Big *players*

Despite myriad problems in many countries, pockets of excellence thrive in South American science.

IT MAY SEEM HERETICAL TO SAY SO IN THE LAND OF THE BEAUTIFUL GAME, but science in Brazil beats the World Cup — at least in a financial match-up. Government and businesses there invest some US$27 billion annually in science, technology and innovation, dwarfing the price tag for the football tournament, which tops out at about $15 billion.

Science in Brazil and many other countries in South America has come a long way since the dark days of the dictatorships just a generation ago. In Argentina, the number of science doctorates jumped nearly tenfold between 2000 and 2010; Peruvian scientists tripled the tally of articles they produced over the same period; and science funding is climbing in most countries.

South American science still has far to go if it hopes to catch up with other continents. By many measures — such as investments, patents and education — the countries there lag behind other nations with similar levels of gross domestic product (GDP). There is looming instability in countries such as Argentina and Brazil, where recent protests reflect deep social and economic divisions — problems that plague much of South America. But amid the concerns, there are many bright spots in the world of science. Here, Nature highlights several examples of outstanding researchers and institutions in the region.

B. TAFRESHI/ESO

The European Southern Observatory operates the Very Large Telescope in northern Chile.

CHILE

UPWARD TRAJECTORY

BY MICHELE CATANZARO

When Mario Hamuy finished his university degree in Chile in 1982, he was one of just a handful of students in the country interested in pursuing graduate studies in astronomy. Now, more than 25 Chilean students join such programmes each year and Hamuy directs the Millennium Institute of Astrophysics in Santiago, home to 95 students and faculty members.

During the course of Hamuy's career, Chile has emerged as a major player in the world of international astronomy, in no small part because of the extraordinary collection of telescopes housed in the country's highlands. "Astrophysics has come to the forefront of Chilean science thanks to the increase in human resources and to the fact that

CDFM/FAPESP

A ZnO semiconductor from a FAPESP-funded project.

BRAZIL

SÃO PAULO'S HEAVY HITTER

BY GIULIANA MIRANDA

Although Brazil rivals Europe in size, much of the leading research in South America's largest country emanates from an area the size of the United Kingdom. São Paulo, in southern Brazil, is the richest of the country's 26 states and publishes more than half of Brazil's scientific articles. One of the main reasons for its success is the São Paulo Research Foundation (FAPESP), the state agency that promotes research and education. In 2013, the agency invested $512 million in science funding, more than many nations in the region. (At the federal level, Brazil's National Council for Scientific and Technological Development has a budget of about $650 million for science, technology, and innovation in 2014.)

Created in 1960, FAPESP has a stream of funding guaranteed by the constitution of São Paulo, which requires that 1% of the tax revenue goes to the foundation. Its success in fostering research and education inspired other Brazilian states: all but one now has a similar agency, and most have guaranteed funding linked to taxes.

FAPESP directs 37% of its funding to basic research in fields ranging from climate change to particle physics. About 10% goes to infrastructure and the rest is channelled to applied research. Nearly one-third of its total budget is devoted to medical research.

"One difference in FAPESP's work is that we invest a lot in basic science," says Carlos Henrique de Brito Cruz, FAPESP's scientific director. "We believe in balance."

The most recent large project approved for funding is the Long Latin American Millimeter Array radio telescope, a joint project between Brazil and Argentina that will receive $12.6 million from the agency and an equal amount from Brazil's science ministry. FAPESP's board is considering a $40-million investment in the Giant Magellan Telescope, which would give São Paulo astronomers access to the facility, planned for construction in Chile.

Science officials in other nations can only look with envy at the agency's guaranteed funding. "FAPESP is a very interesting model for us because São Paulo is one of the few states in the world where support of research is linked directly to GDP," says Martyn Poliakoff, foreign secretary and vice-president of the Royal Society in London.

Regional agencies such as FAPESP play a very important role in Brazil, says Wanderley de Souza, a biomedical scientist at the Federal University of Rio de Janeiro and a member of the Brazilian Academy of Science. "They can make research happen even if the federal funding gets scarce."

Brazil struggles with vast economic differences among its various regions, and that is reflected in regional science budgets. FAPESP has the biggest budget of all the regional agencies, but that does not reduce federal investments in the state, says Clelio Campolina, the minister of science, technology and innovation. "We want to improve other states, but also reward excellence," he says.

FAPESP's rapid growth has raised some concerns among scientists in São Paulo who complain about an increase in bureaucracy. But agency officials defend its performance and say they are working to improve its procedures.

It's all part of an effort to produce high-quality work, says Brito Cruz. "We want the best projects." ■

we have the cleanest sky in the world," says Dante Minniti, an astronomer at the Pontifical Catholic University of Chile in Santiago.

Although Chile invested just 0.44% of its GDP in scientific research in 2011, the latest year for which figures are available, funding for astrophysics has steadily grown, from $2 million in 2006 to $6.8 million in 2010. Over the same period, the number of faculty positions has almost doubled. And the country's publications in astronomy have risen more than fourfold during the past decade.

The quality of the work has improved as well. Chile ranks highly in terms of citations per paper in space science, and some of its scientists have made important discoveries. In the early 1990s, Hamuy made a key contribution that helped others to measure the accelerating expansion of the Universe and win a Nobel Prize in 2011. And Minniti is one of the leaders at the VISTA infrared survey telescope at the European Southern Observatory's Paranal Observatory in northern Chile, which has created a catalogue of more than 84 million stars in the central parts of the Milky Way.

Chile's skies have been attracting international telescopes since 1964. By 2020, when the European Extremely Large Telescope is due to be completed, the country is expected to host 70% of the global observation surface for large optical and infrared telescopes.

By contract, Chilean astronomers get 10% of the observation time on each telescope installed in the country. But some astronomers say that this is too little, considering how much the country provides for the organizations running the telescopes.

"This country has given enormous advantages to the international consortia, ranging from full tax exemption to diplomatic status: it's time that Chile participates in a more active way," says Mónica Rubio, director of the astronomy programme of the Chilean funding agency CONICYT.

A unanimous aspiration of Chilean scientists, says Rubio, is not just to use observatories but also to build them, through local companies and engineers. Another plan Rubio is working on is developing the Atacama Astronomical Park, a 36,347-hectare protected area around the Atacama Large Millimeter/submillimeter Array, which CONICYT plans to use to attract future telescopes from Brazil and the United States, and maybe also from China, South Korea and Thailand.

But many astronomers are worried about the governance of science in Chile. CONICYT has lacked a director since José Miguel Aguilera resigned eight months ago, and the country's new president, Michelle Bachelet, has frozen plans to create a science ministry (see *Nature* **507,** 412–413; 2014). "It's a good moment for Chilean astronomy, but keeping the momentum will require more sustained support from the government," says Minniti. ■

COLOMBIA

GROWTH CENTRE

BY LISA PALMER

In the Cauca Valley of western Colombia, a herd of hefty cows at Petequi farm munches away on lush grass that looks as if it has grown there forever. But the plants are relative newcomers. They are cultivars of African super grasses, bred for enhanced nutrition and hardiness by researchers at the International Center for Tropical Agriculture (CIAT), less than 50 kilometres to the north.

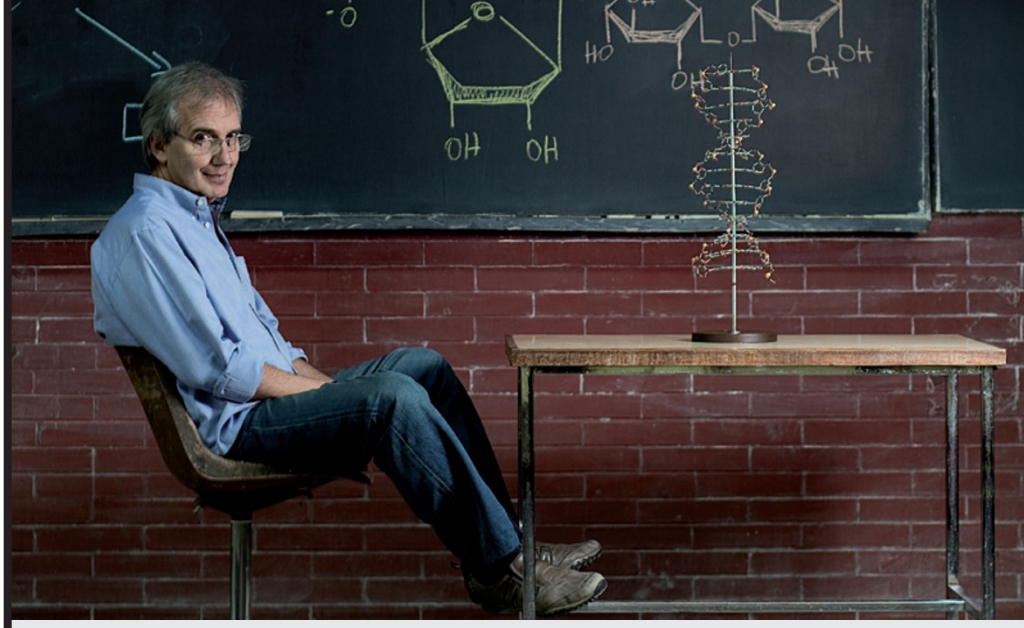
Cows at Petequi once took four years to reach market weight. Now they fatten up in just 18 months. The story is much the same throughout the South American *cerrado*, or savanna. The improved grasses have revolutionized tropical forage across the continent thanks to the combined work of researchers at CIAT and the Brazilian Enterprise for Agriculture Research, a state-owned Brazilian company, says Eduardo Trigo, an agricultural economist and science adviser to the Argentine ministry of science, technology and innovation in Buenos Aires. "CIAT has been one of the key actors in the development of the South American *cerrado*," he says.

Established in 1967, the Colombian facility was one of the first members of the CGIAR consortium of international agriculture research centres. CIAT employs 325 scientists and has an annual budget of $114.4 million, paid for by the multi-donor CGIAR fund and by other international donors.

Aside from its work on grasses, CIAT has focused on breeding improved varieties of beans, rice and cassava — staple crops that are important to the food security of the rural poor. "Genetic improvement of these crops has proved to be a powerful weapon for combating hunger and poverty," says Ruben Echeverría, director-general of CIAT. For example, beans developed by CIAT from Latin American varieties are now feeding up to 30 million people in Africa, according to the centre.

Some 70% of rice in South America, and 90% of cassava in Asia, can be traced back to CIAT's breeding programme. "Cassava is now a multibillion-dollar business for starch production in Asia, providing income to smallholders," says Andy Jarvis, leader in policy research at CIAT.

The centre has also helped to grow expertise on the continent and elsewhere; since CIAT opened, some 13,000 researchers have trained there. Its facilities have been instrumental in building capacity for plant physiologists in the poorer countries of the Andean region, says Trigo. ■



Alberto Kornblihtt: RNA pioneer.

VERA ROSEMBERG

ARGENTINA

THE RNA SLEUTHS

BY ALESZU BAJAK

Molecular biologist Alberto Kornblihtt likes to put things in perspective. "We may be on the periphery of scientific research," he admits from his office in Buenos Aires. "But it's not an impossible place to do science." In fact, he and his community of researchers in alternative RNA splicing — a field he helped to create — have shown that they can do world-class research despite tight government budgets and three-month delivery times for reagents that can cost three times as much as they would in the United States or Europe.

Like Kornblihtt's lab, alternative RNA splicing makes use of constrained resources in innovative ways. Through varied patterns of cutting and rejoining, a single transcribed gene can give rise to many different messenger RNAs, thus permitting a single gene to express different proteins. Kornblihtt found one of the first cases of this process in humans while he was a postdoctoral fellow in the United Kingdom. He moved back to Argentina in 1984 and has assembled a group of researchers that continues to explore this realm.

It has been a good year for his group. Kornblihtt and his doctoral student Ezequiel Petrillo published a paper in *Science* in April on how light affects alternative splicing in plants (E. Petrillo *et al. Science* http://doi.org/s2d; 2014). And last month, Gwendal Dujardin, a postdoctoral fellow from France (a rare sight in an Argentine lab), published a splicing study in *Molecular Cell* (G. Dujardin *et al. Mol. Cell* **54,** 683–690; 2014).

The work is all part of a continuum, says Kornblihtt. He considers scientific research in his native Argentina to be part of a long tradition that started with Bernardo Houssay and Luis Leloir, twentieth-century Nobel laureates whose names now adorn avenues, museums and universities across the country. "The scientific institutions they founded led to generations of disciples that continue to do the science of today," he says.

Kornblihtt carries on that tradition, in part by teaching an introductory course on molecular biology at the University of Buenos Aires. "That course has been a nursery for many young Argentine scientists," he says. It lures in many students, says Diego Golombek, a biologist at the National University of Quilmes in Buenos Aires. "Imagine that on the first day of classes, young students find themselves before the country's most well-known researcher teaching molecular biology classes with an absolutely contagious enthusiasm," he says. "He's had an influence over the new generations of biologists."

Petrillo, who has just left Argentina for a research post at the Medical University of Vienna, says that he will sorely miss the camaraderie of the tight-knit group of RNA researchers from labs and universities all over Buenos Aires. The RNArgentinos, as they call themselves, have for years organized informal seminars and get-togethers to share ideas, concerns, protocols and techniques.

Kornblihtt recognizes that Argentine scientists cannot all work in their home country and he encourages his students to "seed the world" as postdocs abroad. But he asks his university students to complete their PhDs in Argentina. "It's not necessary to leave the country to get a doctorate," he says. "We have a strong science ministry, lots of scholarships and subsidies and new research buildings. The structure to do science in Argentina is not precarious. It has many pillars." ■