



THE GLOBAL FARM

With its plentiful sun, water and land, Brazil is quickly surpassing other countries in food production and exports. But can it continue to make agricultural gains without destroying the Amazon?

Jeff Tollefson reports from Brazil.

Mateus Batistella used to be a vegetarian, but Brazilian cuisine has worn him down. At lunchtime, virtually all the restaurants offer a classic dish of thin-cut beef with salad, rice and beans, served with a cooked-flour dish called farofa. In cities and towns, traditional butchers and supermarkets alike sell every cut of beef imaginable. “It’s everywhere, and it’s cheap,” says Batistella, who heads a satellite-monitoring research centre in the southern city of Campinas for Embrapa, the research arm of Brazil’s agriculture ministry. “Today I eat beef all the time.”

That isn’t the most politically correct course of action in a country in which cattle ranching is often linked with destruction of the Amazon rainforest. Batistella even has a satellite image on his office wall, showing the world’s largest tropical forest under siege from the south by agriculture. Nonetheless, the world, like Batistella, is consuming more and more beef each year.

All that meat has to come from somewhere, and increasingly it is coming from Brazil. This rising agricultural powerhouse has quadrupled beef exports over the past decade, and in 2003 it vaulted past Australia as the world’s largest exporter. Capitalizing on its vast natural resources and a booming economy, Brazil



is competing with the United States for the title of world’s largest soya exporter. The United Nations Food and Agriculture Organization forecasts that Brazil’s agricultural output will grow faster than that of any other country in the world in the coming decade, increasing by 40% by 2019.

There was a time when such figures would have spelt doom for the Amazon. In the past, when demand for commodities such as beef, maize (corn) and soya went up, trees came down. But the opposite has happened in recent years. Despite rising production and persistently high commodity prices since the height of the global food crisis in 2007–08, Amazon deforestation plunged to a historic low last year, nearly 75% below its 2004 peak, and some expect more good news this year. This trend fuels hopes that Brazil is establishing a sustainable agricultural system that will help to feed a growing world in the decades to come — and lower the environmental cost of beef habits like that of Batistella.

“We broke the paradigm in the past five years,” he says. “There is no longer a direct correlation between food and deforestation.”

Brazil has managed that feat through policy, improvements in agricultural science, better enforcement of environmental laws and pressure from consumers. But the country still faces

numerous challenges as it seeks to boost food production. Conflicts over land-use policies are common, and climate change will take a bite out of many important crops unless plant breeders can keep up.

Fields of soya

Brazil’s rise as an agricultural giant began with soya beans, the country’s largest food crop, which had a value of nearly US\$17 billion in 2008. In the 1960s, soya’s range was largely limited to the south of Brazil, but since then breeders have developed varieties that can grow across most of the country. Agricultural scientists tamed the highly acidic soils of the Brazilian savannahs with applications of lime and other nutrients, and reduced fertilizer costs by developing methods to inoculate seeds with rhizobia, bacteria that colonize the roots of plants such as soya and fix nitrogen. Brazilian farmers are now competing with the United States to set the record for soya-bean yields (see graphic).

And after a long delay, Brazil is also making up ground on transgenic crops. A decade ago, the fate of genetically modified (GM) crops in the country was uncertain. A federal commission had approved the first GM soya plant for cultivation in 1998, but a judge later issued a moratorium on planting the herbicide-

P. WHITAKER/REUTERS/CORBIS

resistant beans, developed and sold by the US-based company Monsanto, calling the seeds a “foreign monster”. Rather than abide by the legislation, however, Brazilian farmers turned to Argentina for illegal imports of the Monsanto seed, which earned a nickname in honour of Argentina’s most famous football player, Diego Maradona.

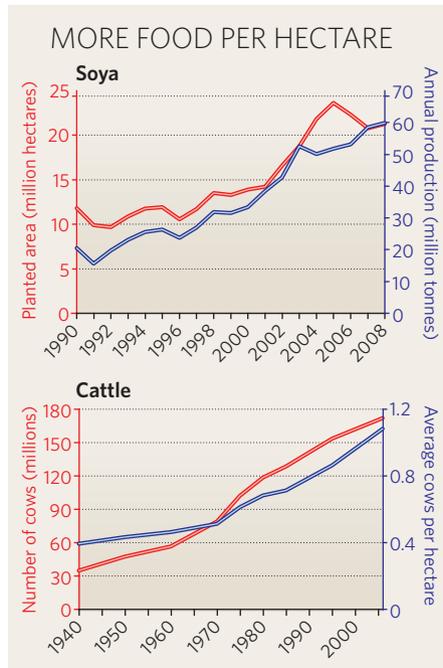
The illicit ‘Maradona’ soya bean became so widespread that Brazilian president Luiz Inácio Lula da Silva signed a law in 2003 legalizing it in an effort to bring order to imports, institute basic quality controls and protect Brazilian seed companies that were unable to compete with illegal vendors. Two years later the Brazilian Congress enacted a biosafety law overhauling the process for approving transgenic crops, and by 2006 the National Technical Commission on Biosecurity was busy approving transgenic plants, beginning with soya beans, cotton and maize.

Brazil now has more than 21 types of GM plant approved for use in the field and is second only to the United States in the number of hectares planted with transgenic crops. GM soya will make up 70% of the Brazilian soya market this year and could hit 75% in 2011, according to Alda Leraer, executive director of the Council of Information on Biotechnology, a non-profit organization based in São Paulo.

“I lived four years of hell there, but I believe we did things that will be recognized as very important for Brazilian agriculture in the years to come,” says Walter Colli, a biochemist who stepped down in February as president of the commission. He pushed through the approval of GM crops by ignoring ideological debates during commission meetings and focusing on technical questions about public and environmental safety, a strategy quietly endorsed by da Silva’s government.

Legally, food containing transgenic plants must be labelled with a T, but Leraer says that although environmental groups have raised concerns, public opposition to the spread of GM crops has so far been muted.

Brazil currently relies on GM products developed abroad, but earlier this year the biosafety commission approved the first transgenic seed to be developed by Brazilian scientists. Researchers at Embrapa had



enhanced soya with a gene supplied by the German chemical giant BASF that provides resistance to a new class of herbicides. For Elíbio Rech, who headed the project at Embrapa’s centre on genetic resources and biotechnology, the work showcases Brazil’s budding capacities in biotechnology while serving as a model for how governmental

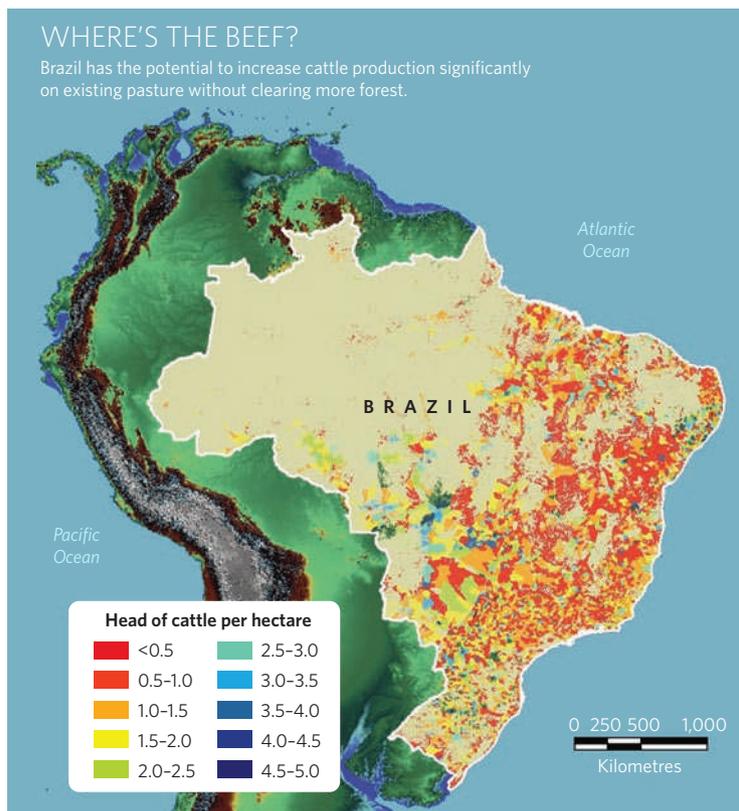
researchers from Embrapa can partner with the private sector.

“The planet will have to work together in order to assure that we will be able to double the food production by 2050, and Brazil will play an important role,” he says.

For now, transgenic crops in Brazil and elsewhere help farmers battle against weeds and insects, but they do not directly increase the amount of food produced by individual plants. However, Embrapa is working on new techniques that may one day open the door to plant varieties that are more nutritional and more productive. Some Brazilian crops have a long way to go; maize varieties there produce less than half the yield of those in the United States.

The land of plenty

More productive varieties may eventually take pressure off the rainforest, which has been extensively cleared to make way for agriculture. But Brazil has already slowed deforestation by trying to make better use of land that has already been cleared. Spurred by pressure from consumers and environmental groups such as Greenpeace, soya-bean producers were the first to commit to protecting the Amazon. Four years ago, the major exporters agreed to a moratorium on trade in soya beans grown on land deforested after July 2006. Monitoring is done by satellite, and Greenpeace says that



the pact has helped to reduce the most egregious violations. Environmentalists secured a similar promise last year from the major slaughterhouses, which have committed to mapping out their direct suppliers by November 2010 to ensure that beef does not come from newly deforested land.

To increase production without sacrificing forests, Brazilian researchers have to monitor how land is actually being used. “Everything starts with the maps,” says Paulo Adario, who manages the Amazon campaign for Greenpeace, which is working with industry to analyse satellite images. The organization also conducts monitoring flights over suspect terrain — something that government agencies often don’t have the resources to do. “There is no environmental policy that can run without having land use figured out,” says Adario.

Batistella’s team at Embrapa

SOURCE: EMBRAPA SATELLITE MONITORING CENTER

SOURCE: A. CARNEIRO/STRATEGIC AFFAIRS SECRETARIAT

is running multiple studies analysing satellite data in an effort to tease out information about land use. In one, researchers are designing ways to assess photosynthetic activity and determine the amount of crops planted and cut down each year. The goal is to more easily identify existing agricultural lands that can be targeted by policies to increase agricultural production.

By far the largest potential for increasing production is in pastures, which in Brazil cover more than 200 million hectares, according to some estimates — nearly a quarter of the country, or an area three times the size of France. Brazilian ranchers on average raise just over one cow per hectare of land, but many well-managed pastures, with better grass production, carry three, four or even five cows per hectare (see map on previous page). The situation is slowly getting better; over the past decade, pasture in the Amazon region has increased by 30% and the number of cattle has increased by 80%.

Luís Barioni, an agricultural modeller at Embrapa, has conducted as-yet unpublished research suggesting that Brazil would need to nearly double productivity on cattle pastures between 2010 and 2030 to accommodate future demand without clearing further forest. The numbers suggest that it is more than doable, says Sergio Salles, an agricultural economist with the State University of Campinas (UNICAMP). Squeezing the current cattle population onto half as much pasture — which is possible from a technical stand point — would free up enough land to more than double grain production, he notes, “without cutting down a single tree”.

As part of a broader effort to reduce greenhouse-gas emissions and increase agricultural intensity, the government has instituted a US\$2-billion programme, which will among other things improve 15 million hectares of degraded pasture over the next decade. A second component aims to expand systems that rotate crops and livestock by 4 million hectares over the same period; research suggests that such systems can improve soils, increasing production of crops and grasses for livestock.

New incentives will be needed to get farmers to adopt such systems. “The banks have always been behind deforestation in Brazil, and the idea is to change that logic,” says Arnaldo Carneiro, a landscape ecologist and science adviser to the Strategic Affairs Secretariat, a cabinet-



The expansion of cattle pastures has taken a large bite out of the Amazon.

level body in charge of long-term planning. Rather than funding farmers to clear land, he says, the banks could provide discount rates to pay for land improvements, such as fertilizing soils, planting new grasses or rotating crops through the pastures. The secretariat is currently exploring zero-deforestation policies and their implications for agriculture.

A risky future

The government is also hoping to boost farm production by helping farmers pick the best seeds to plant. In 1996, Embrapa began to produce climate-zoning maps for several key crops to ensure that government loans weren't being spent on plants that were likely to fail. The maps are published state by state for each crop and take into account factors including topography, soils, past weather and seasonal patterns. When farmers go to apply for a loan, the banks look up their location and can determine exactly what kind of crop is allowed on any given day of the year.

The system now covers most crops, says Eduardo Assad, a researcher with Embrapa's agriculture information centre. “We think we can increase productivity by 20% using climate zoning,” he says.

The zones will be a moving target because of climate change. Assad and a colleague, Hilton Pinto at UNICAMP, are now trying to assess how global warming might affect crop zones in the coming decades. Their projections suggest that annual agricultural losses could surpass US\$4 billion annually by 2020 because of increasing temperatures. More than half of the losses are in soya; the lone winner is sugarcane,

the optimal territory of which more than doubles in the forecasts.

These projections are based on temperature alone, because global climate models differ markedly in their predictions for precipitation and broader effects on the Amazon. Nonetheless, the researchers have enough confidence in the results to urge plant breeders to take note and begin preparing for a warmer future. They should start now, says Pinto, because it takes a decade to bring new varieties to market.

Climate is just one of many challenges that Brazil faces as it attempts to expand and modernize its agricultural system. The biggest corporations already run world-class operations, but many of the country's farmers in remote rural areas are desperately poor and are using equipment that seems to date from the nineteenth century. Improving rural agriculture thus involves expanding access to information and reducing social inequities.

It will require a change in attitudes as well. Although researchers have signed up to sustainable growth policies, many ranchers and farmers are not yet on board. Agricultural interests prevailed over environmental concerns this month when a special congressional commission approved a proposal to scale back Brazil's landmark forest-protection code, which lays out minimum standards for protecting native habitats. Scientists and environmentalists are gearing up for a prolonged battle against the legislation, and it is not at all clear that any radical changes will survive the broader congressional debate. But the very tone of the discussion strikes many as a setback.

The various challenges have so far prevented Brazil from producing a coherent plan to advance agricultural intensification, says Salles. “The potential is big, really big, but we are still not intensifying production on millions and millions of hectares of land,” he says. “If you ask me why, I can't tell you.”

Yet the agricultural research community has demonstrated that Brazil can advance quickly. “Twenty years ago, we were thinking only about frontier expansion and monocrops,” says Batistella. “Now all agricultural researchers are talking about intensification, no-tillage agriculture, about crop rotation and agroforestry.” Ways, in other words, to feed the world without levelling the forest. ■

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See Editorial, page 531, and Food special at www.nature.com/food.

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