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Report Highlights:

The United States and Brazil are world leaders in agricultural research, and our collaboration over the last several decades has been a cornerstone of the close relationship between our two countries. Strengthening this relationship by expanding collaborative research will be critical as the world faces the existential threat of climate change and food insecurity. To meet this challenge, scientists from the United States and Brazil are developing a fertilizer-use efficiency research initiative that will be launched at the 50th anniversary celebration of Embrapa (Brazilian Agricultural Research Corporation) on April 26, 2023.

Introduction

Until the 1970s, Brazil was a food-insecure country that had to import most of its food. However, in less than 30 years Brazil transformed itself into an agricultural powerhouse, going from a net importer of food into one the world's leading exporters. Brazil is today among the top five producers of thirty-six agricultural products (Klein and Luna, 2019). It is also the leading exporter of soybeans, corn, coffee, sugar, beef, poultry, coffee, and orange juice. The country's tremendous increase in agricultural production is known as Brazil's Green Revolution and is widely considered one of the most important world developments of the second half of the 20th century.

Brazil's abundant supply of land and rich endowment of natural resources, the country's political commitment to a modern agricultural sector, the entrepreneurial spirit of Brazilian producers, and advanced agricultural research were key elements for this transformation. In addition, countries such as Japan were an important contributor in helping Brazil modernize its agriculture. For example, in the 1970s and 1980s the Japanese-Brazilian Cooperation Program for Cerrado Development (PRODECER) developed agricultural technologies in the Cerrado savanna that helped transform the region into an agricultural powerhouse (Ekman and Macamo, 2014). Notably, the United States, through technical assistance and scientific collaboration, also played a vital role in Brazil's agricultural development.

Today, the United States and Brazil feed around 25 percent of the world's population. Without these two countries' production, the world's food supply would be critically low for a growing population. The United States and Brazil are also world leaders in agricultural research and the collaboration over the last several decades has been a cornerstone of our close relationship. In the coming decades, strengthening this relationship by expanding collaborative research will be critical as the world faces the existential threat of climate change and food insecurity.

The Early Years of Technical Assistance

Peter Henry Rolfs (Source: Wikimedia Commons)

The United States has had a long history of collaboration with Brazil in agriculture. President Abraham Lincoln signed into law on July 2, 1862, the Land Grant Act to fund educational institutions by granting federally controlled land to states to create land-grant universities. A key mission of these institutions was to support agriculture. The University of Florida became the first land-grant university in Florida in 1884. Peter Henry Rolfs, born in Iowa in 1865, was an agronomist who was the Director of the Florida Agricultural Experiment Station from 1906 to 1920 and the Dean of the College of Agriculture at the University of Florida from 1915 to 1920.

In 1920, Dr. Arthur da Silva Bernardes, the Governor of the State of Minas Gerais, became concerned about his state's gradual decline in agricultural productivity, including poor harvests, inadequate pastures, and the general lack of development (Fernanda, 1991). The decline was due to poor planning in the use of natural resources that led to soil depletion and lower harvests, especially for coffee, the major cash crop in the state. As a result, Governor Bernardes decided to establish an agricultural and veterinarian school that would train technicians to help develop agriculture in Minas Gerais.

In cooperation with the Brazilian Foreign Ministry and the U.S. Department of Agriculture (USDA), Governor Bernardes invited Dr. Rolfs to Brazil to help establish the Federal University of Viçosa (UFV), today one of the country's premier agricultural universities. Rolfs, who arrived in Brazil on February 4, 1921, created an agricultural institution that adhered to land-grant university principles: teaching, research, and extension. Rolfs served as the Director until 1929. He then became a technical consultant on agricultural affairs for Minas Gerais, retiring in 1932 and passing away in 1944 (Peter Henry Rolfs Collection: University of Florida). The University of Florida continues to play a major role in agricultural research collaboration with Brazil, including as a member of the U.S.-Brazil Fertilizer-use Efficiency Initiative.

Other U.S. land-grant universities also have a long history in Brazil. In 1958, at the request of the Brazilian and U.S. governments, Purdue University entered into a contract with UFV (Fernanda, 1991). Generally, Brazilian agricultural universities are teaching universities and do not include research and extension. The purpose of the Purdue-UFV plan was to assist Brazilians improve research to solve agricultural problems, reinforce the university curriculum, and develop agricultural information systems in the country. Purdue University faculty stayed in Brazil for many years to strengthen UFV commitment to the land-grant principles of teaching, research, and extension. Purdue continued its institution building with UFV until 1973. Even though the formal program has ended, this long-standing relationship between UFV and Purdue University continues today.

The Influence of Nelson Rockefeller

One important American who played a critical role in Brazil's agricultural development was Nelson Rockefeller. Rockefeller wore three hats in his work in Brazil, a U.S. government official, philanthropist, and businessman (Nehring, 2021). Rockefeller had a long-standing interest in Latin America, beginning with his work in the oil industry in Venezuela. With WW II approaching, Rockefeller proposed to President Franklin D. Roosevelt a "Hemisphere Economic Policy" to assist Latin America to develop economically and ally with the United States against the Axis Powers (Cobb, 1989). As a result, the President asked Rockefeller to become the Director of the Office of the Coordinator of Inter-American Affairs (OCIAA) so that Rockefeller could put his ideas on Latin America into action.

Formal U.S. technical assistance to Brazil began in 1942 because of U.S. wartime needs for raw materials and food and the strategic importance of Brazil to the United States. Brazil was also an ally of the United States during the war. Under the leadership of Rockefeller, the OCIAA supported multi-million-dollar programs in mineral exploration, public health, rubber growing, and food production in Brazil during the Second World War. Because of OCIAA's efforts, Brazil became a source of natural rubber, nickel ores, and vegetable oils for the United States during the war.

Early on, Rockefeller saw tremendous potential in Brazil. He related a story to Brazilians of having lunch during WW II with President Franklin Roosevelt after a recent trip to Brazil. President Roosevelt pulled out a map when he finished lunch and stated, "You know, Brazil is a wonderful country. If I were a young man starting out, I would go there." He then pointed to the central part of Brazil and added "Someday that will be the most important area of development in the world, the whole history of our West will be repeated. Never forget one thing, when this war is over the hope for the future is going to rest in the new world" (Dalrymple, 1968). President Roosevelt seemed to be foreshadowing the creation of Brasilia, the new capital of Brazil in the central part of the country, and the potential of the Cerrado, the tropical savanna biome in the central-west region of Brazil that at the time was inhospitable to most crops.

Private philanthropy played a major role in early agricultural development after the war. As an outgrowth of the work of OCIAA, in 1946 Rockefeller created the American International Association for Economic and Social Development (AIA) as a non-profit organization to assist Latin America in economic development and foster greater cooperation between countries. AIA established the Brazilian Farm-Credit Agency, ACAR, which helped to develop agriculture in Brazil and modernized the livestock sector (Dalrymple, 1968).

Brazilian President Getúlio Vargas and Nelson Rockefeller in 1942 (Source: Wikimedia Commons)

In 1947, Nelson Rockefeller organized a for-profit organization, the International Basis Economy Corporation (IBEC), to enhance economic development in Latin America. IBEC sold agricultural products such as hybrid corn and fertilizer throughout Latin America, and part of its profits helped fund technical assistance through AIA and later the IRI Research Institute.

Neither AIA nor IBEC specialized in agricultural research. Rockefeller created the IRI Research Institute in 1950 as a sister organization to AIA and IBEC to undertake research in Brazil to solve this issue. Under IRI, U.S. researchers first worked on devasted coffee land in Sao Paulo state but quickly turned their attention to the Cerrado.

U.S.-Brazil Economic Commissions

After the Second World War, U.S. government policy prioritized assisting Brazil in developing economically to help it become a stable, prosperous country and a bulwark against communism. In 1948, in response to Brazil's requests for assistance in economic development, the two governments created the Joint Brazil-U.S. Technical Commission or the Abbink Mission, named after the Chairman of the Mission John Abbink, an international economist who was the chairman of McGraw-Hill International Corporation. The Commission studied the problems in developing agriculture, livestock, minerals, fisheries, transportation, and banking. Their final report in 1949 stressed the need for foreign capital to promote development, and the importance of agriculture in that development. Abbink, for instance, told the New York Times in a February 1949 interview that the "development and

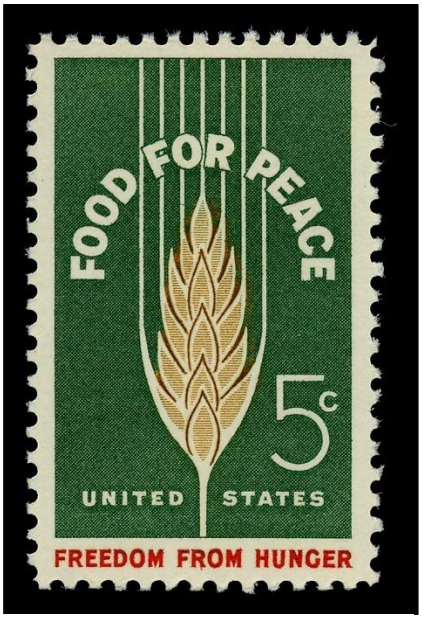
modernization of agriculture in Brazil would go a long way toward making that nation prosperous." (New York Times, 1949)

Following the Abbink Mission, the two countries established the Joint Brazil-U.S. Economic Development Commission in 1951, which guaranteed $1 billion (over $12 billion in today's dollars) in internal and external financing to Brazil. The purpose of the Commission was to help create linkages between industry and agriculture to improve economic development. The Commission created an outline on which crops would be research priorities; rice, beans, corn, soybeans, and cattle were identified as the most suitable crops for agricultural development (Nehring, 2019). Brazil is now a world leader in these agricultural products.

The Commission created the National Bank for Economic Development (Banco Nacional de Desenvolviento Economico e Social - BNDES) in 1952 (USAID, 1986). BNDES has been the major source of long-term financing of capital investment in Brazil since its creation and is still the leading development bank in Brazil.

The Commission also offered a tremendous amount of technical assistance, providing 421 scholarships and fellowships for Brazilian students to study for advanced degrees in the United States. In addition, in 1953, the Commission created a bilateral agriculture service to assist rural universities and programs in agricultural credit. The Commission operated until 1953 and set up the basic plan for development in Brazil for the next two decades (USAID, 1986).

Public Law (PL) 480 (Food for Peace) for Brazil



Freedom from Hunger stamp from 1963 commemorating the Food for Peace Program (Source: Smithsonian National Postal Museum)

The U.S. government provided a significant amount of food and economic aid to Brazil through PL-480, a U.S. government assistance program. After the Korean War, the United States needed to dispose of surplus commodities to help prop up prices for U.S. commodities. On July 10, 1954, President Dwight Eisenhower signed into law the Agricultural Trade and Assistance Act of 1954, commonly known as PL- 480 or Food for Peace. PL-480 provided food deficit "friendly countries" the opportunity to purchase U.S. agricultural commodities at concessional rates, mostly in local currencies, or obtain U.S. commodities through grants.

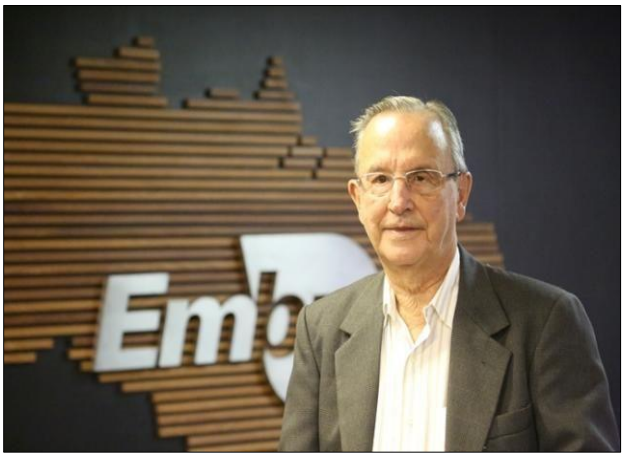
Brazil was a major user of PL-480, mainly importing wheat from the United States to help with food shortages and development projects. Brazil purchased PL-480 commodities at concessional rates from 1956 through 1972 and gradually phased out grants by the 1980s. Some PL-480 funds were used for agricultural development. For example, USAID used PL-480 funds for technical assistance in agricultural planning, extension, research, marketing, and education, along with loans to purchase fertilizer imports, local fertilizer production, and the construction of farm-to-market roads (USAID, 1968).

From 1955 to 1969, Brazil imported around $800 million (around $8 billion in today's dollars) worth of commodities using PL-480, which comprised almost three-quarters of the U.S. agricultural exports to Brazil (Adams, 1970).

USAID Technical Assistance and The Creation of Embrapa

The Brazilian government created Embrapa in 1973. Embrapa was the product of a Ministry of Agriculture working group that met in 1972 to discuss the future of agricultural research in Brazil (Klein and Luna, 2019). With the findings of the working group, Embrapa was born. The purpose of Embrapa was to improve agricultural productivity by applied research and technology transfer to farmers (Correa and Schmidt, 2014). The new Brazilian agency created dozens of research centers in Brazil that focus on specific agricultural commodities and biomes. Through a healthy level of public funding, investment in human capital, and international research collaboration, Embrapa became a world-class research institution within 10 years of its founding. Embrapa would emerge as the global leader in improving degraded tropical soils and is the source of 30 percent of all public research in Latin America (World Food Prize Foundation). Today, Embrapa is widely known as the leading research center on tropical agriculture in the world.

When the U.S. government established USAID in 1961, Brazil became a top priority for the agency. USAID played an essential role in creating Embrapa. USAID funded the construction of laboratories and research centers and the training of agricultural scientists in the United States. From 1961 through 1978, USAID sponsored hundreds of young Brazilian agricultural scientists to obtain advanced degrees at more than 25 U.S. land-grant universities (USAID, 1986). Many of these scientists became the backbone for Embrapa and ushered in the close and enduring partnership between U.S. and Brazilian scientists.



Eliseu Alves at Embrapa's Headquarters in Brasilia (Source: Embrapa)

One of the early leaders of Embrapa was Eliseu Alves, who graduated from Federal University of Viçosa and later received a PhD from Purdue University. At Purdue University, Alves worked with Edward Schuh, an American expert on Brazilian agriculture whose research in Brazil for the Ford Foundation in 1966 and 1967 became the basis for a book on agricultural development in Brazil (Schuh and Alves, 1970). Schuh believed it was essential for Brazil to invest in agricultural research and to train Brazilians abroad (Nehring, 2021).

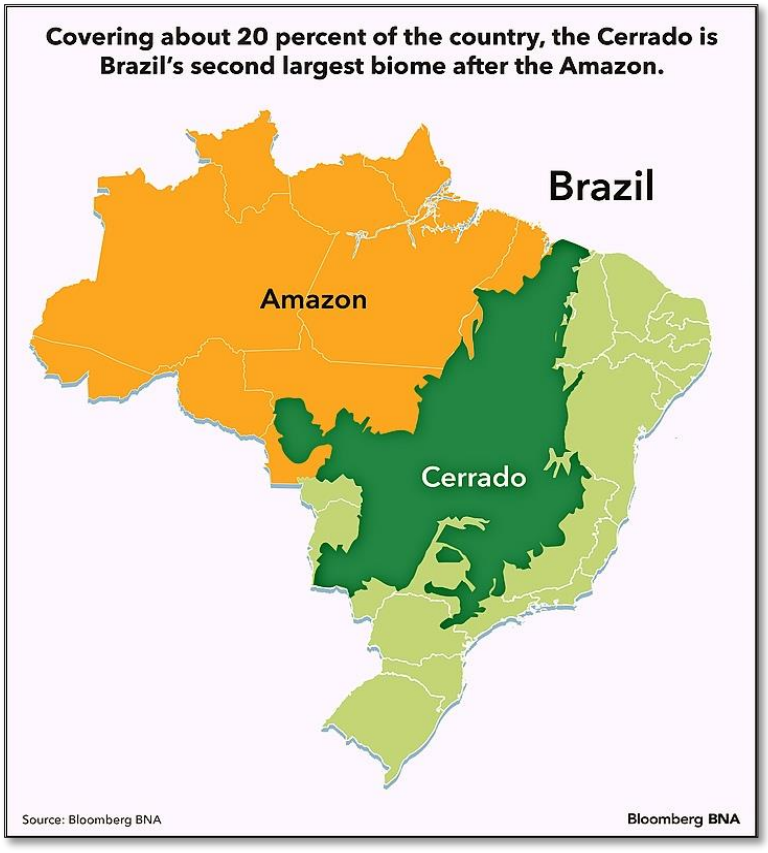
Alves took that belief and ran with it at Embrapa, where he served as President from 1979 to 1985. Alves sought international loans and grants, including from USAID, to finance postgraduate training abroad for existing and future Embrapa scientists. After his time as President, he worked for Embrapa until early in 2023, when he retired at 92.

Alves recently commented on his time in Embrapa, "Nothing gave me more pleasure in life and justified me coming to earth than the creation of Embrapa" (CompreRural).

Since its creation in 1973, Embrapa has had a very close relationship with U.S. scientists. An example of Embrapa's collaboration with the United States is LABEX USA, which started in 1998 between Embrapa and USDA's Agricultural Research Service (ARS) (Embrapa Labex Program). LABEX USA is modeled as a virtual laboratory to connect Embrapa and ARS scientists doing mutually beneficial research.

Since the mid-1990s, Embrapa has accelerated its international scientific cooperation through Labex-USA and Labex-Europe, which was established in 2002. Through these programs, Embrapa has partnered with 27 scientists in the United States, 17 in Europe, two in South Korea and one in China. As the hub of tropical research, Embrapa uses the technology developed with scientists from the Northern Hemisphere and shares it with scientists from the Southern Hemisphere. For instance, in 2013 Embrapa joined the FAO's South-South Cooperation Initiative to support food security initiatives in developing countries (FAO).

Turning the Cerrado into a Global Breadbasket



In Spanish, Cerrado means closed, but in Portuguese it is also used to describe scrubland or savanna, a grassy plain in tropical and subtropical regions with few trees. The Brazilian Cerrado is a vast region of tropical savanna stretching from central to western Brazil. It covers around 20 percent of Brazil and is the second largest biome after the Amazon. To give some perspective, the Cerrado is almost three times the size of Texas (The Nature Conservancy). The soils in the Cerrado have high acidity and aluminum levels that were toxic to most crops.

Brazil, however, transformed the Cerrado from an infertile region to a highly productive one in less than 30 years during the second half of the 20th century. The transformation of the Cerrado is one of the most significant increases in farmland in the world since the settlement of the U.S. Midwest in the 19th century and is widely viewed as one the greatest achievements of agricultural science in the 20th century. Norman Borlaug, the father of the Green Revolution and the 1970 Nobel Peace Prize laureate, called the development of the Cerrado "the largest agricultural event in the 20th century" (Tota, 2021). According to the World Food Prize Foundation, the

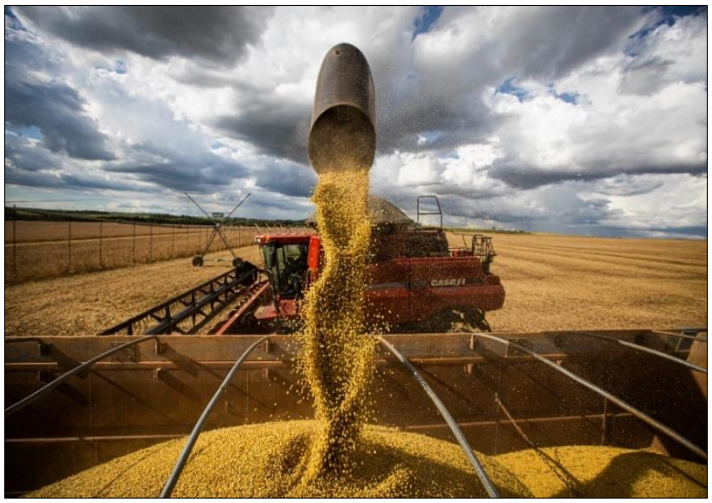
Cerrado now produces over 54 percent of all soybeans in Brazil, 28 percent of the corn, and 59 percent of the coffee. The region also produces a significant quantity of rice, cotton, cassava, sugar, and supports 55 percent of Brazil's beef industry.

The miracle of the Cerrado was science-driven and an example of the strong collaboration between Brazilian and U.S. scientists. In 1955 Andrew McClung, an agronomist from Cornell University, arrived in Brazil to work as an IRI researcher and initiated a series of experiments on poor soils in the Cerrado to help cultivate corn, soybeans, and cotton. McClung worked in close collaboration with the Brazilian research center Instituto Agronomico de Campinas (IAC) and his results on soil improvement in the Cerrado were published in 1957 and 1960. McClung believed Brazil could be a world leader in agriculture, and that the Cerrado was the key to this potential. However, until he discovered the precise application of lime and fertilizers that made its soils productive, the infertile Cerrado had been of little interest to Brazilian agriculture.

With Andrew McClung's research as its foundation, the Brazilian government and Embrapa brought the Cerrado to life for agriculture in the 1970s. Alysson Paolinelli was Brazil's Minister of Agriculture from 1974 to 1979. He developed and implemented science-based policies and institutions that helped to transform the Cerrado into a global breadbasket. For example, Minister Paolinelli expanded Embrapa during his time as Minister and created Polocentro (The Program for the Development of the Cerrado), which formulated agricultural policies for the region (Redapaolinelli).

Embrapa scientists developed high-yielding crop varieties for the Cerrado that were tolerant of aluminum toxicity and acquired soil micronutrients more efficiently. For instance, Edson Lobato, a researcher at Embrapa's Cerrado Research Center, worked to improve soil quality and counteract water stress, contributing to increased yields. In addition, Embrapa agronomists developed no-till planting techniques that reduced environmental impact and refined soil nutrient applications in the Cerrado.

For their work in bringing the Cerrado to life, two Brazilians, Alysson Paolinelli and Edson Lobato, and one American, Andrew McClung, received the 2006 the World Food Prize, widely known as the Noble Prize for food and agriculture.



Brazilian Agriculture (Source: CNA)

The U.S.-Brazil Fertilizer-use Efficiency Research Initiative

Today, the United States and Brazil are leading the way with an innovative research project on fertilizer. Over the last year, scientists from the United States and Brazil have been developing a fertilizer-use efficiency research initiative in response to the global fertilizer crisis. This research program highlights the vital collaboration between Embrapa, USDA's ARS and the Foreign Agricultural Service, the University of Florida, and the International Fertilizer Development Center.

The initiative will consist of four research projects: 1. Precision agriculture; 2. nutrient management; 3. fertilizer alternatives; and 4. soil management. Each research project will last up four years. The research initiative is being partially funded under USDA's Fertilizer Right Initiative as part of the U.S. Department of State funded Global Fertilizer Challenge.

ARS Fertilizer Research (Source: USDA)

The research projects are being developed through a series of workshops, funded by USDA and USAID. The first workshop was held virtually on July 29, 2022, and the second hybrid workshop was held at the University of Florida from November 16 and 17, 2022. On January 18, 2023, over 60 scientists met virtually to present their progress in developing their projects. A fourth workshop was also held virtually in March. This groundbreaking research initiative will be launched at a ceremony in Brasilia on April 26, 2023, marking the 50th anniversary of the founding of Embrapa, with a final meeting in Brazil in May to begin the four projects.

The partnership will greatly strengthen U.S.-Brazilian ties in fighting climate change and food insecurity. The joint research initiative will also lead to outcomes that go far beyond Brazil and the United States to the developing world to improve fertilizer use efficiency that will lessen the world's dependence on imported fertilizer, advance global food security, and reduce greenhouse gas emissions. This research on fertilizer efficiency should only be the beginning of increased collaboration between the United States and Brazil as the world tackles the existential threat of climate change and global food insecurity.

The Existential Threat of Climate Change and Food Insecurity

The world's population could reach around 9.8 billion by 2050 and 11.2 billion in 2100 (World Population Prospects, 2017). As a result, food production must increase significantly during this century to feed every mouth on earth. Climate change will make this already daunting task much more difficult. The effects of climate change on agriculture could result in lower crop yields and nutritional quality because of drought, heat waves, flooding, and increased pests and plant diseases.

Climate Change and Agriculture (Source: USDA)

Last year, 26 World Food Prize Laureates sent a letter to the leaders of the G-7 urging them to leverage food systems to combat global hunger, Covid 19, and climate change (The World Prize Foundation). The letter mentioned that 800 million people are now hungry or malnourished, and that climate change has disrupted food production for the world's increasing population, and conflicts in Africa, Asia, Latin America, and Europe have intensified these negative trends. The World Food Prize Laureates recommended aid to expand farmers' access to climate-resilient technologies and support domestic food production.

The scientific communities in the United States and Brazil are up to the challenges of climate change and food insecurity. Embrapa, for example, has over 300 scientists that participate in climate change research. The U.S.-Brazil Fertilizer-use Efficiency Research Initiative is an example of our recent collaborative efforts. This rich bilateral history between our two countries provides linkages to expand our agricultural research efforts to improve climate-smart agriculture and global food security.

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Attachments:

No Attachments.