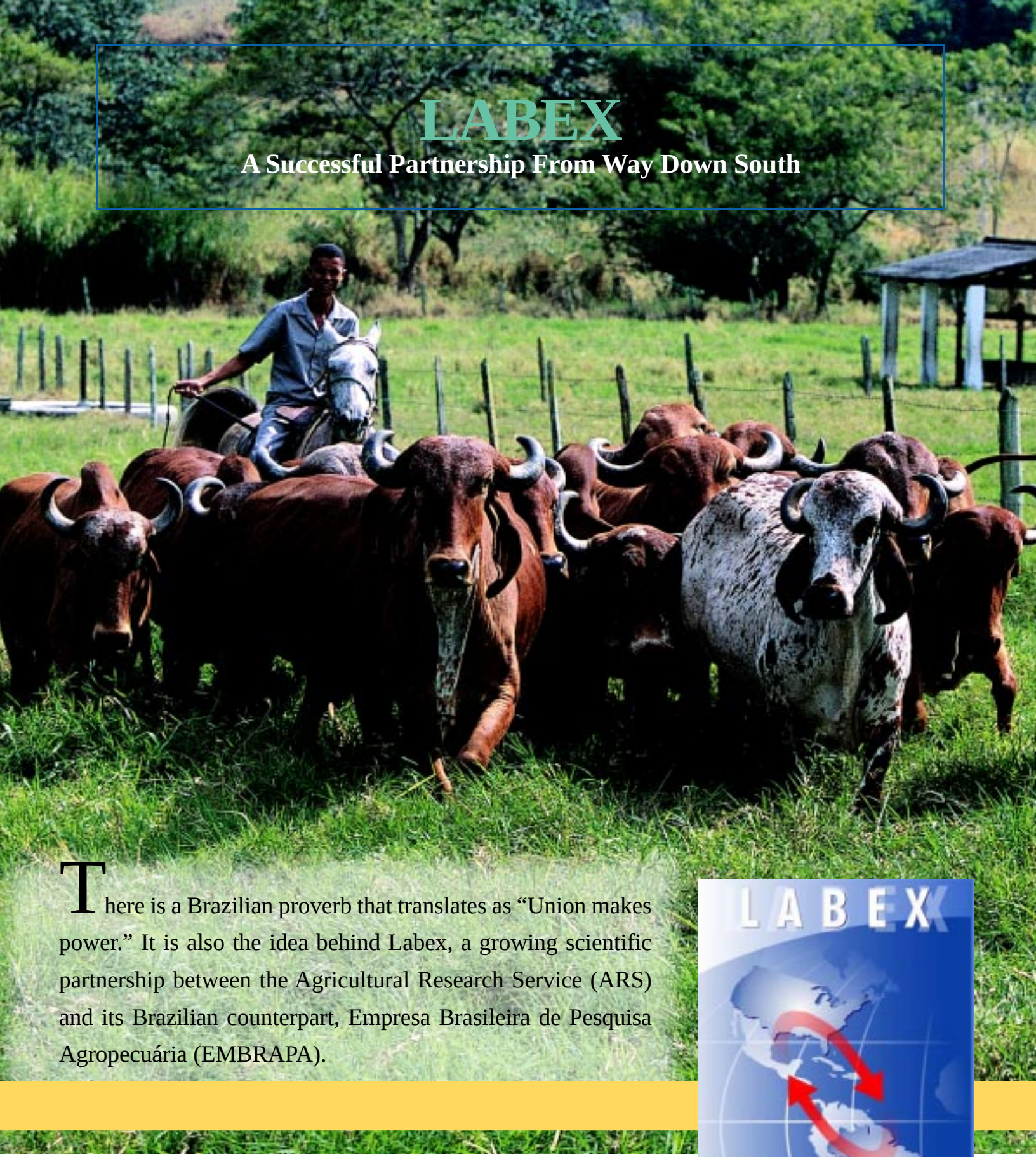
LABEX

A Successful Partnership From Way Down South



There is a Brazilian proverb that translates as “Union makes power.” It is also the idea behind Labex, a growing scientific partnership between the Agricultural Research Service (ARS) and its Brazilian counterpart, Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA).

SCOTT BAUER (K9687-12)

This herd of Gyr, a tropical cattle breed, is being studied as part of Labex research on cattle genetics. Above, animal caretaker José Cristiano dos Santos takes the cows for a health inspection at the Coronel Pacheco Experimental Station, near Valenca, Brazil.

Brazil proposed the Labex program because the country saw itself and the United States as natural partners in agricultural research, with many similar agricultural and environmental problems to solve. Both are also world leaders in agricultural research and technology—the United States particularly in temperate and subtropical agriculture and Brazil more so in tropical agriculture.

Under way only since 1998, the Labex program, which is coordinated by ARS' Office of International Research Programs, is already paying off with significant results. (See "Crossing the Equator with Science," *Agricultural Research*, May 2000, pp. 12–15.)

Labex brings Brazilian scientists to ARS laboratories for 2- to 3-year terms and encourages other formal and informal exchanges between the two research services.

"This program is unique in several important aspects," explains soil scientist Silvio Crestana, who served as Labex coordinator from its inception until June 2001. "From the first, it has been designed as a two-way street, with both countries benefitting from the cooperation. The United States has as much to gain from the collaboration as Brazil. Secondly, EMBRAPA committed itself to sending only senior scientists; this is not a typical postdoc training program."

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EMBRAPA entomologist Marina Castelo Branco collects plant samples for a new pollen reference library that will help document plants that attract insect pests.

Soil Subtleties

Crestana himself is a renowned soil scientist who stepped down as director of EMBRAPA's National Instrumentation Laboratory to participate in Labex. Besides being program coordinator, he also found time to collaborate with hydrologist Walter J. Rawls, research leader with ARS' Hydrology and Remote Sensing Laboratory in Beltsville, Maryland, to adapt decision support software to estimate water retention in Brazilian soils from soil composition data.

Precise information about water retention is essential for predicting soil-erosion potential and even global climate monitoring. But when ARS developed the original pedo-transfer functions (PTFs)—the basic algorithms for the software—the work was based on U.S. soils, which cluster almost completely on the sand-loam side of the clay-sand-loam triangle of soil types.

But Brazilian soils are mirror images of U.S. soil, with almost all on the clay-loam side.

Crestana and other Brazilian scientists worked with ARS researchers to successfully adapt the PTFs to deal with clay soils.

"In addition to the scientific use that will be made of the PTFs, they will also help shape future agricultural policy for Brazil. With solid soil-water retention information, we can look at areas of Brazil to see which can be used to expand agriculture without harming the environment and which are likely not good for farming," Crestana says.

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At EMBRAPA's Soils Research Center in Rio, geographic information specialist Ronaldo Pereira de Oliveira (right) and research assistant José da Silva de Souza (left) review soil-climate data maps and charts obtained from the Brazilian Amazon.

Adapting the PTFs to clay soils has helped validate Rawls' work within a larger context. It will also be directly useful for some places in the United States, such as Mississippi, that have clay soil areas. But there are much more widespread implications.

"We now understand that soil represents a major carbon sink that may mitigate greenhouse gas effects. This is an air quality and climate change issue

that all of us are going to need to deal with on a global basis," Crestana says. "So soil models that are applicable to the whole globe are going to be essential."

With this global view, Labex has helped foster discussions for an ARS-EMBRAPA-NASA program to establish data-collecting stations in Brazil for an Advanced Microwave Scanning Radiometer satellite that can monitor the water cycle on Earth's surface.

SCOTT BAUER (K9701-2)

Plots at the "Display of EMBRAPA's Technologies," a field exposition located at EMBRAPA's headquarters, in Brasilia, Brazil. The annual event gives visitors technical information about the crop studies being performed.

Planting By the Book

Water in the soil, or the lack of it, is also one of the most limiting factors in Brazilian agricultural production, explains Luiz M. Aguiar Sans, a soil scientist with EMBRAPA's National Maize and Sorghum Research Center in Sete Lagoas, who helped adapt the ARS PTFs to Brazilian soils used for growing corn.

"We can predict how well a crop will do basically from soil water retention information, including making recommendations on when to plant for the best chance of a good harvest," Sans says.

In fact, in order for Brazilian farmers to get agricultural bank loans, they must agree to plant during the periods specified for their area in manuals that have been published for each crop each year. In the past, the planting periods were based on only three soil types for each county. But for next planting season, Sans and his colleagues have come up with planting windows that are based on the PTFs and the actual soil composition in thousands of specific locations.

"In past years, the planting interval manual for corn has been about 60 pages long. The new book for this spring, which will be the first based on the PTF work, is more than 800 pages and with smaller type," Sans says. "A single small town now might list nine soil types and specific planting windows for corn for each type."

Similar, more detailed manuals are being developed for additional crops, such as soybeans, coffee, apples, wheat, and cotton.

A Ripple Effect

Labex soil research has also rippled out to involve additional projects. "This is the true point of Labex. Just doing one project together doesn't build very much beyond that one project; what we want is lasting collaboration between scientists," Crestana points out.

For example, Labex brought together ARS and EMBRAPA researchers to test a combined penetrometer-moisture probe that was recently developed in Brazil as a new device to measure soil strength (resistance to penetration and compaction) and water content. This will allow researchers to combine the effects of soil compaction and composition on characteristics such as water retention.

"Soil penetration resistance, or compaction, is one of the few remaining factors that are not available on precision agriculture field maps. This probe could answer that," explains EMBRAPA soil

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At EMBRAPA's Soils Research Center, laboratory technician Jorge Luis Nunes Ramilo examines a soil sample from Soloteca, a collection of 15,000 samples representing all Brazilian soils.

scientist Carlos M. P. Vaz. "Silvio Crestana suggested that ARS scientists had expertise to help test this probe, and he helped put me in touch with them."

Precision agriculture has been one of the Labex core issues from the outset. It was Brazilian agronomist Ariovaldo Luchiari's focus when he was posted to the ARS Soil and Water Conservation Research Unit in Lincoln, Nebraska, as part in the first wave of Labex scientists. His research looked at water and nitrogen stresses in corn to see if chlorophyll fluorescence could indicate when intervention by irrigating and/or fertilizing would be truly worthwhile.

But the Labex connection has grown far beyond that for Luchiari's ARS collaborator James S. Schepers.

Schepers is developing a remote sensing probe that can be wheeled through fields as it measures changes in the light reflecting from plant leaves as a way to determine the nutritional needs of a crop. He has been working for several years with his EMBRAPA counterparts to refine the system.

"But it was hard to get his sensor carrier into many of Brazil's rough areas," says mechanical engineer Ricardo Y. Inamasu with EMBRAPA's National Agricultural Instrumentation Laboratory in São Carlos. "So we developed 'Skinny Boy,' a much lighter version of the sensor carrier that is easier to take into fields. Building on Dr. Schepers' work saved us several years of development time, and now we're pooling all the data—his and ours—to help advance everyone's work."

One major benefit of the cooperation has been the opportunity to double data collection each year by taking advantage of the reversal of seasons between the United States and Brazil. "The Brazilian growing season is also much broader than it is in Nebraska," says Schepers. "They've been able to plant corn sequentially every 2 or 3 weeks in Brazil, and then when we come down, they have corn ready in three or four different growth stages for us to test our monitoring strategies. We make modifications based on the results, and we're ready to start again when we've got corn in Nebraska. We've been able to get 2 years of work out of one."

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Field assistants Carlos César Gomes and Célio de Almeida discuss wheat experiments at EMBRAPA's Maize and Sorghum Research Center in Sete Lagoas.

Not Just Soil and Plants

Labex partnerships have not focused only on plants and soil. Senior veterinarian Terezinha Padilha is looking for resistance to internal parasites in beef cattle at ARS' Immunology and Disease Resistance Laboratory in Beltsville. She is sequencing genetic markers that could lead to a scientific basis for breeding cattle with natural resistance.

Internal parasites—worms—are one of the major problems facing the beef and dairy industries in both the United States and Brazil. Worms cost these industries $2 billion a year in the United States alone. Recently, worms have started to build resistance to commercial anthelmintics, the agents used against them. The resistance is now being seen in Brazilian beef cattle, although it has not been found in the United States yet. But it is coming.

Working with ARS microbiologist Louis C. Gasbarre in Beltsville, Padilha has already identified more than 200 genetic markers in Angus cows. These markers could be related to some ways by which cattle can naturally resist internal worm infestations, lessening the need for anthelmintics. Now, she's matching these markers to physical traits, which will tell her which of the markers are best associated with the cattle's ability to deal with worms.

Similar research will also be done on Brazilian cattle.

"Brazil has some unique breeds that have to survive in the Tropics, where there are no winters to create breaks in the parasite population. By working together, we will all have access to data from a much larger germplasm pool, which will significantly expand the potential for finding the genes we want," Padilha says.

But like Crestana, who has fostered many soil-science collaborations, Padilha's Labex work also extends beyond her own specific project. She has been instrumental in bringing together several EMBRAPA and ARS researchers

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Cattle in Brazil, like this Zebu bull, represent a different gene pool from U.S. cattle and could help scientists locate genes for desirable traits like tick resistance and heat tolerance.

whose work will be enhanced by informal and formal collaboration.

For example, in August 2001, Padilha arranged for three ARS geneticists—Curtis P. Van Tassell and Tad S. Sonstegard with the Gene Evaluation and Mapping Laboratory in Beltsville, and Eduardo Casas from the U.S. Meat Animal Research Center (MARC) in Clay Center, Nebraska—to visit EMBRAPA beef and dairy research centers and confer with their Brazilian counterparts about coordinating research and sharing data so both groups benefit.

At a research farm in Valenca, Brazil, EMBRAPA is establishing a special research herd by crossing Holsteins with a Brazilian strain of Gyr, a tropical breed from India. Both phenotyping and genotyping will be done for production traits in which both ARS and EMBRAPA are interested, such as parasite resistance and carcass weight.

"Some of what the Brazilians are most interested in, and for which their cattle are likely to have a genetic basis, are traits like heat tolerance, which also has great relevance for subtropical areas in the States, like Louisiana and Florida," says Casas. "The Brazilian researchers are very open to suggestions about other traits to measure. I've suggested they measure testes size and time to first ovulation to see if either of these traits correlates with production traits we're measuring in our cattle. This is a great chance to get data on totally different breeds than we have.

"In the end, if an allele for a genetic marker is associated with a trait in the Brazilian herd, then I can look to see whether this allele is present in our herds and vice versa," Casas explains. "If an allele associated with an economically important trait is present in one herd but not the other, we can use genetic markers to try to incorporate it through a crossbreeding scheme."

Artificial insemination has also narrowed the genetic basis for U.S. herds, which makes the opportunity to look at germplasm from other sources even more important, Casas adds.

The hunt for genetic markers for economically important traits will also involve EMBRAPA's Southeastern Cattle Research Center in São Carlos, Brazil.

"Several joint projects are in the plans," says animal biotechnologist Luciana C. de Almeida Regitano. "On the first level, we're going to validate genetic markers that ARS has found in the herd at MARC for important traits. On the second level, we're looking for new markers associated with the same traits in our Canchim and Nelore crossbred herds."

Looking for markers for tick resistance, muscling, and months to slaughter weight is also planned.

One immediate advantage of collaborating, Regitano points out, is that just getting a big enough population sample for good statistical analysis is very expensive with large animals like cows, so pooling data means many more numbers for everyone without asking for a budget increase.

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Research to preserve the fragile red clay typical of Brazil while expanding agricultural production is providing new insights for both ARS and EMBRAPA scientists.

Intellectual Modeling

Brazilian molecular biologist Maria Jose A. Sampaio spent her Labex assignment learning about ARS and U.S. university intellectual property rights (IPR). Since returning home, she has served as the agriculture IPR specialist for the Brazilian government and industry.

The Brazilian legislation for IPR was only implemented in 1998, but they are ready to hear feedback about its efficacy, she points out. Their legislation is based on the European model for IPR. "I spend a lot of time explaining the differences in the U.S. system to Brazilian companies and how they affect business issues," Sampaio says.

"These types of collaborations are what makes programs like Labex so important," Padilha adds. "No one research agency will have the resources or the budget to do everything that needs to be done. Two advanced organizations like EMBRAPA and ARS should collaborate rather than each reinventing the wheel. But the biggest advantage is really about putting our brains together. That's where the greatest gains will come from."

Insects Cross the Equator

Another focus for Labex is integrated pest management (IPM). Brazilian entomologist Miguel Borges spent his Labex assignment at ARS' Insect Chemical Ecology Laboratory in Beltsville, seeking biocontrols for stink bugs, a major soybean pest in both Brazil and the United States.

Borges and his ARS collaborator, entomologist Jeffrey R. Aldrich, identified a better pheromone blend to attract neotropical brown stink bugs. Such pheromone identification is essential to building traps that can be used to monitor fields for the appearance of specific insect pests. Precise monitoring allows pesticide use to be narrowly targeted, helping the environment and the farmer's bottom line.

Borges and Aldrich also developed an effective trap design to go with their pheromone lure. They are currently seeking commercial producers for the trap system. "Jeff is talking with companies in the United States, and I'm talking to companies in Brazil; or one company could sell in both countries," says Borges.

One of their research results is confounding the pair. They looked at U.S. and Brazilian strains of *Telenomus podisi*, a wasp that parasitizes stink bug eggs, in hopes of using it as a biocontrol. Two leading taxonomists in the United States and Argentina both proclaimed the strains to be the same species. But the two entomologists cannot get the two species to successfully crossbreed—which is the definition of separate species—nor do the two wasps always react to the same species of stink bug from the other continent.

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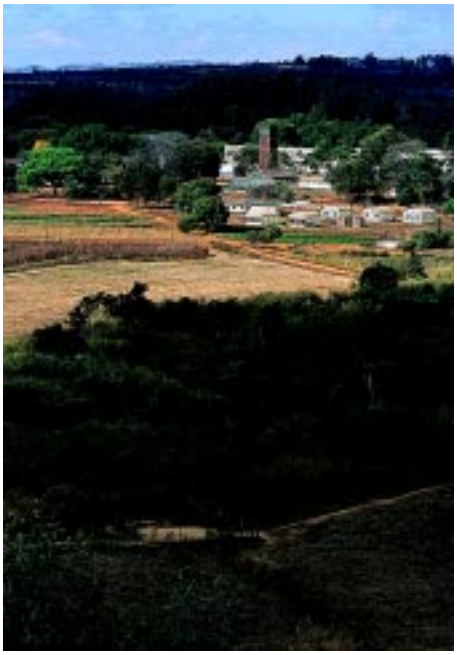

EMBRAPA's maize and sorghum experimental fields located in Sete Lagoas, State of Minas Gerais, Brazil.

"It opens up all sorts of possibilities for what may be most effective for each country," Borges says.

Collaboration between Aldrich and Borges isn't over just because Borges is back at EMBRAPA's Genetic Resources and Biotechnology Center in Brasilia. They are already hard at work with a colleague in Italy, setting up parallel real-time video web sites in each of the three countries to monitor insect behavior in soybean fields.

"Everyone will be able to see what is happening at any of the sites at any time. The amount of data that will be available at all times of the year will be amazing," Borges says.

The Future

Labex appears to have a bright future. EMBRAPA has already selected the next generation of Brazilian scientists who will come to ARS. Food safety and new uses for agricultural commodities have been additional focuses.

"We see Labex as a new model for international cooperation," says Alberto D. Portugal, EMBRAPA's director-president. "We see so much opportunity for synergy between two of the largest and most advanced agricultural research agencies in the world."—By **J. Kim Kaplan,** ARS.

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In Sequence

Labex and the ARS Office of International Research Programs have also helped foster an important collaboration between ARS and Brazil's São Paulo State Research Foundation to successfully sequence the genome of the bacterium *Xylella fastidiosa*, strains of which cause Pierce's disease, a major U.S. grape problem, and a citrus disease that costs Brazilian citrus growers millions of dollars annually. (See "Spinning a Global Web for Agricultural Science," *Agricultural Research*, April 2001, pp. 4–8.)

"Now we are organizing an annotation jamboree, a meeting where scientists will work together to do the functional genomics—matching gene sequences with the physical traits they control," says José Fernando Perez, scientific director of the foundation. "The real beauty of this collaboration is that by taking what ARS already had and what we already had and both our expertises, the gene sequencing project was completed ahead of schedule and with more detail than we originally planned."