IRIBA
International Research Initiative on Brazil and Africa

Research briefing:

How EMBRAPA catalysed productivity gains in Brazil's Soybean and Pulp and Paper Industries

Summary

- Brazil's soybean and forestry-based pulp and paper industries have made world leading advances in innovation and productivity, catalysed by the innovative work of the government's agricultural research institute, EMBRAPA.
- An important feature of EMBRAPA's contribution to the innovative performance and competitiveness of both soybean and forestry-based pulp and paper sectors, is its application-oriented research, linked with industry demands.
- EMBRAPA's activities have increasingly been undertaken on the basis of a network involving extensive partnerships with other public and private research institutes and universities and companies.
- Innovative activities that have generated a significant productivity increases are not solely the product of sophisticated R&D efforts. The implementation of the zero-tillage (ZT) technology in Brazil's soybean industry is an example of effective creative imitation, coordinated by EMBRAPA.

The Issues

While there has been an unprecedented increase in demand for agricultural produce around the world, productivity growth has been slowing. Globally, productivity is expected to rise by just 1% a year over the next two decades, much slower than historical trends. To meet the likely demand for food and fuel in 2030 will require an additional 175 million to 220 million hectares of cropland.

An alternative way to meet the growing demand for resources over the next decades will be to expand innovation capabilities and institutional infrastructures to deliver large scale and high productivity crops, especially in developing economies. Yet the next so-called green revolution should also bring the benefits of agricultural innovation and research to the poorest farmers across the developing world.

This briefing summarises the main results of an exploratory study on the role of indigenous institutional infrastructures (knowledge related institutions and government policies) in the accumulation of world-leading innovative capabilities (technological catch-up) in latecomer natural resource-related industries. These issues are examined from the perspective of the Brazilian Corporation for Agricultural Research (EMBRAPA) and Brazil's soybean and forestry-based pulp and paper industries.

The role of EMBRAPA

Since its creation in 1973, EMBRAPA has operated under Brazil's Ministry of Agriculture, Livestock and Food Supply. EMBRAPA has a budget of approximately US$ 1 billion, largely funded by the federal government. It has approximately 9,600 employees, of which 25% (2,400) are researchers. More than 80% of EMBRAPA's researchers hold PhD degrees. It is organized on the basis of centralised units (e.g. finance management, IT), services units, national product centres, national thematic centres, and eco-regional units. EMBRAPA also coordinates the National System of Agricultural Research (SNPA), see Figure 1.

Figure 1: EMBRAPA's coordination of agricultural research in Brazil

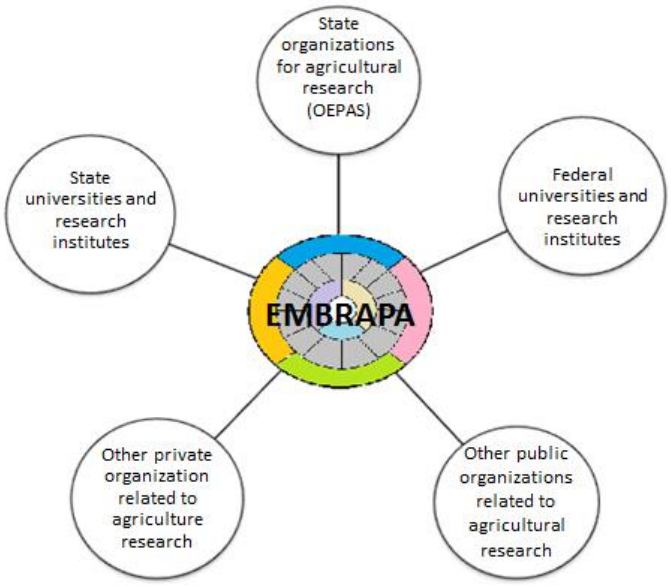
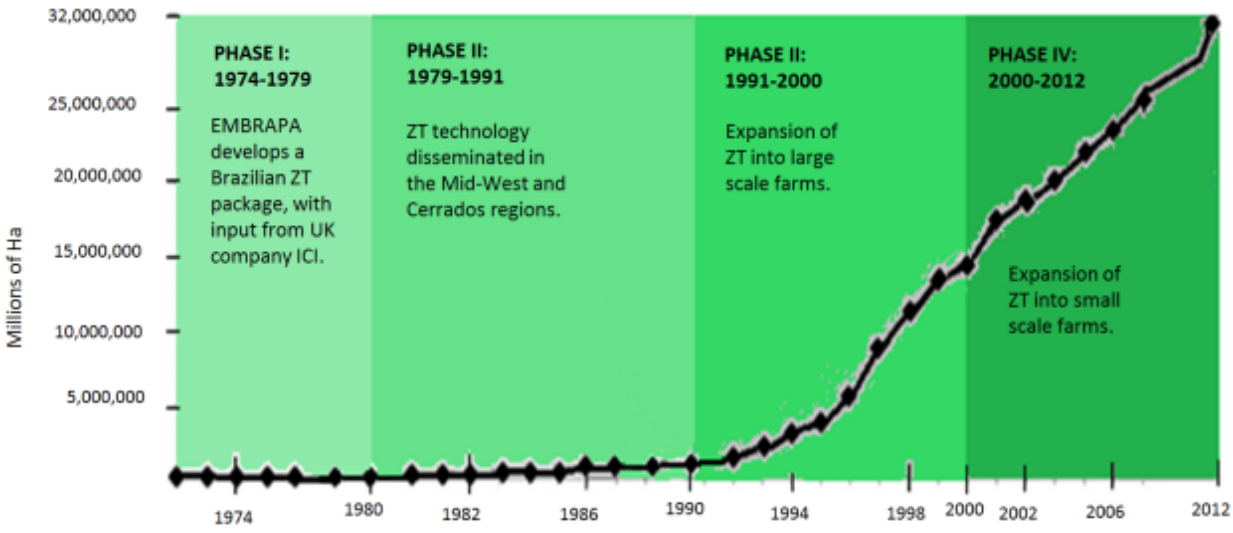


Figure 2: Evolution of Zero Tillage Development Phases in Brazil



Brazil's soybean industry: competitiveness and innovation

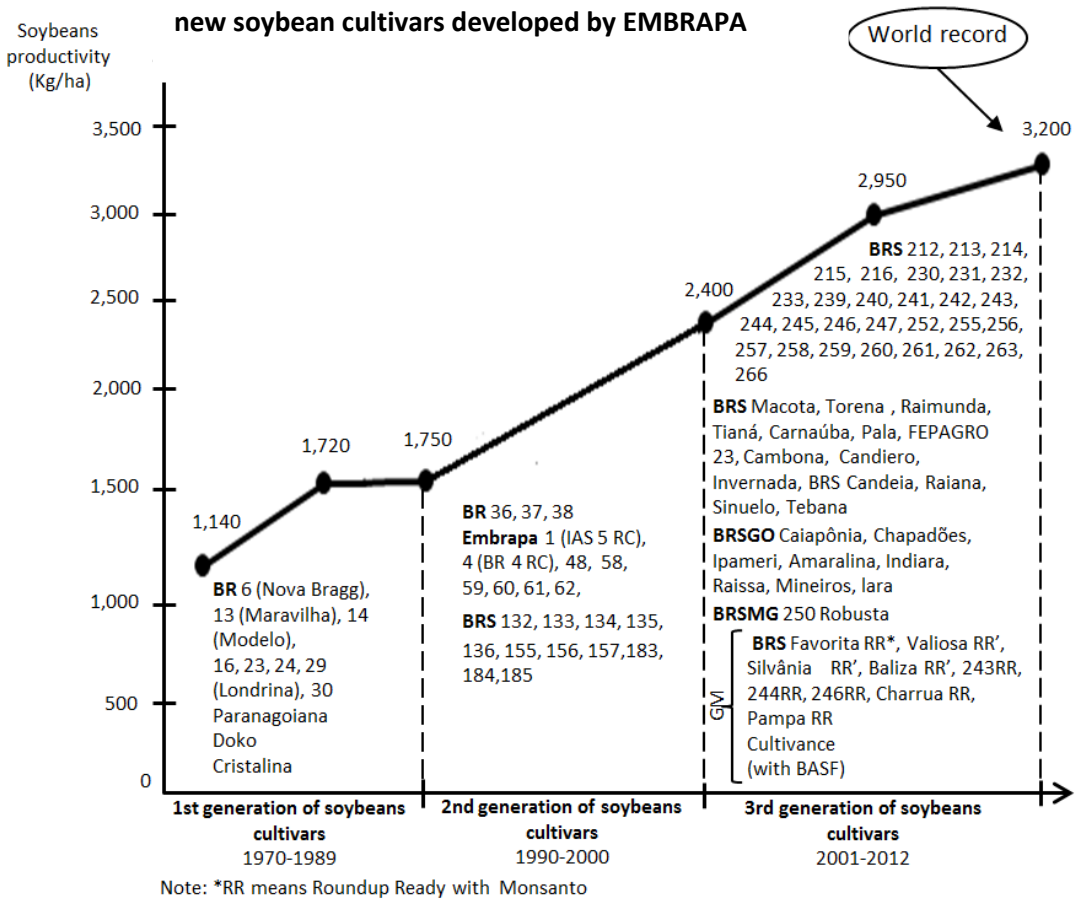
Brazil is the world's second largest soybean producer (behind the US) and the world leader in soybean productivity (Kg/ha). In the 2012/13 crop Brazil produced 81.5 million tonnes of soybeans, while the US produced 82.1 million tonnes. Brazil's soybean production grew by 9.3% from 2008/09 to 2012/13, while US production grew by 0.43% over the same period. Brazil produces a quarter of the world's soybean exports on just 6% of the country's arable land.

By 2012, the overall average yield for soybeans in Brazil (3,000 Kg/ha) surpassed the average yield in the US (2,800 Kg/ha). The cost of producing soybeans in Brazil fell to about $6.23 per 60 kg/bag, around half of the US cost of $11.72. EMBRAPA has played a significant role in achieving such impressive productivity gains.

Innovation in agricultural process: adopting of the zero tillage technology

Zero tillage (ZT) means planting with minimum soil disturbance, coverage of soil with plants and plant residues and rotation of crops. By 2009, Brazil had 25,502 million hectares of ZT cultivated area, slightly more than the US. ZT is sensitive to local ecological conditions so Brazil could not simply replicate the same technique adopted in other countries. To adopt the ZT technique, Brazil had to engage in a process of creative imitation. This adoption process involved four phases (Figure 2).

Figure 3: The evolution and productivity increase of new soybean cultivars developed by EMBRAPA



Note: *RR means Roundup Ready with Monsanto

Development of new soybean cultivars

EMBRAPA Soybean, one of EMBRAPA's crop-focused units, was created in the early 1970s. Since then it has developed over 300 new soybean cultivars to suit different regions of Brazil, which are resistant to major crop diseases and now account for over 50% of the national seed market. New cultivars developed by EMBRAPA have seen yields more almost triple since the 1970s.

Brazil's forestry-based pulp and paper industry: competitiveness and innovation

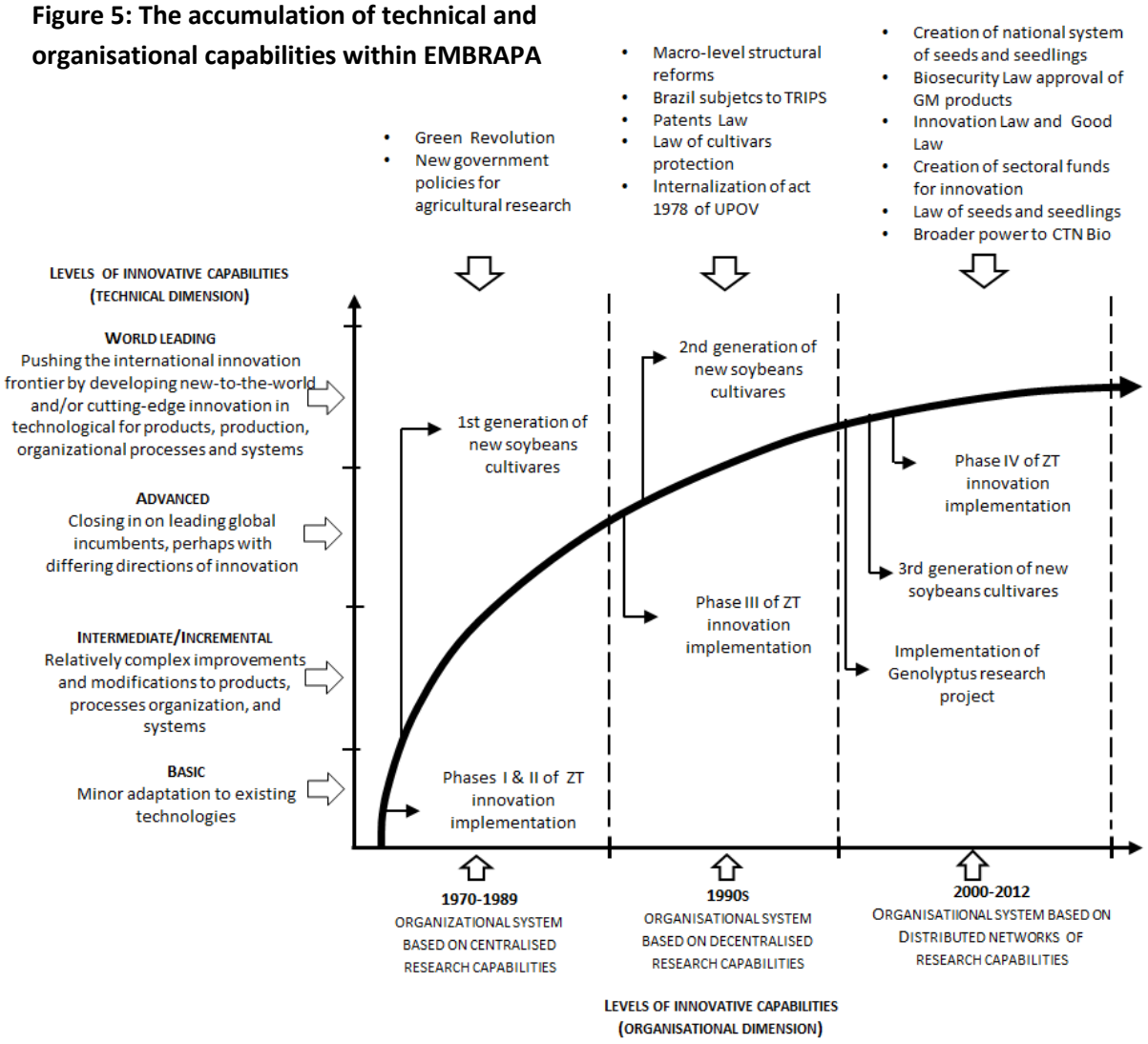
Brazil is the world's largest producer of hardwood pulp ('eucalyptus pulp'), the world's fourth-largest pulp producer, and the ninth-largest paper producer. Of the pulp and paper produced in Brazil, 100% is derived from planted forests, which are renewable resources. Brazil has 2.2 million hectares of fully certified land planted for industrial use. In 2012, the revenue from Brazil's pulp and paper industry approached US$17 billion, yielding exports of US$ 7.2 billion. From 1970 to 2012, Brazil's output of pulp grew by an average of 6.8% and paper by an average of 5.4% per year.

In the forestry-based pulp and paper industry, EMBRAPA played a more significant role **after** leading firms accumulated world-class innovative capabilities. By the late 1990s, Brazil had already consolidated its world-leading technological position in the eucalyptus-derived pulp and paper industry.

During the early 2000s, the EMBRAPA Forestry and EMBRAPA Genetic Resources and Biotechnology led a remarkable nationwide research project on the eucalyptus genome. The Genolyputs network established a collection of over 150,000 DNA sequences generated from genes and genomes of four species of Eucalyptus.

In addition to being an important organisational innovation for the forestry-based pulp and paper industry, Genolyptus also generated:

Figure 5: The accumulation of technical and organisational capabilities within EMBRAPA



(i) The development of new human capital (e.g. MSc and PhD's)
(ii) The development of new techniques for assisted molecular breeding
(iii) The development of new techniques for wood quality improvement
(iv) New techniques for physical wood analysis
(v) An organised network of researchers

Relevance of increased technological capabilities:

The innovative activities outlined above have been implemented on the basis of technological capabilities accumulated by EMBRAPA and increasingly distributed among its partners. These technological capabilities have a technical dimension centred on human resources, skills, and knowledge bases, and an organizational dimension, centred on different forms of specialization/differentiation, integration/co-ordination and 'orchestration'.

As shown in Figure 5, as EMBRAPA's innovative capabilities increased, its organisational structure developed from a centralised approach, towards more networked research capabilities. The accumulation and strengthening of this organisational basis over time has been decisive to support innovative activities in these two industries. Figure 5 also suggested that the accumulation of these innovative technological capabilities have been influenced by changes in government policies, particularly since the 1990s.

Policy Implications:

1) In agriculture, public research organisations play an important role in catalysing industrial innovation. But they need to work together with key industry stakeholders to meet their needs and demands.

2) Investment in science is not a guarantee of achieving relevant innovative performance. Policy makers should adopt a comprehensive perspective on innovation based on a spectrum of activities: from duplicative copy, creative imitation to progressive levels of innovation. Important innovative activities can be implemented on the basis of capabilities other than R&D.

3) Natural resource-related industries offer important opportunities for innovation and for achieving international competitiveness. Achievements in this area depend on the accumulation of innovative capabilities, connected with market needs and demands, at the level of industry and organisations. They also depend on the design and implementation of government policies to stimulate, support and fund the development of these capabilities.

This briefing is based upon IRIBA working paper 3, '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', by Paulo N. Figueiredo, available at **http://www.brazil4africa.org**

Further reading:

- FAO (Food and Agriculture Organization of the United Nations). (2014). The State of Food and Agriculture.
- Grattapaglia, D. (Ed.). (2011). IUFRO Tree Biotechnology Conference 2011: From Genomes to Integration and Delivery. BMC Proceedings. Bahia, Brazil, 26 June–2 July.
- IFPRI (International Food Policy Research Institute). (2012). ASTI Global Assessment of Agricultural R&D Spending.
- McKinsey Quarterly. (2014) Are you ready for a resource revolution?
- McKinsey Global Institute (2011). Resource revolution: Meeting the world's energy, materials, food and water needs.
- The Economist (2014). Briefing: The new green revolution. May 10th.

IRIBA is a DFID funded research programme, based at the University of Manchester. It brings together an international team of researchers, examining how lessons from Brazil's development experience can be learned and adapted for African countries.

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