa demonstrates that investing in state-led high-tech agricultural capability development can play an important role in a country's economic transformation.

This case study will outline Embrapa's main achievements and analyse the factors behind its success.

EMBRAPA'S ORIGINS AND ACHIEVEMENTS

The Brazilian Corporation of Agricultural Research (Embrapa) was established in 1973 by the military regime. The country was struggling with increased demand for food created by rapid urbanisation, exacerbated by the high cost of imports. Embrapa was created to deliver a step-change in domestic food production which would help the balance of payments by reducing food imports and ultimately move towards an export-oriented model.

In the past 50 years Brazil's agricultural production has increased dramatically, with a more limited increase in planted area (see Chart 1).

Increase in agricultural production in Brazil since the establishment of Embrapa

Grain production **up 510%**

Wheat and corn production **up 240%**

Rice production **up 315%**

59-fold increase in beef and chicken production

Source: Embrapa "**Your Future Inspires Our Science**" 2023

[1] Embrapa website

[2] Barbosa, V.C.R. & Brisola, M.V. (2024) "**Beyond the fields: EMBRAPA'S sustainable technological prospects for Brazilian agribusiness**" *Revista de Economia e Sociologia Rural*

ABOUT EMBRAPA

Expertise: 2,051 researchers, 90% of whom have a PhD

Reach: The largest research and development organisation in Latin America with 43 research centres located in every region of the country and over 150 research projects in approximately 40 countries.[1]

Success: Embrapa has developed and transferred more than 1,188 technologies, created over 2,043 cultivars and obtained more than 363 patents.[2]

POLICY QUESTIONS FOR CONSIDERATION

- What are the priority areas for agricultural research and innovation in your country?
- What innovation-support institutions could be created, supported or invested in?
- What are the barriers to more effective public provision of agricultural research?
- Are poor agricultural outcomes in your country the result of an over-reliance on private market actors to allocate resources and innovate?

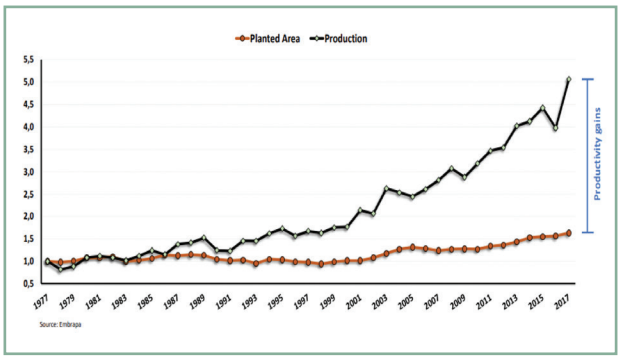

Chart 1: Growth in Brazil's agricultural production and planted area 1977-2017 (Source: Embrapa)

In 2024 Brazil's agribusiness exports totalled US$ 164.4 billion - the second-highest value on record - accounting for 49 percent of the country's total exports[3] and Brazil has overtaken agricultural competitors such as the USA to become the world's largest exporter of major commodities including soya, beef, corn, sugar and ethanol-related products.

This remarkable shift towards a highly capital intensive and advanced technological model of agriculture was enabled by many factors, including the large-scale experienced farmers who moved from the south of the country to the newly-opened Cerrado (see below) and a smart mix of policy tools such as highly subsidised credit and targeted trade liberalisation which reduced input prices. Within this mix, Embrapa played a pivotal role. Embrapa's research-led technological innovations helped raise agricultural productivity, expand Brazil's agricultural frontier, reduce production costs and diminish dependence on external technologies. Together, these developments fulfilled Embrapa's original mission of contributing to lower and more stable food prices and significantly boosting foreign exchange earnings.

Amongst Embrapa's major achievements are:

A. RECLAMATION OF THE CERRADO

The Cerrado is Brazil's second largest biome and is the world's largest and most biodiverse savannah. The land was considered unsuitable for agricultural production due to the acidity of the soil. Through a series of technical interventions, Embrapa turned this around thus opening up one of the largest reserves of arable land in the world. The interventions included: liming the soil; introducing a new variety of cross-bred grass and developing 'rhizobium', a bacterium adapted to the Cerrado soil which helps reduce the need for costly fertilisers. The formerly 'unproductive' Cerrado is now responsible for almost 60% of Brazil's agricultural production.[5]

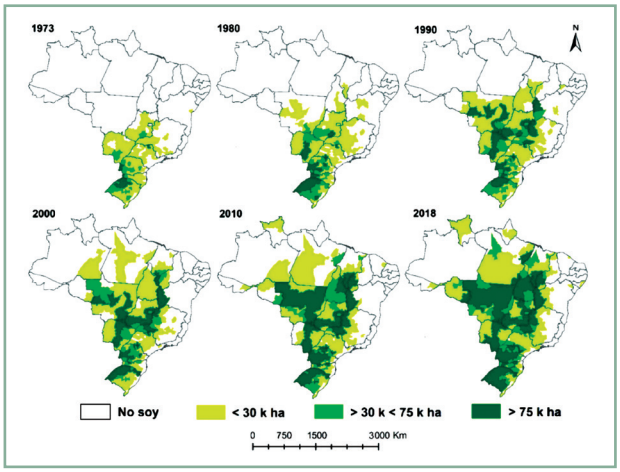

Figure 1: Area cultivated with soybean in Brazilian microregions (thousands of hectares)[6]

> **But the availability of farmland is in fact only a secondary reason for the extraordinary growth in Brazilian agriculture. If you want the primary reason in three words, they are Embrapa, Embrapa, Embrapa.[4]**

B. TROPICAL SEED AND CROP DEVELOPMENT

Embrapa was pivotal in the development of seeds suitable to tropical conditions, helping to increase agricultural productivity and also supporting tropical agriculture in other parts of the developing world. Through cross-breeding and genetic modification, Embrapa created new soya seeds which enabled this temperate crop (native to East Asia) to thrive in a tropical climate, as well as developing a shorter life-cycle crop that enabled two harvests per year.[7] Brazil is now the world's largest exporter of soya beans by a considerable margin with exports approaching double the value of US exports in 2024.[8]

In the 1980's Brazil's cotton industry was struggling with the impacts of the boll weevil pest and trade liberalisation, which had resulted in domestic production being undercut by imports. Embrapa developed a new cottonseed which was adapted to semi humid tropical conditions. With the new seed farmers were able to achieve higher yields per hectare at a fibre quality equivalent to imported products. This helped to turn around a sector that is an important employer of unskilled labour.

C. DEVELOPMENT OF 'ZERO TILLAGE AGRICULTURE'

Zero tillage (ZT) agriculture is a system of planting crops directly in the ground with minimal soil disturbance, as well as using cover crops and crop rotation. This technique increases water infiltration and organic matter retention, hugely improving soil fertility whilst also reducing soil erosion and lowering production costs. The technique is highly sensitive to ecological conditions and so requires substantial adaptation. Embrapa, working closely with private companies, developed a ZT package suitable for the subtropical conditions of southern Brazil. It then adapted and expanded this further for use in the Cerrado, providing training and input packages adapted to a variety of different sizes and types of farm.[9]

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[3] Ministry of Agriculture and Livestock News (3 February 2025) "**Brazilian agribusiness reaches historic milestone in global food security**"

[4] Cremaq, P (26 August 2010) "**The miracle of the cerrado**" *The Economist*

[5] De Paula, T. (15 April 2024) "**Comment: How to boost Brazil's agricultural sector and protect the Cerrado**" Reuters

[6] Source: Pires, S. et al (2021) "**Soy Expansion, Environment, and Human Development: An Analysis across Brazilian Municipalities**" *Sustainability*

[7] Hopewell, K. (2017) "**A changing role for agriculture in global political economy? Brazil's rise as an agropower**" in ME Margulis (ed.) *The Global Political Economy of Raúl Prebisch*

[8] ITC Trade Map

[9] *Figuereido, P. (2014)* "**Technological Catch-up and Indigenous Institutional Infrastructures in Latecomer Natural Resource-related Industries: An Exploration of the Role of EMBRAPA in Brazil's Soybeans and Forestry-based Pulp and Paper Industries**" *University of Manchester Global Development Institute Working Paper Series*

THE BATTLE OVER EFFECTIVE AGRICULTURAL SUPPORT

Agricultural research and innovation is notoriously challenging for a number of reasons: it is highly location specific; has to constantly adapt to environmental risks; there is a high risk of failure; limited returns, especially in the short-term; and economies of scale are not always easily available. Consequently the private sector often fails to invest. Despite this, in the 1980s and 1990s donors argued that the state was not capable of supporting innovation and required the withdrawal of state support from agricultural research, education, extension, and infrastructure as a condition of their support - with disastrous consequences for productivity and food security. The example of Embrapa – as well as many now-successful agricultural economies such as Germany, Denmark, The Netherlands and the United States – demonstrates that state-led organisations can be effective vehicles for the development of high-tech agricultural research and innovation.[10]

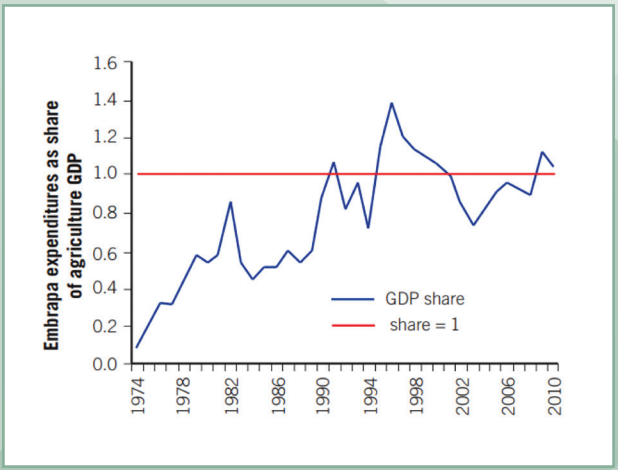

Chart 2: Embrapa expenditures as share of agriculture GDP[13]

SUCCESS FACTORS

Embrapa succeeded in generating highly market-relevant research in a reasonable timeframe, at reasonable cost, supported adoption by farmers and generated measurable real-life results. This section will look at some of the factors behind Embrapa's success.

1. Public funding.

In contrast to the economic orthodoxy at the time (see above), Embrapa received substantial and sustained public funding for the first forty years of its existence. Total government investment in Embrapa's first twelve years was around US$ 6 billion dollars (in 2008 value).[11] Even as the Brazilian economy suffered various shocks and contractions, the impact on Embrapa's funding was relatively minor as shown in Chart 2. Expenditure levels from 1994-2014 were around 1% of Brazil's agricultural gross GDP which compared well to developed countries such as Canada, the US and Australia (1.2, 1.4 and 0.8 respectively between 2006 -9).[12]

These levels of public funding were possible because Embrapa not only delivered impressive on the ground results such as lower food prices, but was also proactive in communicating these results to politicians and the public. It had a team of journalists, public relations and communication professionals dedicated to maintaining Embrapa's media profile. Today Embrapa experts still regularly feature on Globo Rural – a TV show - thus contributing to 'brand awareness' and association of Embrapa with national pride.[14]

2. Governance, human resources and culture.

Between 1974 and 1982 an impressive 20% of Embrapa's budget was invested in the education and training of its employees. Today 90% of its researchers have PhDs.[15] The organisation has focused on developing clear pathways for career advancement, paying good salaries, delivering merit-based promotions and an excellent training programme. This approach was supported by the decision to establish Embrapa as a public corporation which gave it flexibility to operate under private, rather than public sector, rules.[16]

As well as the quality of its research, Embrapa has developed and maintained a very practically-oriented company culture. The emphasis is on creating solutions to practical problems and disseminating these quickly and effectively to farmers. In achieving this, Embrapa has been helped by its coherent strategic planning process, rigorous evaluation processes and governance systems which include a Board with representatives of small and large farmers, researchers, agribusiness and universities.[17]

3. Clear public interest mandate and flexible approach to intellectual property.

Embrapa has always had a clear public interest mandate. As a state-owned enterprise it has had administrative independence which has enabled it to plan long-term and interact effectively with all market players ensuring uptake of its innovations.

Embrapa's approach to intellectual property, derived from this public interest mandate, favoured social well-being, allowing new technologies such as improved seeds to be distributed at production cost. This open innovation system facilitated technology transfer and the diffusion of new cultivars.[18] From the mid-1990s, following the development of Brazilian IPR laws, commercial production using any of Embrapa's publicly funded technologies requires a contract which ensures royalty payments or profit-sharing.

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[10] Chang, H (2009) "**Rethinking public policy in agriculture: lessons from history, distant and recent**" *Journal of Peasant Studies*

[11] Alves, E. (2010) "**Embrapa: A successful case of institutional innovation**" *Revista de Politica Agricola*

[12] Correa, P. & Schmidt, C. (2014) "**Public Research Organizations and Agricultural Development in Brazil: How Did Embrapa Get It Right?**"

[13] Correa, P. & Schmidt, C. (2014) "**Public Research Organizations and Agricultural Development in Brazil: How Did Embrapa Get It Right?**"

[14] See Alves, E. (2010) "**Embrapa: A successful case of institutional innovation**" and Cabral, L. (2020) "**Embrapa and the construction of scientific heritage in Brazilian agriculture: Sowing memory**"

[15] Embrapa "**Embrapa 50+ The revolution of the future starts now**" 2024

[16] Correa, P. & Schmidt, C. (2014) "**Public Research Organizations and Agricultural Development in Brazil: How Did Embrapa Get It Right?**"

[17] OECD (2015) "**Innovation, Agricultural Productivity and Sustainability in Brazil**"

[18] Correa, P. & Schmidt, C. (2014) "**Public Research Organizations and Agricultural Development in Brazil: How Did Embrapa Get It Right?**"

4. Decentralisation, collaboration and coordination

Embrapa has excelled at delivering demand-driven research which creates technologies that are specifically oriented towards local needs rather than merely transferring foreign technologies.[19] This has been supported by the spatial distribution of its research and development infrastructure which enables it to reach all Brazilian biomes. It has centralised units (such as finance and IT) and then 43 units located in every region of Brazil covering different products, technologies and research themes (see map).

Embrapa has also played a vital leadership and coordination role at the centre of a complex agricultural research and innovation network composed of the private sector, state-level agriculture research and extension services, universities (Brazil has around 80 agricultural universities), NGOs and foundations. Much of this 'web' is rooted in local institutions further underpinning the organization's responsiveness.

Over time, Embrapa has been key to the development of a range of cross-sectoral linkages and capability developments, with increasingly sophisticated connections between agriculture, manufacturing, and services. Examples of this type of cross-pollination include satellite monitoring services created in land leased by the Brazilian military and facilities for quality improvement in the meat production chain.[20]

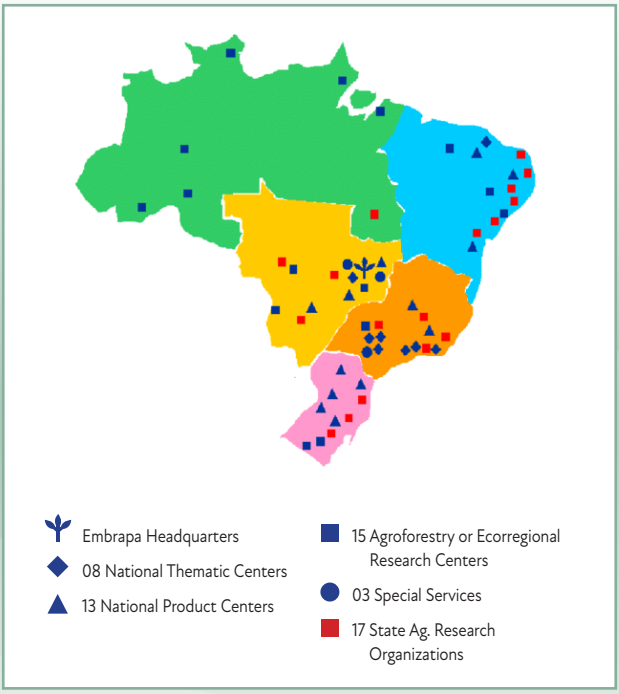

Figure 2: Map of Embrapa's Units (Source: Embrapa)

EMPRAPA'S PAST AND FUTURE

Brazil's tropical revolution, with its emphasis on large-scale vertically integrated commercial farming, did not come without a cost in terms of loss of biodiversity, worsening land distribution, forced removals and corporate concentration.[21] In addition, rising land prices in the Cerrado pushed some cattle enterprises north into the more fragile Amazon. In recent years Embrapa has placed a greater emphasis on sustainability including resilient production and crop-livestock integration systems.

The last decade (2014 to 2024), has seen a marked downturn (80%) in Embrapa's discretionary budget and a move towards a partnership model and greater use of external funding sources.[22] There is concern that this shift away from public funding will challenge its ability to deliver its mission. However, there is also an argument that Embrapa's principle mission (to establish viable modern tropical agriculture to deliver national food security and export potential) has largely been achieved and it can now more safely adapt to the times.

ABOUT SOAS DEVELOPMENT LEADERSHIP DIALOGUE (DLD)

Economic and social development requires many actors: however, typically these have operated in separate spheres, not understanding each other well and even seeing each other as adversaries. In a world characterised by profound changes and heightened uncertainties, overcoming this 'silo-ization' and the lack of mutual understanding it leads to is ever more important.

DLD brings people and disciplines together to generate more creative and strategic solutions to difficult development challenges. DLD is generously supported by Hyundai Motor Group UK Ltd. and Kia UK Ltd.

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FURTHER READING

Cabral, L. (2020) "**Embrapa and the construction of scientific heritage in Brazilian agriculture: Sowing memory**" *Development Policy Review*

Correa, P. & Schmidt, C. (2014) "**Public Research Organizations and Agricultural Development in Brazil: How Did Embrapa Get It Right**?" World Bank Poverty Reduction and Economic Management (PREM) Network *Economic Premise* Series

Figuereido, P. (2014) "**Technological Catch-up and Indigenous Institutional Infrastructures in Latecomer Natural Resource-related Industries: An Exploration of the Role of EMBRAPA in Brazil's Soybeans and Forestry-based Pulp and Paper Industries**" *University of Manchester Global Development Institute Working Paper Series*

Hopewell, K. (2017) " **A changing role for agriculture in global political economy? Brazil's rise as an agropower**" in ME Margulis (ed.) *The Global Political Economy of Raúl Prebisch*

[19] Hopewell, K. (2017) "**A changing role for agriculture in global political economy? Brazil's rise as an agropower**" in ME Margulis (ed.) *The Global Political Economy of Raúl Prebisch*

[20] Andreoni, A. & Tregenna, F. (2018) "**Stuck in the middle: Premature deindustrialisation and industrial policy**" Centre for Competition Regulation and Economic Development Working Paper

[21] Cabral, L. (2020) "**Embrapa and the construction of scientific heritage in Brazilian agriculture: Sowing memory**" *Development Policy Review*

[22] AgriBrasilis (13 January 2025) "**Brazilian Agricultural Research Corporation Faces Budget Reduction**" & Walendorff, R. (31 January 2025) "**Embrapa seeks alternative funding sources**" *International Valor*