Spinning a Global Web for Agricultural Science

About a year ago, a series of events unfolded that cemented a collaboration between ARS and Brazil's São Paulo State Research Foundation (FAPESP). Call it synchronicity. But it's more likely that an established ARS-Brazilian connection paved the way—with plenty of help from a group of scientists and international affairs specialists in ARS' Office of International Research Programs (OIRP).

The goal is to sequence the genome of a bacterium that is killing California's grapevines. *Xylella fastidiosa*, which causes Pierce's disease, is a chronic problem in northern California vineyards, costing growers $33 million between 1995 and 1997 alone.

FAPESP was working on sequencing the genome of a different strain of *X. fastidiosa*, which costs Brazilian citrus growers millions of dollars annually. After hearing of the U.S. grape-growers' problem, the Brazilian scientists approached the American Vineyard Foundation about sequencing the California *Xylella* strains.

FAPESP's proposal was then sent to ARS research leader and plant pathologist Edwin L. Civerolo in Davis, California. He forwarded it to ARS headquarters in Beltsville, Maryland, recommending that ARS support some of the proposal.

Shortly afterwards, ARS administrator Floyd P. Horn was chatting with Brazilian soil scientist Silvio Crestana, who's stationed in Beltsville to coordinate another U.S.-Brazil project, called LABEX. (See "Crossing the Equator With Science," *Agricultural Research*, May 2000, pp. 12-15.) Crestana mentioned that FAPESP had just sequenced the *Xylella* genome, and Horn remembered FAPESP's proposal. Since Horn had earlier visited California and learned firsthand about the plight of grape growers there, the proposal piqued his interest—and that of Judith St. John, ARS associate deputy administrator for crop research.

Soon after, a deal was struck, with ARS funding half of a $500,000 project and FAPESP funding the other half.

"We had a verbal agreement with FAPESP within half a day, thanks to Crestana and our existing relationship with Brazil through the LABEX project," says OIRP's Richard V. Greene, who put together the written agreements spelling out intellectual property rights and setting up a system to transfer funds.

"Maintaining financial transactions between the United States and Brazil takes a bit of work. But it's worth it," says Greene. "The FAPESP scientists were ahead of U.S. scientists in sequencing the *Xylella* genome, so we went to them."

The Brazilians are now testing strategies to interrupt genes in the citrus-damaging *Xylella* strain, and U.S. scientists are using information from that genome in search of ways to foil the grape-damaging strain, says Civerolo, co-leader of the FAPESP-ARS genome-sequencing project.

Win-Win Situations

Science has been an international game almost since its beginning. ARS research is no exception. Last year, ARS

KEITH WELLER (K9393-1)

In Beltsville, Maryland, ARS plant pathologist John Hartung examines quarantined sweet orange plants for symptoms of a strain of *Xylella fastidiosa* that causes heavy citrus losses in Brazil. The pathogen's genome—recently sequenced by the Brazilian research foundation FAPESP—was the first genome of a plant pathogen to be sequenced.

scientists reported close to 500 collaborations in some 70 countries. In the past, they have turned to international specialists on ARS' National Program Staff for assistance with the many legal and logistical challenges of such partnerships.

The October 1999 formation of OIRP gives the agency a principal contact for international issues and strengthens its commitment to international research-and-development collaborations in agriculture and natural resources, says its acting director Arlyne Meyers.

The 15 OIRP staffers, located at ARS' headquarters in Beltsville, Maryland, help initiate contacts between ARS scientists and potential collaborators abroad and search for funding from outside sources. And they handle the many details involved in linking ARS' national programs to international activities.

"We have three goals," says Meyers. "We facilitate international cooperation and exchange in support of the agency's national research agenda, promote strategic interests of the U.S. government, and support ARS overseas laboratories.

"It's a win-win situation when American and foreign scientists combine their unique knowledge, experience, and resources to develop solutions to shared agricultural problems."

Under Greene's guidance, OIRP supports and helps manage ARS' biocontrol programs in four overseas locations: Hurlingham, Argentina; Indooroopilly, Australia; Beijing, China; and Montpellier, France—the flagship lab. A half-dozen ARS scientists work in these labs, along with many foreign nationals, to gather and study insects and pathogens that have potential to control other insects or weeds that have entered this country without their natural enemies in tow.

"Their work is our first line of defense against invasive agricultural pests," Greene says. (See articles on pp. 10 and 26 for more on the overseas laboratories.) Five of the six ARS overseas personnel work at the European Biological Control Laboratory in France, while the sixth heads the Australian lab. The ARS labs in China and Argentina are operated solely by foreign nationals.

OIRP's International Scientific Enhancement Program for ARS scientists is designed to enhance individual performance while increasing the productivity and impact of ARS research. The program pays travel expenses for ARS scientists to spend from a few weeks to 1 year at an international laboratory.

Preference is given to those who apply to visit one of 16 International Agricultural Research Centers. These labs, affiliated with the World Bank-funded Consultative Group for International Agricultural Research, are located in developing countries around the world. Last year, the program paid for eight ARS scientists to spend time abroad.

Meyers says the World Food Summit and the U.S. Action Plan on Food Security were prime movers in OIRP's creation. To carry out its mandate, staffers partner with numerous government and nongovernment agencies, state universities, and international organizations. Many provide the financial support for international projects or share the support with organizations backing

KEITH WELLER (K9390-1)

OIRP acting director Arlyne Meyers, International Program leader Richard Greene (center), and LABEX coordinator Silvio Crestana review locations of facilities engaged in ARS-Brazil cooperative projects.

international collaborators. (See box on page 7.)

The projects weave an intricate web of interactions among nations and continents—a web that serves to promote more interactions. This builds understanding and friendships around the globe and will hopefully enable countries to produce ample food that provides all the required nutrients while sustaining their natural resources.

Following is a sampling of projects OIRP staffers help facilitate.

Conferences To Build Latin-American Network

The Tropical Agricultural Research and Higher Education Center (CATIE) in Costa Rica is a focal point for several projects sponsored by ARS and partners in USDA's Foreign Agricultural Service, U.S. universities, and international organizations. The center offers advanced studies and research aimed at improving natural resources management and sustainable agriculture for all of Latin America.

Last November, USDA, through ARS, launched a new project with CATIE—a series of conferences in memory of former U.S. Secretary of Agriculture Henry A. Wallace, an early proponent of international cooperation. The conferences will provide a forum for discussion and collaboration between scientists in the United States and Latin America on important issues affecting this hemisphere, says ARS administrator Floyd P. Horn, who serves on CATIE's board of directors.

"We envision one or two conferences a year for the next 3 years," says Horn, noting that they will take a problem-solving approach. Invited speakers will be leaders in their fields, and participants will be selected for their potential to translate knowledge gained at the conference into positive impacts for their individual countries.

SCOTT BAUER (K9383-1)

Soil scientist Jean Reeder shows graduate student Goodman Jezile how to code and log the hundreds of soil samples he has collected to determine differences in soil properties.

The Russian Connection

There's a very human side to international collaborations, too. A medical emergency sealed a new friendship between ARS research leader Norman J. Stern and Edward Svetoch, a Russian microbiologist. Svetoch and two colleagues from the State Research Center for Applied Microbiology near Moscow had come to the United States to work on the *Campylobacter* bacterium with Stern's laboratory in Athens, Georgia. But the morning after the Russians arrived, Stern rushed Svetoch to the hospital instead of to ARS' Poultry Microbiological Safety Research Unit.

After a 12-hour flight, Svetoch had developed a blood clot in his leg that could have been life threatening. But thanks to Stern's intervention, it wasn't. "A medical emergency imposed itself on our relationship," says Stern, "and it enabled me to befriend the Russians." And, such friendships can help smooth the research path.

According to current estimates, poultry-borne transmission is thought to be responsible for more than half of human *Campylobacter* infections, says Stern. Some of these infections develop into more serious syndromes.

Svetoch and his colleagues were a good match for the Athens scientists, who want to control *Campylobacter* using a three-pronged attack. Stern's lab had been able to control the pathogen's growth in the birds' guts by giving baby chicks a culture of beneficial microbes that crowd out the pathogen. But the makeup of the culture is poorly defined, so results have been inconsistent.

The Russian scientists are identifying which microbes in what proportions make a foolproof recipe for a commercial cocktail for poultry producers. Scientists in both labs are also searching for microbes in their respective flocks that secrete toxins (known as bacteriocins) and for bacteria-infecting viruses (called phages) lethal only to *Campylobacter.*

Svetoch and his colleagues do their research in Obolensk, a city intentionally omitted from Soviet maps until the early 1990s, because it was once a mecca for biological weapons production. The Russian government no longer funds this research, and many of their highly skilled scientists are left with no livelihood.

The U.S. State Department is eager to redirect these scientists into more benign research. ARS is one federal agency enlisted to help reduce the threat of bioterrorism. Last year, six joint projects between ARS and scientific groups in Russia (four) and Kazakhstan (two) were under way, thanks to coordination by OIRP international affairs specialist Melanie P. Peterson. Ten more projects for Russia were awaiting State Department funding, she says.

"Selling this program to ARS scientists has been easy because they see it as a way to extend their own research

projects," says ARS veterinary medical officer Richard L. Witter in East Lansing, Michigan. Witter serves as a scientific advisor to launch the initiative, organizing trips, setting goals and operating procedures, and developing a plan for meshing former Soviet research with the interests of ARS.

"A small amount of money buys a lot of research," Witter says. As many as 30 foreign scientists work on some of the joint projects, earning the equivalent of $15 to $35 a day, depending on their level of expertise. That's a hefty increase over the $25 to $50 a month they were earning after the fall of the Soviet Union.

"These projects will create relationships that will assure cooperation for a long time," says Witter. He expects new projects to be funded after the current ones expire.

"It's critical that we fashion real partnerships with hands-on collaboration and continued contacts," he adds. That's why ARS scientists also visit their counterparts in Russia and Kazakhstan during planning and execution of the projects.

A Sample of ARS Partners in International Research

USDA
Foreign Agricultural Service
Animal and Plant Health Inspection Service
Cooperative State Research, Education, and Extension Service
Other government agencies
Agency for International Development
Department of State
Department of Defense
Department of Commerce
National Science Foundation
State universities, historically Black colleges/universities (1890) and Native American colleges (1994)
International organizations
Food and Agricultural Organization
International Atomic Energy Association
World Bank
Consultative Group of International Agricultural Research (16 centers worldwide)
Tropical Agricultural Research and Higher Education Center
South Africa National Department of Agriculture
South Africa's Agricultural Research Council
U.S./Israel Binational Agricultural Research and Development Fund
EMBRAPA

West Africa: Natural Corn With Ample Nutrients

ARS scientists are also involved in projects to improve the nutritional content of crops. Plant physiologist Ross M. Welch, of ARS' U.S. Plant, Soil, and Nutrition Laboratory in Ithaca, New York, has worked with four international agricultural research centers in Africa, Asia, South America, and Washington, D.C., to boost levels of iron, zinc, and provitamin A (beta-carotene and related carotenoids) in a variety of staple crops.

Welch is now assisting his co-worker, ARS animal physiologist Raymond P. Glahn, on a collaboration with a fifth center—the International Institute for Tropical Agriculture in Nigeria.

Iron deficiency is the most serious nutritional deficiency worldwide. In Africa alone, nearly half of all pregnant women and more than half of all school-age children are iron deficient, according to UNICEF figures. Among its many repercussions, iron deficiency impairs learning ability in infants and children. Vitamin A deficiency is the second most critical deficiency in developing countries. Its victims suffer impaired vision and blindness and more severe infections due to a weakened immune response. And zinc works hand-in-hand with the vitamin to reduce infections.

Thanks to a grant from the U.S. Agency for International Development (USAID) and coordination by Eileen M. Herrera, OIRP's international affairs specialist for Africa, a young Nigerian scientist is spending this year at the Ithaca laboratory. She'll search through some 150 varieties of West African corn for those high in iron, zinc, and provitamin A and learn to use a cell culture system developed by Glahn. The system measures how much of the nutrients in a given food is actually absorbed by intestinal cells. (See "A Gut Issue—Measuring Iron Bioavailability," *Agricultural Research*, August 1999, pp. 4-6.)

Glahn developed the culture system to measure iron absorption, but he's confident that it can be adapted to assess carotenoid and zinc bioavailability. He says the culture system requires only 10 to 15 percent of the time and money it takes to do these studies in animals—and costs far less than human studies. This makes the system ideal for scientists in developing countries who want to screen existing crops or breed new crops for better nutrient bioavailability.

"Agriculture has been very successful at producing more food. What we need to do now is produce more nutritious food that will alleviate hidden hunger," says Glahn. He notes that the vitamin and mineral content of major grains has decreased in recent years while their calorie content has increased.

Because fortified foods don't necessarily get distributed to the areas where those nutrients are needed the most, he says, "our laboratory takes the approach of turning back to agriculture to provide a more nutritious food supply."

In fact, Welch and collaborators at the International Rice Research Institute in the Philippines recently developed a high-yielding, disease-resistant rice packed with substantially more iron and zinc than traditional varieties. Welch says a study of Filipino nuns is in progress to see if the rice raises their iron status. If so, the rice will be made available to breeders around the world who can adapt it to their regional environments.

South Africa: Students Give as Much as They Take

Goodman Jezile, from Cape Province in South Africa, found his way to Colorado State University (CSU) via another ARS international program that grew out of a binational commission. Jezile says he heard about the internship program for promising early-career scientists through his mentor at the Agricultural Research Council—the ARS counterpart in South Africa.

"I realized the advanced state of soil erosion in the eastern Cape Province and in neighboring KwaZulu/Natal Province. I really looked forward to finding solutions to reverse this erosion," says Jezile, who is now studying soil science and ecology on rangelands.

The internship program matches aspiring scientists who want to obtain a master's or doctoral degree with mentors in U.S. universities and in ARS laboratories that have programs in the students' fields of interest. It's geared toward disadvantaged South Africans who were excluded under previous governments. A description of the internship program for early-career South African scientists is online at http://www.cnr.colostate.edu/RES/arip/southafrica.htm.

R. Dennis Child, head of CSU's Department of Rangeland Ecosystem Science and a former ARS program leader, oversees the placement of these students "in the right institution and with the right mentors," he says. "We want them to develop a good relationship with ARS and their universities, so they will have strong ties to both when they return home. It will help them stay current in their fields and may lead to cooperative research that helps both countries."

Child, who is Jezile's academic mentor, says 10 young South Africans are currently studying for advanced degrees in U.S. universities around the country. He develops the agreements with the universities and distributes the funds, which come from ARS and USAID.

S. Jean Reeder, a soil scientist in ARS' Rangeland Resources Research Unit at Fort Collins, Colorado, is Jezile's research mentor. She says his project is a novel approach to assessing rangeland health by correlating properties of the vegetation with those of the soil. "Soil scientists have had their heads below ground, while range scientists have looked at the vegetation above the ground. Now we're putting our heads together to better understand the ecosystem."

Jezile will receive a master's degree this spring and hopes to continue at CSU toward a doctoral degree. Then he'll return to South Africa. "The opportunity I received didn't just happen by chance. It's part of God's plan for me to contribute something to my people."—By **Judy McBride,** ARS.

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SCOTT BAUER (K9387-1)

At Fort Collins, Colorado, Goodman Jezile (right) and mentor Dennis Child discuss differences in plant composition in moderately and heavily grazed native range sites.