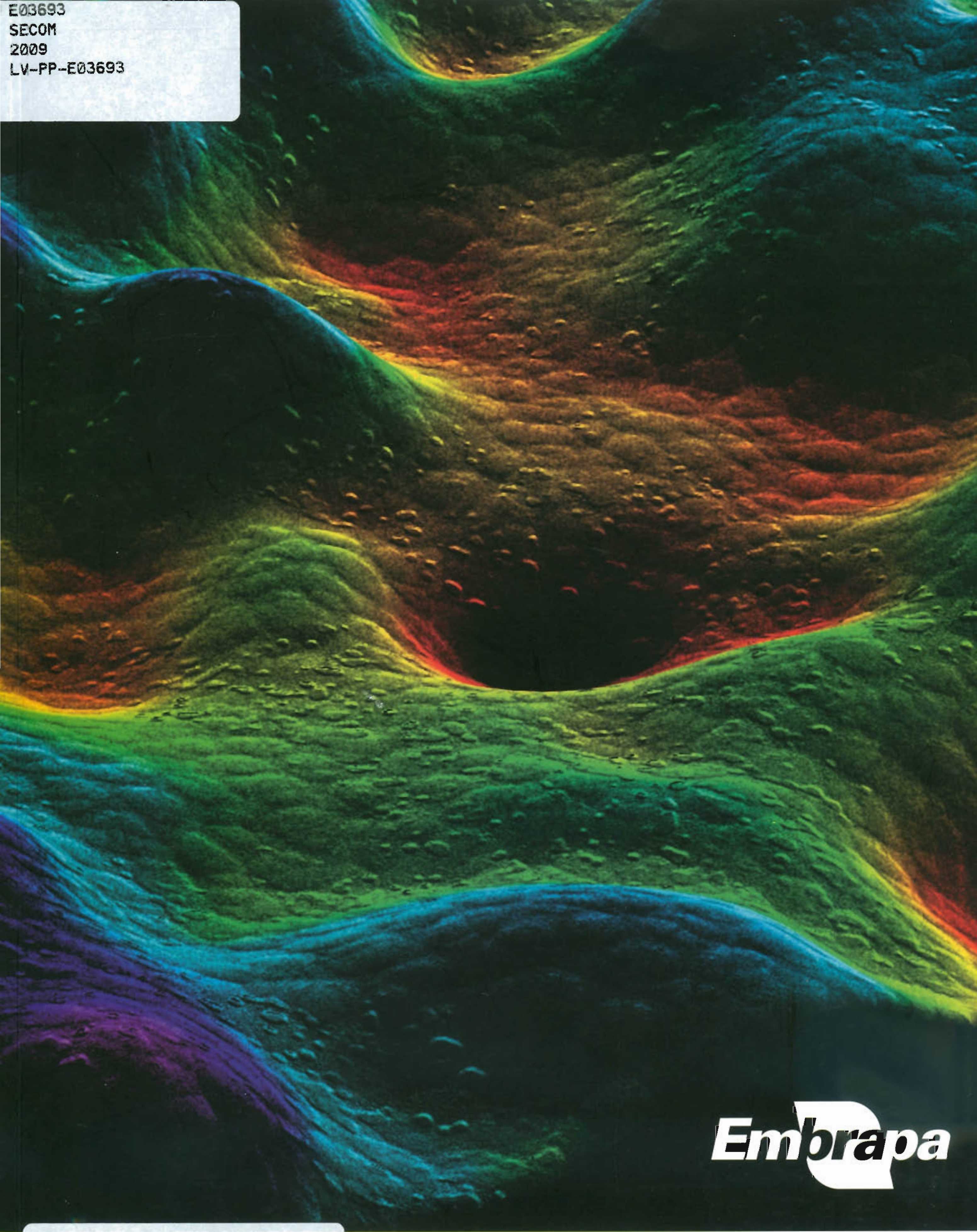


Embrapa

e Challenge of Sustainable Agriculture

Embrapa. Social Communication Office.
The Challenge of Sustainable Agriculture / EMBRAPA, Social Communication Office. – Brasília, DF : Embrapa - Assessoria de Comunicação Social, 2009.
79 pages.

1. Sustainable agriculture. 2. Cropping and Livestock. 3. Agricultural development. 4. Social development 5. Economic development. I. Embrapa. Empresa Brasileira de Pesquisa II. Tittle.

CDD 630.72

International Cataloging Data of the Publication (ICP)
Social Communication Office

The Challenge of Sustainable Agriculture

Embrapa

Final text and edition
Social Communication Office

Edilson Fragalle
Head of the Social Communication Office

Marita Féres Cardillo
Press Coordinator

Luzmair Siqueira Santos
Coordinator of Events and Publicity

Gilceana Soares Moreira Galerani
Coordinator of Internal Communication

Text
Renato Cruz Silva

Text on the cotton and late corn case studies
Alberto R. Cavalcanti

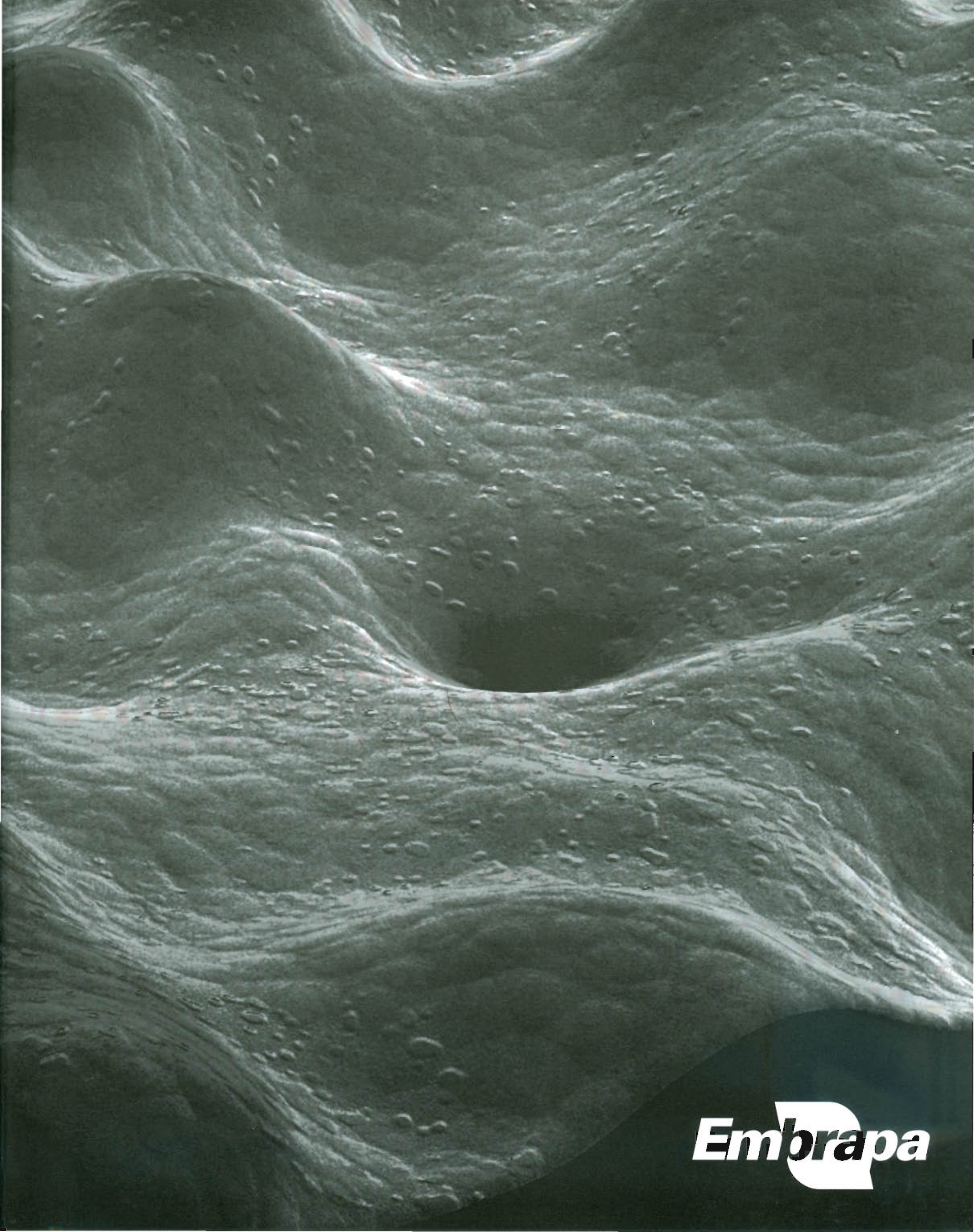
Collaborators
Carlos Alberto Domingues da Silva
Derli Prudente Santana
Deva Rodrigues
Edilson Fragalle
Eduardo Pinho Rodrigues
Elizabete Antunes
Ester Lilian Alves Castro
Flávio Ávila
João Carlos Garcia
José Carlos Cruz
Juliana Freire
Luiz Antonio Laudares Faria
Marita Féres Cardillo
Napoleão Esberard Macedo Beltrão
Renner Marra
Rosângela Evangelista
Rose Azevedo
Ubiraci Rafael Gomes
Vera Maria Carvalho Alves
Vitor Moreno

Photo selection
Alberto R. Cavalcanti
Deva Rodrigues
Edilson Fragalle

Cover
Art based on an image by Rubens Bernardes Filho that captures the bacteriostatic action of propolis (reddish-yellowish areas) on Staphylococcus aureus bacteria.

Our thanks to EMBRAPA's Centralized and Decentralized Units.

Run: 1,000 copies



Embrapa

TABLE OF CONTENTS

FOREWORD **6**

STRATEGIC MANAGEMENT OF INNOVATION **8**

Innovation management in Tropical Agriculture 10

Innovation as Official Policy 12

TECHNOLOGICAL MATURITY CYCLES: COTTON AND LATE CORN AS CASE STUDIES **14**

Cotton: a leap toward modernity 15

The name of the revolution: CNPA ITA 90 16

Production system 18

Today's cotton fibers 19

New EMBRAPA cultivars 20

The challenges of cotton research 21

Corn: *safrinha* corn has become the second summer corn crop 24

The contribution of research: new varieties 26

Crop management technology 27

National Seminars 28

Research challenges 29

INSTITUTIONAL BUILDING **30**

EMBRAPA's Accelerated Growth Program (PAC) 33

STRATEGIC MANAGEMENT OF RESOURCES **34**

Intellectual capacity and creativity 36

Material resources 39
Financial resources 41

STRATEGIC MANAGEMENT OF R&D 44

Strategic partnerships 45
New technologies and knowledge 47
Family agriculture 48
Agroenergy 50
Competitiveness 51
Management of socioeconomic clusters and farms 56
Natural resource management 59
Food security 62
Environmental Security 65
The new R&D tropical agenda 66
International partnerships 68

STRATEGIC MANAGEMENT OF COMMUNICATION AND TECHNOLOGICAL BUSINESS 70

Support to government programs 74
Support to society at large 75
Fostering innovation 76
International expansion of tropical agriculture 78

FOREWORD

In 2008, on completing 35 year of existence, EMBRAPA revisited its origins. EMBRAPA has become an institution of excellence in research, development, technology transfer, and innovation, and is once again deeply involved in the development agenda of the Federal and State governments.

The official announcement of a Corporate Strengthening and Growth Program – the EMBRAPA PAC – by the President of the Republic, in April, was a landmark in the institution's history. In an innovative manner, seeking to restore the flexibility required by EMBRAPA's institutional model, the government pledged additional investments, totaling R$ 914 million, during 2009-2010 period, in the National Agricultural Research System (SNPA, in Portuguese), which also includes state organizations and universities.

Our responsibility has grown since that day, and we are responding as we usually do, with actions. We have drawn a new Master Plan to guide our institution in the years ahead and define our goals by EMBRAPA's 50th anniversary in 2023. The international agenda has made great strides, and EMBRAPA is now present in Venezuela, the United Kingdom and South Korea, with the creation of an EMBRAPA Laboratory Abroad (Labex, in Portuguese) in the latter.

In Brazil, we have met current needs and demands by setting up new research units in the states of Mato Grosso, Maranhão and Tocantins, as well as a new unit called EMBRAPA Macro Strategy, in the Federal District. The mission of the latter is to anticipate possible future scenarios and plan EMBRAPA's response to changes in agricultural research in Brazil and throughout the world.

The EMBRAPA Management System (SEG), in charge of our project portfolio, has also borne good fruit, namely, the consolidation of large projects in the research, technology transfer and institutional development network: nanotechnology and animal genomics. The staff of those two projects have already published diverse papers on animal and plant health, family agriculture, oleaginous plant chains, crop-livestock-forestry integration, agroenergy, genetic resource platforms, and global climate changes, in addition to the animal genomics work published in Science magazine.

In order to fulfill so many commitments, in addition to investments in infrastructure, we have broadened and renewed our most important asset: our cadre. We have had the strong support of our Board of Trustees in implementing one of the clauses of the Collective Labor Agreement, bringing up EMBRAPA's stipends and competitiveness up to par with the salaries in companies with similar structure.

We are exposed to news about international crises and other adversities characteristic of a competitive and challenging world, meeting challenges, however, is ingrained in EMBRAPA's DNA. After all, we cannot lose sight of the enormous contribution of research in making tropical agriculture viable and competitive and, thus, helping overcome any crisis. Just look at the surplus agricultural products being exported; the generation of jobs and fixation of rural populations – 31,368,000 Brazilians live in rural areas today; the decreasing cost of the basic food basket, despite the

In the ceremony announcing the creation of the EMBRAPA PAC as a lever to achieve a new cycle of technological breakthroughs, President Lula honored Luiz Fernando Cirne Lima, former Minister of Agriculture who proposed the creation of EMBRAPA in 1972.

international threat of increasing food prices; and the contribution to renewable energy sources, especially biofuels.

EMBRAPA has been undergoing a revitalization process that began in 2005 and culminated with the implementation of the EMBRAPA PAC last year. As a new tropical agriculture technological cycle emerges, EMBRAPA seeks managerial modernization; increased efficiency in the use of resources; and agility and flexibility to establish strategic public-private partnerships in the field of innovation and, thus, update its institutional model, which is the recipe for success in this new scenario.

We bring to these pages the result of a collective effort of the Board of Directors, heads, managers and employees translated into an unequivocal demonstration of the value of EMBRAPA's credibility with the executive, legislative and judicial branches of government, as well as the private sector, partner-institutions in Brazil and abroad, and the social movements with which the company interacts.

In the sphere of government, EMBRAPA's credibility is translated into the decisive support of the President of the Republic; Vice President; Chief of the Civilian Cabinet; and ministries of Science and Technology; Land Development; Foreign Relations; Treasury; Planning, Budget and Management; Development, Industry and Foreign Trade; Social Development and Fight Against Hunger, Agriculture, Livestock and Food Supply; and Fisheries, among others.

For the Brazilian society, EMBRAPA's 35th anniversary is more than just a commemorative date. It represents the government's commitment to provide EMBRAPA the required instruments for both the present and the future, with public policies that, according to our Social Statement, resulted in a return of approximately R$ 13.55 for each real invested in 2008.

In the next few years, those investments and public policies should generate new technologies, products, services, and innovations to help reduce regional inequalities and insert Brazil into the globalized world as a sovereign nation, economically, socially and environmentally developed. Those are the challenges of sustainable agriculture.

Good reading!

Reinhold Stephanes
Minister of State for Agriculture, Livestock and Food Supply

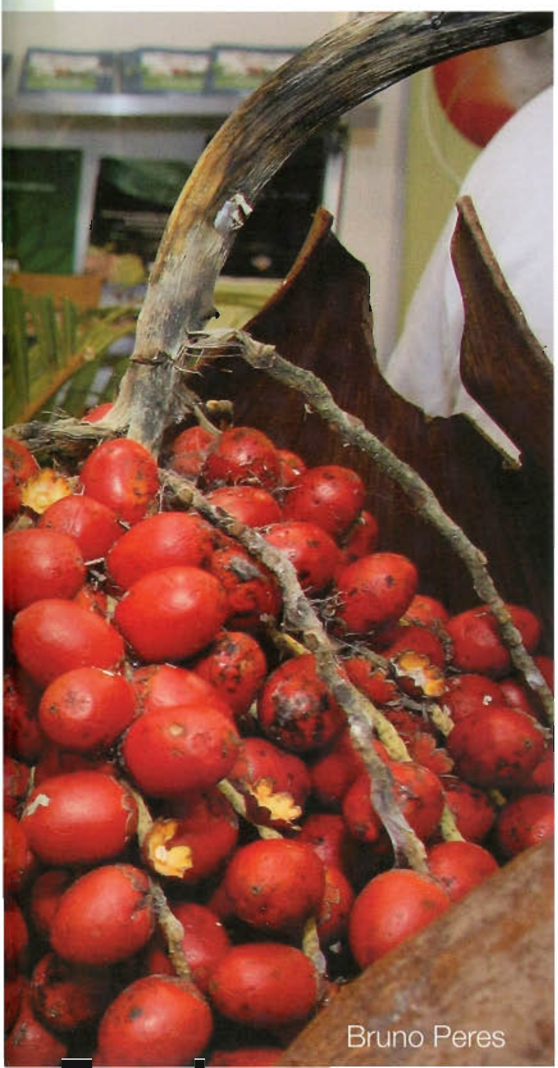
Silvio Crestana
Director-President of EMBRAPA

STRATEGIC MANAGEMENT OF INOVATION

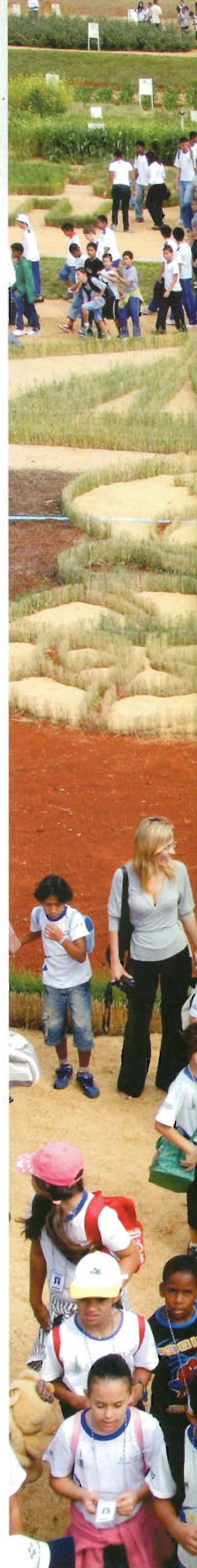
Although Nature in its evolution along the ages promotes spontaneous innovations, creating new biological, physical and chemical entities, Innovation is an essentially social and economical phenomenon. More simply, innovation results from the constant and deliberate effort of people and institutions trying to generate new knowledge and, on that basis, develop new materials, products and ways to solve their problems with production, consumption and relationships and, in a game of mutual and reciprocal influence, absorb and use the new knowledge, products and formulas to change habits and life quality and styles.

Left to the natural forces, the evolution of knowledge and innovation is not linear. It tends to be erratic, fickle, occurs by leaps and bounds, in all directions, with high levels of unpredictability. This happens, in part, because no one can predict when the knowledge necessary for a given innovation is going to be achieved, as many medical studies show us.

In addition, many people participate in the process, always as independent players, at unconnected and uncoordinated times and places, making unilateral and random choices, as creators or users, who select some knowledge or habits, disregarding others, and, thus, determine the direction of innovation.


Bruno Peres

One of the most important characteristics of innovation is that it follows cycles of maturation: since they arise from the same scientific, cultural and environmental base, knowledge and technology accrued until, from time to time, after their creation and refinement by scientists and appropriation and adjustment by users, part of them crystallize in sets of products and practices and new associated habits. At a given point, the consolidated knowledge and technology no longer serve the new habits and, therefore, there is a rupture with the consecrated economic, social and cultural patterns.



Such rupture broadens the frontiers of knowledge, establishes more sophisticated technological and cultural standards and higher productivity levels, bringing to light new players and life styles in a given nation, providing them with comparative advantages, increased competitiveness, influence and power, which explains the economic, technological and social imbalances between the different peoples since the dawn of time.

In response to those characteristics and consequences, companies and governments engage in the strategic management of Innovation, seeking, precisely, to reduce such unsteadiness, inconstancy and unpredictability in the generation of the knowledge required, replacing such traits with diagnoses, monitoring, anticipated prospection of problems, demands, and needs, guiding investments in knowledge generation, organizing technology development fluxes and, consequently, making processes less random and more committed to their objectives of growth and well-being of their people.

Their purpose is to enable a more equitable distribution of opportunities for innovation, selection and prioritization of an agenda that contemplates the development of technologies considered more pressing and promising, increasing the technological alternatives available to the users, in order to induce more frequent innovation maturation cycles and, thus, spread their economic and social benefits and reduce existing inequalities.

In other words, the strategic management of innovation seeks to conciliate public and private efforts and resources, as well as environmental, economic and social requirements, to guarantee that innovation does not emerge randomly and that it produces the desired consequences.

Innovation Management in Tropical Agriculture

In terms of agricultural innovation, the development of Brazilian tropical agriculture during the last 35 years can best bear witness to the importance and success of the strategic management of innovation focusing on the intrinsic needs and characteristics of the process of development and appropriation of knowledge.

The initial issue was food security and, essentially, a matter of the amount of food: the social and economic well-being of Brazil required diversity and stability of food

supply and the production of exportable surpluses. At a later point, the problem incorporated concerns about the multiple aspects of quality: the management of natural resources, management of socioeconomic clusters and farms, defense against weather-related perils, nutritional enrichment, good farming practices, social inclusion opportunities, diminishing regional imbalances, increased international competitiveness, etc.

Ever since, the strategic management of innovation coordinated by EMBRAPA assigns priority to expanding the creative capacity by hiring scientists with sophisticated skills, trained in wide-ranging fields of knowledge, and to maintaining an extensive and well-equipped network of laboratories and experimental fields, focusing on products (grains, meat, milk, forestry, fruits, vegetables, etc.); themes (soils, genetic resources, agricultural informatics, etc.); and biomes (Amazonia, Cerrado, Semiarid, Pantanal, etc.).

In terms of the technological agenda, EMBRAPA prioritizes inventories of natural resources, their evaluation for sustainable utilization in food, fiber, essence, and energy systems, as well as the adaptation of exogenous natural resources to such systems and biomes.

Thus, the innovation of Brazilian agriculture has gone through multiple, simultaneous technology maturation cycles. The most notorious were the transformation of the poor Cerrado soils into highly productive farmland; the tropicalization of soybean, corn, temperate-climate vegetables and fruits (apple, grapes and strawberries, etc.); irrigated farming in the Cerrado; and fruit growing in the semiarid.

Equally important were consolidating the use of biological nitrogen fixation to replace chemical fertilizers in leguminous crops (soybean, bean, peas, etc.) and adapting grasses to specific regions in order to increase the carrying capacity of pastures. More recently, the same knowledge base produced the rebirth of cotton farming and the establishment of "late" corn as a second summer crop, as described below.

The most important point, which has already been assessed and demonstrated, is that the technology maturation cycles in agriculture induce a corresponding maturation cycle in industry, as shown in the new agricultural implement and machinery designs by industry to meet the needs of direct drilling. Another example is the ethanol industry bringing together crop productivity, sugar mill efficiency and the sophistication of bifuel (flex-fuel) vehicles, in an unprecedented continuum of environmental gains.

This succession of technological inductions is one of the most important factors for the sustainability of the innovation process and the development of the country. Consequently, the strategic management of innovation must be highly flexible in redefining the strategies, redirecting resource allocation, making new investments and opening new paths of growth when seeking the technology maturation cycles that will ensure the development of Brazil.

Innovation as Official Policy

It is reasonable to state that the success of the strategic management of innovation in agriculture was a determining factor in establishing Innovation as an Official Policy of the State. After all, the ingredients and resulting products of innovation have been the driving force of the economic and social development of the country. It was a revolutionary change in Brazil, where innovation had been, until then, a collateral activity in the professional training programs of Brazilian universities.

When innovation became official policy, Science and Technology (S&T) became one of the mainstays of the Brazilian National Security Policy. Its management was placed in the care of a ministry and important legal instruments, such as the laws on patents and new varieties and, more recently, the Law on Innovation were passed to ensure the framework necessary to foster the association of public and private efforts in this area.

Innovation as Official Policy has had a considerable impact on the strategic management of innovation because of the determinative support received not only from the Presidency of the Republic, but also from important sectoral agencies, such as the ministries of Science and Technology, Treasury, Planning, Foreign Relations, Social Development, Land Development, Environment, and Industry and Commerce, among others.

As regards the strategic management of agricultural innovation, one of the most challenging changes has been its use as an instrument of the Brazilian Foreign Policy and, in particular, of Presidential Diplomacy. The scientific competence of EMBRAPA and the National Agricultural Research System, together with their help in solving technological problems of food, fibers and energy production in the Tropics, has made a positive difference not only in the negotiations initiated by the Ministry of Foreign Relations' Brazilian Cooperation Agency, but particularly in the diplomatic agenda of the President of the Republic.

For EMBRAPA, the adoption of innovation as official policy and its supporting legal framework have consolidated the company's international presence as regards both the generation of new knowledge and technology and the broadening of its Labex Project (EMBRAPA Laboratory Abroad) to include Great Britain and South Korea and the ongoing effort of transferring proven tropical technology to Africa and Latin America.

Technology Maturation Cycles:

Cotton and late corn as case studies

Cotton: A Leap into Modernity

The release of cultivar CNPA ITA 90 in the seed market in 1992 was zero time of the revival of cotton farming in Brazil. With that cultivar EMBRAPA was making available, for the first time, a modern cotton variety capable of meeting the new demands of the textile industry and, simultaneously, achieving truly rewarding yields for Brazilian farmers. Since its adoption by an expressive number of farmers, particularly beginning with the 1997/1998 harvest, Brazilian cotton production has grown with uncommon vigor. Cotton yields measured in kg/ha in the last two harvests are comparable to the highest yields in the world for non-irrigated cotton farming, and have exceeded those of irrigated cotton farming in countries like Australia, China and Spain, and almost doubled that of the United States.

Among annual crop yields, cotton's has been the highest when the current productivity is compared with that of the early 1970s – 600%. The main contribution to the phenomenon came from research, namely, the synthesis of new cultivars. The progress in cotton production achieved by the new cultivars under Cerrado conditions has opened new environments to cotton farming, as regards rainfall patterns, much more regular in the Cerrado than in the semiarid.

Nevertheless, cotton production has suffered ups and downs. After the cotton boll weevil (*Anthonomus grandis*) entered the country in the early 1980s, Brazilian cotton farming was gravely and continuously threatened. In addition to the natural pest, a series of foreign trade policies in the early 1990s fostered cotton imports, placing a heavy burden on domestic cotton production. Consequently, both the cotton farming area and the total cotton production were reduced in Brazil from 1985 to 1997.

The cultivation of the Malvaceae regressed toward extinction: the herbaceous cotton area harvested in 1997 was approximately 70% smaller than that harvested 12 years before, while production had dropped by more than two-thirds. At the same time, the arboreous cotton, called *mocó* in northeastern Brazil, had practically disappeared. The *mocó* cotton produces fine, resistant, long and extra-long fibers, more than 40mm in length. Thus, a good part of the cotton production chain, which was built around the domestic supply, fell apart. Brazilian farmers were losing one of their long-standing income alternatives.

With the beginning of a new cycle, initially based on the excellent adaptation of CNPA ITA 90 to the farming conditions of the Cerrado, the dismal picture was reversed in a short period of time. From large plume cotton importer, in the mid 1990s, Brazil was transformed into a large exporter, to the point of stirring protectionist reactions in some countries, which tried to resist the new competitiveness of Brazilian cotton.

The name of the revolution: CNPA ITA 90

EMBRAPA's cotton research center developed the CNPA ITA 90 cultivar in collaboration with the Itamarati Group, which was interested in breaking away from its almost exclusive dedication to soybean and, consequently, provided the experimental fields and production facilities and shared the running costs of this ambitious breeding program focusing on new cotton varieties adapted to the Cerrado.

To enrich its own gene base, EMBRAPA imported cotton lines from Argentina, Australia, Egypt, the United States, Mexico, and other countries. The CNPA ITA 90 material stood out in terms of fiber yield and quality from the very beginning. After concluding the research phase in 1990, the cultivar was effectively made available to the productive sector in 1992. Since then, CNPA ITA 90 has gradually expanded its territory, winning over cotton farmers in Mato Grosso and other Center-West states. By far, it had become the most frequently planted cultivar by the end of the century.

Ever since, the seed market has witnessed a fierce fight between new cultivars, including genetically modified cultivars. Although CNPA ITA 90 still controls a significant part of the seed market, it is no longer the leading cultivar. It has been bested by ten more recent EMBRAPA cultivars and new cultivars from other sources.

Productive vigor of EMBRAPA ITA 90 on a field in Mato Grosso do Sul, (2002).

Agricultural research in cotton has expanded substantially and the private sector has played a relevant role in this growth. Special mention should be made of the foresight of some state governments, like those of Bahia, Goiás and Mato Grosso, which created research development funds in the 1990s. Private non-profit foundations, partly funded by such resources, began investing in research. Very often in partnership with EMBRAPA, they have continuously generated new cultivars and new technical recommendations better adapted to the conditions of the different farming regions.

EMBRAPA experimental field in Santa Helena de Goiás, where research projects are conducted in partnership with the Goiás Foundation.

Production system

The sustainability of new cotton farming in Brazil is based on a set of techniques that reach beyond the new genetic material. The system recommended by EMBRAPA for large-scale cotton production in the Cerrado includes the following farming practices.

- No tillage or minimum tillage with direct sowing, to protect the soil and enrich it with organic matter, retain moisture during the *veranicos* (short drought periods in the middle of the rainy season) and limit the emergence of weeds in a natural manner, among other advantages.

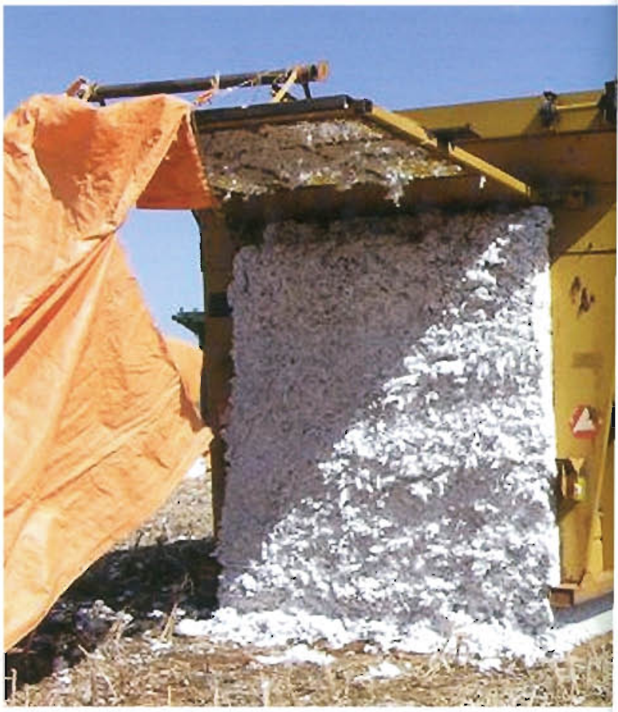
- Integrated pest management, to limit the application of pesticides.

- Mechanization of all stages of the production process.

- Regular use of plant growth and maturation regulators;

- Fiber processing at the farm level, including classification, ginning, pressing, and baling the plume, effectively eliminating any intermediaries, diminishing manipulation and transportation costs at harvest time and, therefore, keeping more money at the rural level of the production chain.

The cotton bales, duly identified as to origin and classification according to the seven characteristics of modern commercialization, go directly from the farm to the textile mill. The cotton seeds – a raw material in the food oil and cake industry – and the linter (short fibers less than ½ inch long) have become additional sources of income for the agricultural enterprises or, when processed and used at the farm, contribute to reduce expenses. More than 400 cotton farms are already directly processing the cotton fibers.



Cotton baling at the farm.

Today's cotton fibers

The modern spinning and weaving equipment adopted in Brazil, particularly in the 1990s, brought about fantastic changes in the cotton fiber market that have had a forceful impact on the agricultural sector. New precision instruments have replaced older artisanal practices. New fiber quality indicators have become indispensable and are already being determined at the plume processing stage. Fiber uniformity is a much more relevant parameter in planning and managing the cotton crop than 20 years ago.

Consequently, the revival of Brazilian cotton farming reaches beyond the gains in plant productivity. The new cotton produced in Brazil also follows the most exacting quality standards that agricultural research has ever had to meet.

Until a few decades ago, the market took in all the fiber produced, and fiber price varied depending on the quality of the product. Fiber length was the fundamental criterion in determining the price; the expected standard was 30-32mm. Nevertheless, even fibers 26-28mm long were in demand. There were no criteria for classifying raw cotton in the producing regions, no testing of fiber thinness and strength.

Today, fibers less than 30mm long are hardly ever accepted, unless by mills producing coarser fabrics, such as sackcloth. The current trend is for fiber lengths to vary between 32 and 34mm. Fiber strength, on the other hand, must exceed 28 gram-force per unit of linear mass density (gf/tex) to be accepted by industry, the ideal strength being 30gf/tex. In the recent past, the strength of Brazilian cotton usually varied from 22 to 25gf/tex, with some cases of 18gf/tex. On the other hand, the micronaire index, assessing the fineness of the fiber, must vary from 3.2 to 4.2 micrograms per inch. Previously, the micronaire index was practically unknown among cotton farmers, who could inadvertently supply too fine or too thick fibers, outside the current margin of acceptability.

Francisco Farias

From another perspective, at the production end, farmers demand cultivars with yields equal to or higher than 3,750kg (almost 10,000 pounds) of unseeded cotton per hectare, with more than 40% fiber by weight of the total "utile sink" weight, or the equivalent to 1,500kg of plume per hectare.

The new EMBRAPA cultivars

The new cultivars issued by EMBRAPA in the last eight years meet the following demands: competitiveness in agronomical, economic and industrial terms. They have been tested in different farming regions and their performance matches that of the main market varieties.

EMBRAPA's current cotton plant population – more than 20 differentiated genotypes – is the basis of all new cultivars obtained for the Cerrado and other regions of Brazil where cotton is cultivated. The researchers combine the desired optimal characteristics in that population to meet the demands of cotton farmers in the various micro regions.

In addition to the genetic yield potential, EMBRAPA researchers have devoted special attention to multiple pest resistance. The extension of the cotton farming area to include the Center-West and western Bahia has led to the emergence of new cotton pests caused by various pathogenic agents, such as bacteria, fungi and viruses. Shorter production cycles and plant size are also important variables to be considered when selecting the lines to be combined in the different breeding projects.

The BRS 286 (Pequi) cultivar, developed in partnership with the Bahia Foundation and released in 2008, combines several desirable characteristics, namely, high plume yield, moderate vegetative growth, early maturation, and satisfactory levels of pest resistance. This cultivar was initially indicated for western Bahia, where the rainy period is shorter than in the other cotton farming regions in the Brazilian Cerrado.


Camilo Morello

The BRS 269 (Buriti) cultivar was released in 2006. Despite its longer-cycle and height, it has been widely sown, and seed production licensing is much sought after by numerous seed producers. Its main characteristics are hardiness and high yield in less favorable environments, particularly because of its excellent level of resistance to grey mildew or areolate mildew (*Ramularia areola*), high resistance to other diseases and lessened fruit rotting, which helped diminish the number of fungicide applications. On the other hand, Buriti responds quite positively to improved environmental conditions – high altitudes and adequate soil fertility – when its plume yield exceeds 40%, with excellent fiber characteristics, particularly its length, longer than 31mm.

The BRS Aroeira cultivar (2001) is characterized by vigorous growth and rusticity. BRS Aroeira is also resistant to viral and bacterial infections and ramulosis (*Colletotrichum gossypii*. var. *cephalosporioides*) and tolerant to the *Fusarium*/root-knot nematode complex. Its fiber has been classified as excellent according to the three main criteria: strength, length and micronaire. BRS Aroeira made it possible to continue planting cotton at low altitudes in the State of Goiás. Although large-scale cotton farming has turned to new cultivars released after 2005, BRS Aroeira is still preferred by family-farmers in the states of Goiás and Bahia.

The challenges of cotton research

The average herbaceous cotton yield in Brazil in the 1998/99 harvest was 55.3% higher than the previous year. It was an extraordinary achievement, very hard to equal anytime, anywhere, for any product whose cropping area covers hundreds of thousands of hectares. Furthermore, it was not an isolated number but, rather, part of series of annual increments that lasted, almost without exception, from the 1996/97 to 2007/08 harvests. With the exclusion of years of very unfavorable weather or extreme scarcity of farm credit, the productivity of cotton farming in Brazil continues to grow significantly. Three-year averages, which eliminate occasional accidents, continue to record the vigor of the modernizing drive. For example: the average productivity of the three crops harvested from 2006 to 2008 was 15.2% higher than those of the previous three-year period.


Francisco Farias

Nevertheless, important challenges lie ahead for Brazilian cotton farming as regards its economic and environmental sustainability. Cotton attracts an enormous variety of insects. The crop covers only 2% of the total farm area in the world, but consumes close to 25% of the pesticides used in all crops. And cotton is subject to numerous diseases.

The cotton plants' growth is indeterminate, i.e., they continue to develop after flowering. Several wild ancestors of cotton are perennial and grow to more than 14 meters and as high as 20 meters. In modern times, therefore, the domestication of cotton has required the application of growth and maturation regulators, which are also detrimental to the environment. And it all must be added to the production costs.

The challenges facing research must necessarily include the development of more pest-resistant or tolerant plants, spontaneously short-cycle or early, and less dependent on growth and maturation regulators. The short-cycle cultivars should enable sowing a second "late" crop, as is already done with corn, for example. In corn, a first, short-cycle crop, sown "early", is followed by a second crop planted "late". The "free period" required in the boll weevil control strategy must be duly observed, however.

The new cultivars should conciliate conformity to such demands with high gross yields, as well as good quality fibers, as measured by modern industrial processing criteria. And, taking into account the energy demand, the oil content of the seeds should be high: equal to or higher than 25% by weight.

In order to reduce fungicide applications, researchers are trying to develop genetic resistance to diseases. Crop management, therefore, should carefully control the microclimate, so that the prevailing associations of temperature and relative humidity are less favorable to the proliferation of the fungi that affect cotton.

Social Balance – 2008

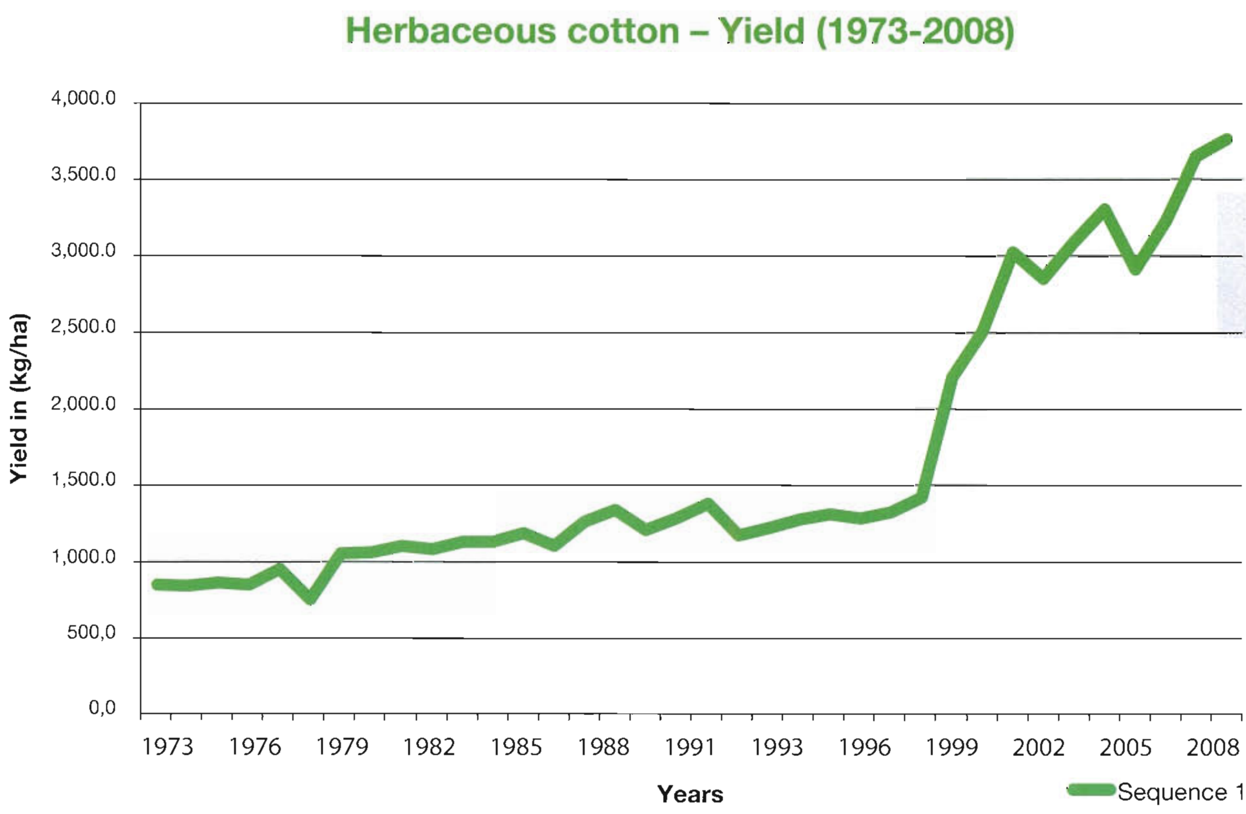
SOCIAL RENTABILITY OF **R$ 18,3** BILLION

from only 112 technologies

EMBRAPA is already working on the synthesis of genetically modified cultivars, via recombinant DNA, for which there is considerable demand. In this instance, the purpose is to enable cotton to coexist with the cotton boll weevil (*Anthonomous grandis*).

Added to that set of requirements and expectations are the variables resulting from the expected world climate changes. Since cotton is quite susceptible to variations in temperature and relative humidity conditions, genetic manipulation will be necessary in the building, by means of genetic engineering and conventional breeding methods, genotypes able to withstand future climatic events, such as droughts and temperatures above the current normal patterns.

Those are the requirements driving the current research work at EMBRAPA.



Corn: *safrinha* corn has become the second summer corn crop.

A marginal crop at best, untimely planted under unfavorable weather conditions, almost unknown less than 30 years ago, *safrinha* or "small harvest" corn has grown so much and spread so widely, to such different regions, that the practice has become a fundamental component of the productive chains in which the production and consumption of corn are important. In 2008, *safrinha* corn from the central and southern regions of Brazil accounted for more than 30% of the country's corn production. This extraordinary success was enabled by the knowledge and technology provided by the Brazilian agricultural research organizations.

The *safrinha* corn practice began in the State of Paraná, around 1978-1979, with the untimely planting of corn, from December to February, immediately after the harvest of another crop – usually short-cycle soybean or "rainy season" bean – or between the rows of the previous corn crop, when the plants achieved physiological maturity and the stalk could be bent.


Paulo Guimarães

A risky activity from the agronomical standpoint and therefore faded to remain marginal or even disappear, the practice was called *safrinha*, or small harvest. From the farmer's point of view, the risk was offset by better selling conditions, after the supply peak at the time of the regular harvest. In addition, the risk was minimized by the absence of additional expenses, since very few inputs were purchased outside the farm. Initially, the seed used for the *safrinha* had been saved from previous harvests and no fertilizers were applied. Crop management was restricted to sowing and harvesting, with a manual or mechanical weeding thrown in for good measure.

Under such conditions, the corn was produced at very low cost and, since it was sold at the most favorable time for the farmer, it had a satisfactory economic return. Additional advantages were maintaining the soil covered during the winter and providing the straw essential to the adequate implementation of the direct sowing system, whose adoption was steadily increasing in Paraná. Thus, new producers began adhering to the "late" corn practice.

Beginning in 1984, the former Commission on the Financing of Production, currently Conab, began including *safrinha* corn in its monthly harvest evaluation reports. At the time, the late corn harvest production from Paraná contributed 381,500 tons to the total corn production of Brazil (close to 21.2 million tons), representing, therefore, only 1.8% of the total production.

In 1990, the estimates also included the *safrinha* harvests in the State of São Paulo. Together, the two states harvested 450,000 tons, planted over 256,000 hectares, with an average yield of 1,758kg/ha. Thereafter, the *safrinha* practice expanded to Mato Grosso do Sul, Goiás and, more recently, Mato Grosso. Only 18 years later, in 2008, according to Conab, the *safrinha* harvest was 18.1 million tons, almost 20% more than the entire Brazilian corn harvest in 1978-1979. In less than 20 years, the late corn harvest grew by more than 3,999%, with the annual geometric growth rate at a very impressive 22.7%.

Mato Grosso and Minas Gerais compete for the honor of being the second largest corn producing state in Brazil, and most of their corn production is *safrinha*. The regional production has accompanied the remarkable development of pig and chicken production in the Center-West, where corn is available at a more favorable price than in the other regions of the country, particularly between harvests. These activities, already consolidated and in constant evolution in southern Brazil, have now attained a new dimension in the country and help reinforce the Brazilian balance of trade. Furthermore, the improved transportation infrastructure in the Center-West Region facilitates the crop's flow to major markets and export ports.


Olimpio Filho

The productivity of *safrinha* corn has risen to 3,810 kg/ha, more than twice that of the 1990-1991 "late" corn harvests. Its geometrical annual growth (4.4%) has closely followed the rise of the regular corn harvest, namely, 4.7% per annum. In the last decade, the "small harvest" has become the second summer harvest.

The contribution of research: new cultivars

The seed corn market ranks among the most active farming input markets in Brazil. The superior yield of the hybrid cultivars, when compared with the varieties, is a powerful incentive to private sector investments. Subject to diminished yields and loss of uniformity in the following generation, the grain obtained after planting hybrid corn is less economically viable in subsequent plantings. Thus, commercial corn farming enterprises go back, every year, to their seed suppliers. The consequence of such permanent demand is the extraordinary dynamism of the hybrid corn seed market.

The private sector has invested heavily in the development of new cultivars. It is estimated that approximately 330 different corn cultivars, both hybrids and varieties, are currently being marketed. The private companies control the market of both long- and short-cycle corn. EMBRAPA offers 26 cultivars, of which eight are simple-hybrids, five double-hybrids, five triple-hybrids, and eight varieties.

EMBRAPA's first hybrid corn release dates back to 1989, when the BR 201 double-hybrid reached the market. Its release shook a market that had become too easygoing. The hybrid cultivars created by EMBRAPA have been well received. Including the BR 205 and BR 206 (double-) and BR 3123 (triple-) hybrids, EMBRAPA's share of the market reached a peak in the mid 1990s, with 16%. The private sector reacted to the loss of market share and released new materials, many highly competitive and of excellent quality.

Notwithstanding, both public and private breeding programs at the time aimed at the generation of cultivars for summer harvest conditions, rather than the adverse weather conditions of the second harvest. At the beginning, second harvest corn producers replaced the second generation seeds, used in the early years of *safrinha* corn, with corn variety seeds, whose price is lower than the hybrid's. Thus, they improved the technological profile of the second harvest, without excessively increasing their expenses.

In their turn, researchers assessed the prospect of expansion of the new crop and began a comprehensive cycle of tests of the cultivars already available, in order to be able to indicate those of better performance under the conditions of the second harvest. Later on, they began including genetic material with increased production potential and short and extra short cycles in their cultivar development programs, with a view to extemporaneous sowing.

The effort resulted in the large number of hybrid cultivars now available to corn producers, whether for first or second harvest. EMBRAPA's current portfolio includes the simple-hybrids BRS 1010, 1030, 1031, 1035, and 1040; double-hybrids BRS 2223, 2020 and 2022; and triple-hybrids BRS 3035 (extra short) and 3025, all with excellent yields in the late corn producing regions.

Crop management technology

In addition to the development of their cultivars, the public sector research organizations support the second corn crop production with recommendations on crop management, risk determination as a function of sowing time – which enables them to define the most appropriate regions and establish farm insurance coverage – and comparative evaluations of the different materials in each region.

In 1985, when the second harvest amounted to only a seventh of the total corn production in Paraná, researchers at the Paraná Agronomy Institute (IAPAR, in Portuguese) were already performing comparative field tests with 16 different cultivars. Two years later, they tested 21 late and 21 early cultivars from a dozen companies.

To IAPAR's pioneer effort were added very important contributions from the Campinas Agronomy Institute (IAC); the Integral Technical Assistance Coordination Office (CATI); Research, Technical Assistance and Rural Extension of the State of Mato Grosso do Sul (Empaer-MS); EMBRAPA Corn and Sorghum; EMBRAPA Western Agriculture; and EMBRAPA Soybean, among others, as well as universities and private sector organizations.

The results obtained enabled researchers to recommend more appropriate cultivars, indicate the sowing end-date limit and the best sowing density for the best cultivars available. Meanwhile, the farmers made adjustments to the cropping systems, adapting them to the prevailing weather conditions in their micro regions.


Olímpio Filho

Late corn farming has also benefited from advances in the research on other crops, especially the development of short- and extra short-cycle soybean, which have made it possible to establish the second corn crop earlier. The improvement and dissemination of the technologies which promoted the expansion of the direct sowing system also favored the increased productivity of second corn farming, as well as increased its profitability. Another crucial technological advantage of direct sowing from the point of view of the second corn crop is the remarkable decrease of the interval between its sowing and the harvest of the preceding crop, since each day gained in the second crop calendar diminishes the possibility of frustration of the future harvest.

National Seminars

In 1993, EMBRAPA Corn and Sorghum began coordinating a series of field tests called "National *Safrinha* Corn Field Yield Trials" in which public and private organizations participated. At the time, when the second corn harvest was equivalent to a little more than 8% of the total corn production of the country, the Brazilian Corn and Sorghum Association (ABMS), together with researchers, university professors and technical assistance professionals, recognized the need to promote regular meetings to establish a knowledge base and discuss the technological issues arising from the practice of planting a second corn crop.

Sponsored by CATI and IAC, the First National *Safrinha* Corn Seminar was held at Assis, São Paulo. The ninth version of the event was held in Dourados, Mato Grosso do Sul, in 2007, and Barretos (São Paulo), Londrina (Paraná) and Rio Verde (Goiás) have also hosted these events. The National Seminars have played an extremely important role in the initial training and continuous education of the technical community that works with *safrinha* corn farming.

The National Seminars are promoted by ABMS and supported by EMBRAPA and public technical assistance and research organizations, universities, and the productive sector. They encourage the production of specialized literature, make a significant contribution to the definition of the research agenda and speed up the dissemination of field test findings. The proceedings of the meetings are a fundamental reference for any technical approach to second corn cropping and its various aspects: breeding, phytotechny, health, production systems, and economics.

Research challenges

From the economic point of view, the second corn crop has become an established practice. Today, the success of both pig and chicken farming in Brazil are based on a more steady corn supply and consequent lessened oscillations of corn prices in domestic markets, which are enabled by the increasing safrinha corn harvest.

The participation of late corn in the crop rotation production systems also plays an important role in the sustainability of the agricultural activities. In Paraná and in some micro regions in São Paulo and Mato Grosso do Sul, the second crop has also become an alternative to winter cereals – particularly wheat. Wherever adopted, it has supported the implementation of the direct sowing system and ensuing environmental and economic benefits.

The weather risk is still the main obstacle to increasing the physical and economic yield of the second corn crop in the Center-West, Southeast and South regions of Brazil. Frosts – in Paraná, São Paulo and Mato Grosso do Sul – and droughts – in all regions where safrinha corn is planted – are the most important deterrents to the further growth of the safrinha corn harvest.

The response to the existing problems will come from the ongoing agricultural research programs, which were designed to provide solutions that enable the coexistence of corn crops with droughts, as well as the development of cultivars that are more efficient in using fertilizers and more resistant to pests and diseases. Another important outcome of the research will be cultivars with production cycles better adjusted to the relatively short period of rainfall, namely, from February to April.

The development of new corn hybrids and varieties is also part of the research programs seeking solutions to the problems posed by the predicted world climatic changes. In exploring the new technological horizons, researchers work with genetic engineering and conventional molecular marker-assisted breeding methods, among other leading-edge investigation techniques.

If gradual adjustments in the technologies have so far enabled the crop's coexistence with the climatic restriction that characterize the new sowing period, overcoming such restrictions will raise the current level of sustainability of the second summer corn crop and ensure continuous productivity increases. Reducing the risks will make farmers more confident and encourage a more intensive use of the production factors, such as fertilizers, contributing to the advancement of the "small harvest", which has already become a "great harvest".

INSTITUTIONAL BUILDING


Robert K. Nyantakyi

EMBRAPA's Master Plan usually provides the guidelines for the strategic management of Agricultural Innovation during a four-year period. EMBRAPA's Fifth Master Plan, however, not only concentrates on the short term management, but also contemplates the new demands and world challenges beyond the 2008-2011 horizon and tries to define the long-term prospects as far as 2023, when the company celebrates its 50th anniversary.

The driving force behind the new master plan is a vision of EMBRAPA's technology development program ranked among the world's leading programs, generating knowledge and technology for the sustainable production of food, fibers and energy in the Tropics.

To that end, the strategic objectives of the company are to intensify the development of knowledge and technologies that promote the sustainable use of the Brazilian biomes and the productive integration of the Brazilian regions; to create differentiated, high aggregate value products based on the country's biodiversity; and to achieve new technological heights in the field of agroenergy. EMBRAPA also plans to incorporate the new emerging technologies, contribute to the advances in the frontiers of knowledge, and guarantee the competitiveness and sustainability of Tropical Agriculture.

The high oil yield potential and compatibility with family agriculture recommend Jatropha curcas for the production of biodiesel. To complete the species' domestication, EMBRAPA coordinates and executes a research program covering all regions in the country, with a view to mastering the species' production and post-production technology by 2013.


Marcelino Ribeiro

The Master Plan acknowledges that EMBRAPA will face some institutional and organizational challenges and establishes guidelines to reach the desired objectives. The company should adopt an even more agile and flexible management model, in order to attract, develop and retain technical and managerial talents and broaden its sources of innovation financing. EMBRAPA must expand its investments in updating the research processes and infrastructure, strengthening institutional and market communication, and managing and protecting knowledge.

Thus, the company will broaden its role in the research networks and partnerships with the private sector, in order to increase the synergy, innovation capacity and speed, and expand its international technology generation and transfer activities, so as to support the growth of tropical agricultural business.

In compliance with those guidelines, EMBRAPA updated the master plans of its research centers in 2008 and created a strategic administration plan for the operational units with venue in EMBRAPA's headquarters, so that their work programs comply with the strategic guidelines and objectives of the EMBRAPA Fifth Master Plan.

Léo J

EMBRAPA's PAC

Expecting major impacts on the implementation of its master plan, in 2008 EMBRAPA designed and began implementing a detailed Program for the Strengthening and Growth of EMBRAPA, also known as EMBRAPA'S PAC. The program was designed at the request of the President of the Republic for the purpose of redefining the strategic management of innovation in the agricultural sector. By 2010, EMBRAPA's PAC will have invested R$ 914 million in the expansion and renewal of its human capital, modernization and adaptation of its research infrastructure to the new scientific and production demands, and implementation of new technology development and transfer actions.

EMBRAPA's PAC sets forth ten major projects designed to meet its technological priorities, such as developing a sustainable agriculture model for Amazonia, ensuring food supply and security, using natural resources more appropriately, increasing the competitiveness of family-based agriculture, increasing the competitiveness of agroenergy, and expanding the frontiers of knowledge pertinent to Brazilian agribusiness.

Four of those projects focus on improving innovation management, seeking institutional and governance model innovation; revitalizing and modernizing the intellectual capacity and physical infrastructure of EMBRAPA and the state agricultural research organizations (OEPAs).

The last major project serves the Federal Government as a whole, since it focuses on the development of a geocoded system for the interpretation and analysis of satellite images to be used in monitoring the works of Brazil's Growth Acceleration Program (Brazil's PAC).

EMBRAPA's PAC support to management

- Studies on a revision of the EMBRAPA management model;
- Studies on the creation of the Macro Strategies Center;
- Studies on the creation of a research center in Mato Grosso and purchase of the initial equipment for its implementation;
- Monitoring 430 works in Brazil's PAC;
- R$ 30.4 million for 17 state agricultural research organizations.

STRATEGIC MANAGEMENT OF RESOURCES

The strategic reorientation of innovation management occasionally requires concentrated investments to reach a higher technological level in the research organizations in response to major changes in either its knowledge base – requiring changes in its intellectual capacity and investigation methods – or its means of collecting and analyzing data and creating new technologies.

Such concentrations of investments have been made throughout EMBRAPA's history. The company invested very heavily in 1982, for example, importing equipment, modernizing federal and state laboratories and expanding its research portfolio. In 1991, once again, a special budget effort was made for less auspicious causes: high labor costs resulting from employee dismissals mandated by the adjustment of governmental expenditures.

Further adjustments of EMBRAPA's cadres caused even greater impacts on the 1996 budget, albeit compensated by the renewal of the company's intellectual capacity, by hiring researchers with up-to-date training in new fields of science, such as information science, genomics and nanotechnology. Significant investments were made in laboratory equipment and communications (computer network, access to satellite data, etc.), modernization of research, and services rendered to the Government and the productive sector. Thereafter, however, the adjustment of the governmental machinery left those human and material resources stranded, without the operating capital required to produce the new technologies demanded by agriculture.


Bruno Peres

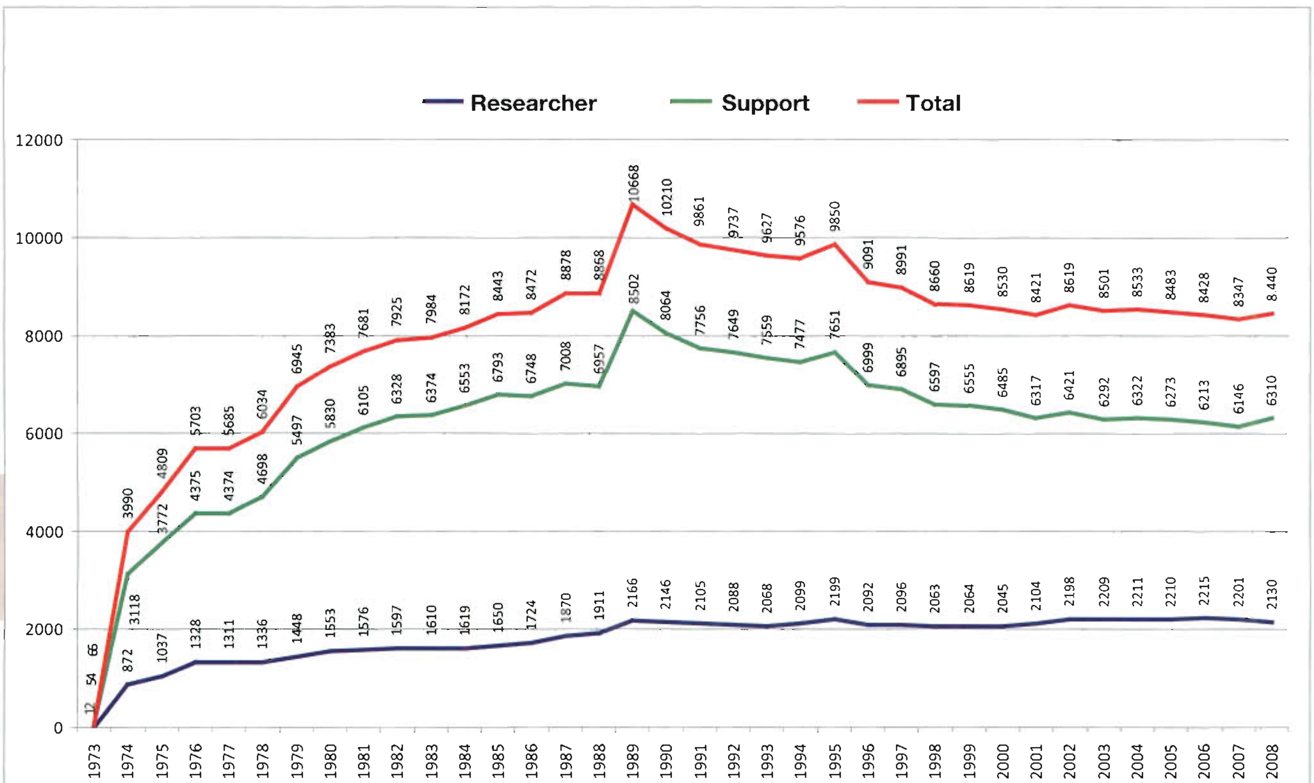
In 2008, EMBRAPA's PAC worked to restore the company's scientific production capacity diluted during the years of adjustment and, particularly, to respond to the need for a new concentration of investments, in order to bring its cadres, infrastructure and research programs up to the new demands for agricultural technology.

The new demands arise not only from the sophistication of Tropical Agriculture, but also from the broadening of the frontiers of knowledge, as well as new sectoral policies that focus on improving the well-being of the Brazilian population, by assuring the inclusion of disenfranchised communities into the economic growth of the country; appropriate land development for the rural settlements; the rescue of our environment; diminishing regional imbalances, and improving the competitiveness of family-based and commercial agriculture to meet the challenge of globalization.

Intellectual Capacity

EMBRAPA hired 565 new employees in 2008, including 77 new researchers, to replace 475 former employees. After 12 years of constant retraction of its work force, during which the company lost more than 1,500 employees, the staff is growing again and now totals 8,440 collaborators.

Graph 1 – Evolution of EMBRAPA's cadres.



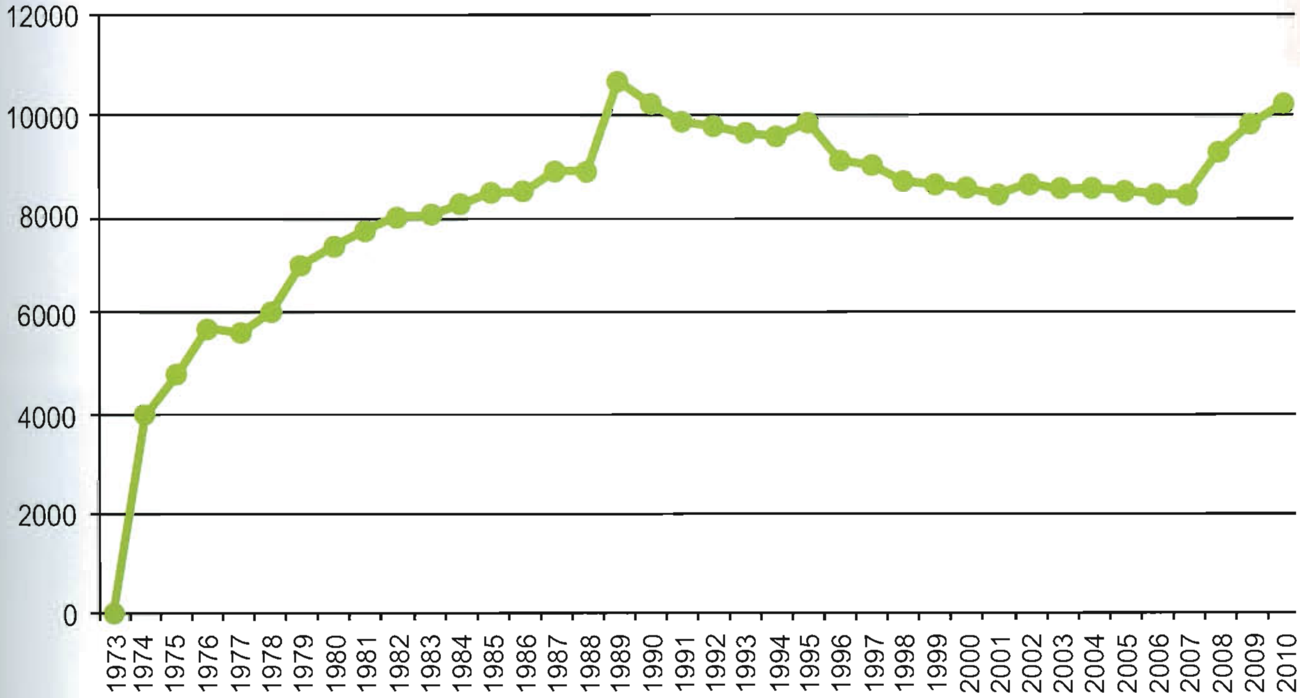
Source: DGP/EMBRAPA

Such numbers reflect, on the one hand, the historical low turnover of EMBRAPA's labor force, which resulted in a cluster of discontinuances of employees who had worked for the company for 35 years, particularly of researchers. Only last year, for example, EMBRAPA lost 155 researchers to full retirement. Overall, 750 new researchers will be hired to replenish the cadres and expand the scientific capacity of the company.

On the other hand, they also reflect the impact of EMBRAPA's PAC: 200 of the 565 new employees were hired as part of the corporate strengthening effort, which contemplates the recruitment of 1,211 collaborators during the 2008-2010 period, to recompose and expand EMBRAPA's cadres.

The Federal Government's effort enables EMBRAPA to restore its operational capacity, by replenishing its labor force to a level close to that of December 1995 (9,850 employees, including 2,199 researchers), as shown in Graph 2, and, particularly, to renew its creative capacity, since the new employees have been recently trained in new fields of knowledge, such as nanotechnology, knowledge management and advanced biology.

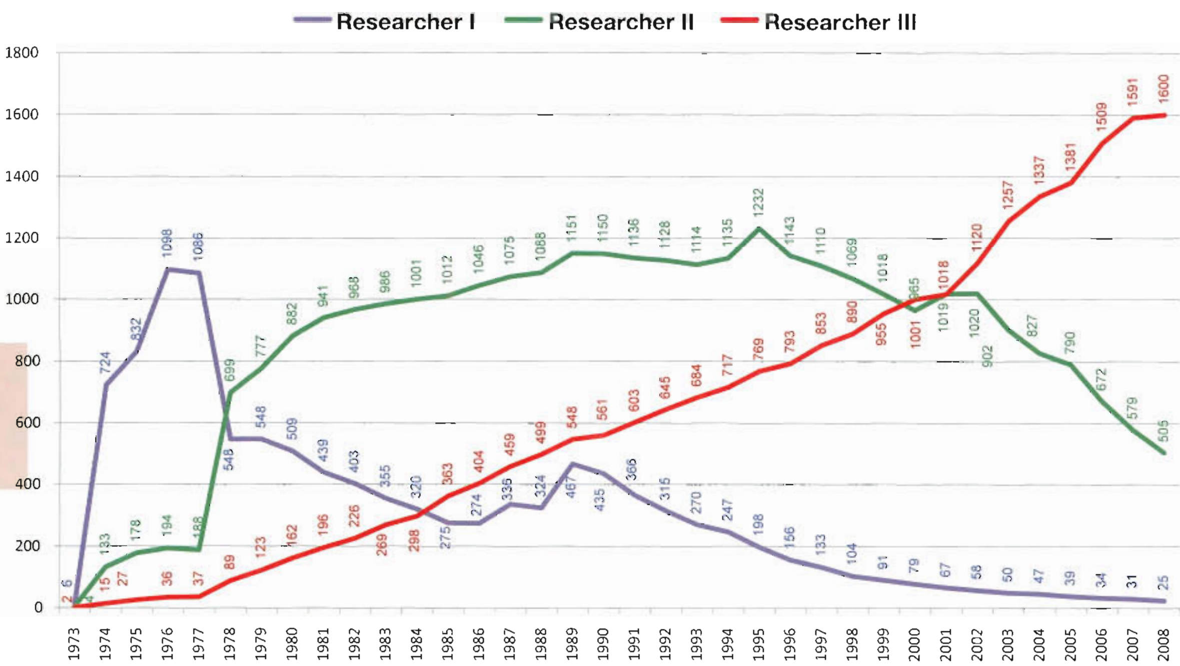
Graph 2 – Desired evolution of EMBRAPA's cadres – 2008-2010.



Added to this effort to update the skills of the company, EMBRAPA has maintained its corporate education program, designed to educate and train its employees to face the new challenges. EMBRAPA's educational program comprises from litteracy, to fundamental education, to managerial and post-doctorate programs.

At the post-graduate level, 25 employees completed specialization courses, another 11 employees received Master's degrees, while 23 concluded PhD programs. During 2008, EMBRAPA maintained 35 professionals attending Master's Degree programs; 154 in Doctoral programs, 26 of them abroad; and 25 researchers in Post-Doctoral programs, 20 of them abroad. This effort greatly broadens the company's educational program, as seen in Graph 3.

Graph 3 – Evolution of researcher training.



Source: DGP/EMBRAPA

In addition, 740 employees participated in short training events abroad, such as technical visits, scientific conferences, exchange actions, scientific cooperation, and technology transfer activities.

In Brazil, 3,898 employees concluded in loco technical training courses, while another 2,003 individuals followed long-distance courses using EMBRAPA's nationwide computer network. The managerial training involved 790 employees from the research centers, including heads of units, coordinators, supervisors, and their deputies.

The social objectives of the educational program include eliminating functional illiteracy and providing young people access to their first job: 184 employees from 21 research centers attended litteracy programs and Fundamental and Middle School Education courses, while 450 high school-level and 2,450 university-level internships were offered, most of them in research areas.

EMBRAPA's PAC Support to training

- R$ 2.2 million for training
- 558 managerial and strategic level employees trained
- 826 short-term training events
- 9 researchers included in the post-graduate program

Material Resources

As regards working conditions, the Federal Government invested almost R$ 125.6 million in 2008 to renew the facilities, laboratories, vehicles, machinery, equipment, and bibliographic material at EMBRAPA and the state agricultural research organizations (OEPAs).

Of the total amount, R$ 61.77 million were allocated within the scope of EMBRAPA's PAC, of which R$ 24.9 million were spent in various civil works and purchases to renew the experimental stations of the OEPAs. As regards EMBRAPA's research centers, the corporate strengthening program allocated slightly more than R$ 17.6 million to an investment program that focuses on civil works, whose total expenditures exceeded R$ 36.7 million.

Those investments correspond to a 32.8% growth in civil work expenditures and include the conclusion of the new EMBRAPA Satellite Monitoring headquarters in Campinas, São Paulo (5,700 m² construction area at a cost of R$ 10.5 million) and the Nanotechnology Laboratory facilities (1,070 m² construction area at a cost of R$ 1.7 million).

EMBRAPA's PAC Works

- 137,000 m² of buildings at 20 research centers
- Good practices in the laboratories and experimental fields and ISO 17.025 certification in 39 research centers
- Architecture and engineering designs for the EMBRAPA Agroenergy facilities

Another important investment was the construction of 32 laboratory waste treatment facilities, 17 similar facilities for experimental field wastes, and sewage networks and treatment plants at 25 research centers. Those facilities are part of EMBRAPA's drive to enhance environmental management at research centers with the support of FINEP (Office for the Financing of Studies and Projects) and the Agrofuturo Program, financed by the Inter American Development Bank.

An additional R$ 52.55 million were invested in vehicles, machinery, equipment, tools, furniture, books, and other permanent assets necessary to the operation of the facilities. EMBRAPA's PAC contributed R$ 19.5 million to those expenditures.

Of the total amount for Other Investments, R$ 12 million were allocated by other public agencies, such as the ministries of Science and Technology, Land Development, and Social Development, as counterpart in a partnership between those agencies and EMBRAPA to carry out research projects of interest.

Financial Resources

When expenditures with employees, investments in civil works and material goods, and operational expenditures with research, technology transfer and administrative activities are added up, EMBRAPA executed last year one of the largest budgets in its history, totaling R$ 1,374,604,345.00, including a quality datum: less money from international loans and more resources from the National Treasury.

The consolidated data confirm the priority assigned and effort made to balance corporate strengthening issues with staffing needs and to restore the working conditions. They also show an important upturn trend, which actually began in 2004, as regards the operational costs, which ultimately guarantee the creation of new knowledge and technology and their transfer to society at large.

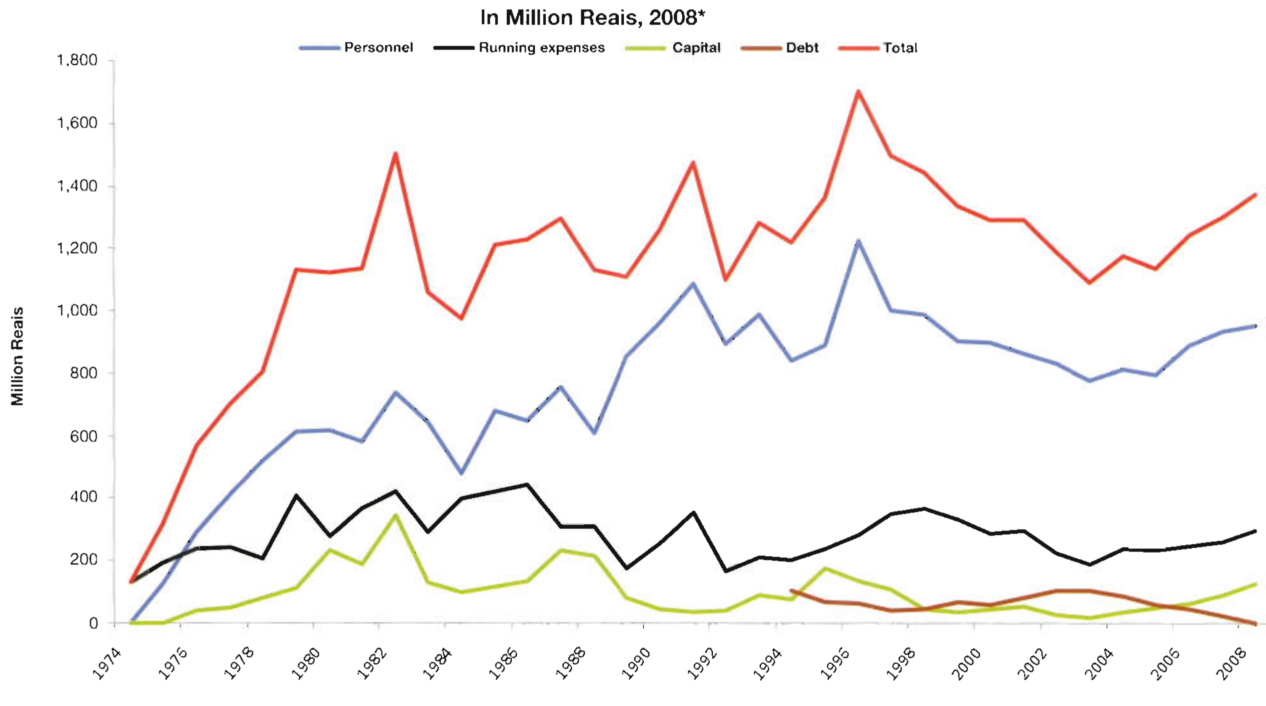
As shown in Graph 4, in executing the budget EMBRAPA achieved a better balance between the three main expense items, namely, Personnel, Other Operational Costs and Other Investments. The fact that fewer resources need to be committed to paying foreign loans has helped considerably.

It is expected that the expenses with personnel and working conditions, on the one hand, and the growing operational costs, on the other, will become more stable in the near future, making it possible to optimize the return of the capital now committed to those two expense items.

Social Balance – 2008

EACH REAL INVESTED generated **R$ 13.55** for the BRAZILIAN society

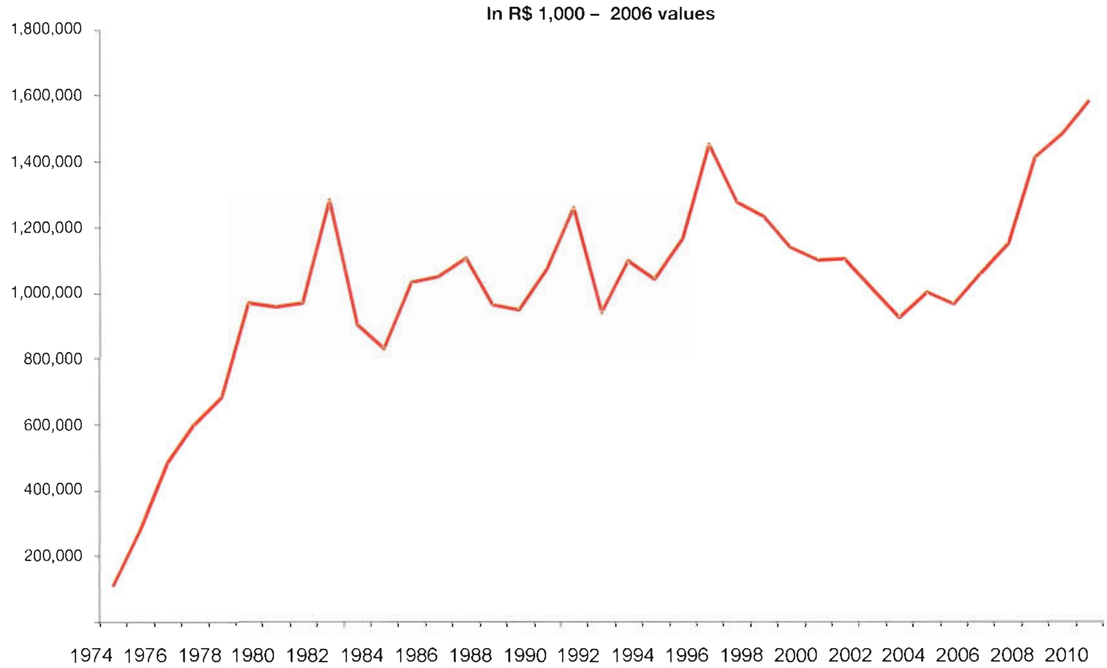
Graph 4 – Resource applied by EMBRAPA by expense category.



Source: EMBRAPA/DAF

* Values adjusted using the IGP-DI Index of the GVF

Graph 5 – Expected evolution of EMBRAPA's resources until 2010.



Source: EMBRAPA/DAF

As EMBRAPA's PAC implementation proceeds in 2009 and 2010, the budget curve should become positive, as shown in Graph 5, returning EMBRAPA's budget execution to the 1996 levels.

The fact that the National Congress understands the role played by agricultural modernization in regional development and in reducing regional inequalities has greatly helped EMBRAPA's performance.

In 2008, the amendments to the EMBRAPA budget proposed by individual Members of Parliament (MPs) totaled R$ 4.59 million. Another R$ 20 million were appropriated by the Committee on Agriculture and Land Reform and R$ 13.92 million, by the Federal District MPs.

Also in 2008, the MPs proposed individual amendments to the 2009 budget in the amount of R$ 14.7 million, together with another R$ 10 million appropriated by the Senate Committee on Agriculture for technology development and transfer projects focusing Tropical Agriculture.

STRATEGIC MANAGEMENT OF R&D

Strategic Partnerships

More substantial funds from the National Treasury for Personnel, Operational or Running Costs and Capital Investments enabled EMBRAPA to increase its direct expenditures with new experiments by 10%, as compared with 2007. Overall, EMBRAPA spent R$ 79 million executing 987 research projects in 2008.

Those resources are EMBRAPA's operating capital, its "operational fuel", without which the whole research "machine" – including scientists and their administrative, laboratory and experimental field support teams; experimental fields and plant nurseries; laboratories and stables; libraries; as well as vehicles, machinery and equipment – could neither operate nor produce, since their renovation and maintenance consume a significant part of the investments in agricultural research.

That growth was made possible by EMBRAPA's PAC, which applied R$ 7.4 million, and by institutional partnerships with other ministries and agencies, such as CNPq, FINEP; foundations that finance research, such as FAPESP and Fundação Banco do Brasil; and development banks, such as BASA and BNB, which financed 307 projects, to the tune of R$ 22.2 million.

Joedson Alves

A major effort has also been made to improve project quality. Ten project calls were issued in 2008 to select new projects, drawing 454 proposals, of which only 282 (60%) were approved and will be executed by 2012. The additional expenditures involved in the new experiments amount to R$ 107.8 million, beginning in 2009.

EMBRAPA has also endeavored to engage large experimental field networks and teams to research very complex themes as part of its quality drive. At the present time, 34 large network-research projects are being implemented, 20 in Brazil and 14 abroad.

Among the themes focused in the network-research program are genetic resources, development of agro-ecology methodologies and technologies, global climate changes, prospection of the Brazilian flora, evaluation of forage species and annual crops for crop-livestock-forestry integration schemes in the Cerrado, and forest management in Amazonia. Two large network-research projects focus on technology transfer strategies for integrated crop-livestock-forestry operations and the oleaginous and biodiesel production chains.

The research planning effort last year tried to achieve greater alignment of the research program with the strategic objectives established in the 5th EMBRAPA Master Plan, in terms of the share of resources earmarked for attaining each of those objectives.

By the end of 2008, three of the five objectives had been fully met, namely, agricultural competitiveness and sustainability; agroenergy and biofuels; and sustainable use of the biomes and regional productive integration. The company should now allocate more resources to the projects focusing on advancing the frontiers of knowledge and prospecting the Brazilian biodiversity with a view to creating new products.

Research supported by EMBRAPA's PAC

- Adjustment of the corn and sorghum production system for inclusion into Good Agricultural Practices;
- Validation of the early diagnosis method used for Citrus Sudden Death (CSD) and Citrus Greening Disease (HLB);
- Validation of the magnetic resonance equipment used for evaluating the quality of agroindustrial products;
- Validation of e-SAPI bovis, a Web platform for cattle tracking;
- Agro-ecological zoning of African palm in deforested areas in the Amazon Region;
- Agro-ecological zoning of sugarcane in the State of Acre.

New Knowledge and Technology

The research projects initiated in 2008 as a response to the concerns expressed in the EMBRAPA Master Plan and its strategic objectives should generate knowledge and technologies to be delivered to society within a 7 to 10-year timeframe, which is the average period necessary to develop a new technology. Likewise, the knowledge and technologies delivered in 2008 resulted from investments made previously, within an equal period of time.

The system used in evaluating the performance of EMBRAPA's operational units reports that the company finalized and released 23 new cultivars; tested and indicated another 46 cultivars for new regions; and made available 39 computer programs, 108 scientific methodologies, 456 zoning or monitoring maps, 188 new agricultural practices or processes, 12 agro-industrial processes, 3 new equipments, and 9 agricultural inputs.

Listed below are some examples of the great variety of knowledge and technologies developed as a function of the company's major investment lines:

- strengthening family-based agriculture;
- increasing the competitiveness of Tropical Agriculture vis-à-vis the challenges of globalization;
- careful management of Brazilian natural resources to ensure their sustainable use;
- food security;
- environmental security; and
- management of socioeconomic clusters and farms seeking sustainable solutions to regional imbalances.

Family Agriculture


Cláudio Bezerra

Resistant Bean

Transgenic bean varieties resistant to the bean **golden mosaic virus** (BGMV) produced using a new technique (RNA interference). These varieties do not generate exogenous proteins and, therefore, cause neither allergies nor toxicity. They benefit small farmers, particularly, because they forgo the application of pesticides to control the disease and, consequently, the high costs involved in their purchase.

Mixed cropping system using African palm

A cropping system featuring African palm associated with food crops and semi-perennial fruit trees to be planted over **altered forest areas**, to be reclaimed by family-based farming, can generate sufficient gross income, in only three years, to cover all crop implementation and maintenance costs.

Stingless bees

Beekeeping management system tailored to Brazilian stingless bees for use in family-based farming operations to provide **more efficient pollination** and, thus, increase production. The honey produced helps increase family income.

Wheat

BRS 276, a hardy, short-cycle wheat cultivar, moderately resistant to Fusarium Head Blight (FHB). It calls for lower investments and its average yield is 3,500 kg/ha. Recommended for the states of Rio Grande do Sul, Santa Catarina, Paraná, Mato Grosso do Sul, and São Paulo.


Paulo Kurtz

Cassava

BRS Caipira, BRS Tapioqueira and **BRS Verdinha** cultivars (in partnership with the Araripina School of Agrarian Sciences, Chapada NGO, Technological School of Ceará, Emater–Ceará, and producers in the states of Sergipe, Pernambuco and Ceará) recommended for the production of flour and starch. All cultivars have good root yield and excellent starch contents.

Farming recommendations for banana, cowpea, cassava, corn, and sorghum

Agroclimatic zoning maps for banana, cowpea, cassava, corn, and sorghum that determine the **crop failure risks** by indicating the best time and places to plant the crops and, therefore, enable family farmers to have access to official farm credit from the Harvest Guarantee (Garantia de Safra) and PROAGRO programs.

Inoculant for cowpea

In partnership with the State University of Maranhão, identification of bacterial lineages for **atmospheric nitrogen fixation** in cowpea crops in the Pre-Amazonia region of Maranhão and in Roraima, replacing nitrogen fertilizers and, thus, reducing the production costs of family farmers; increasing (67% and 30%) yields; and having a positive environmental impact.


Marcelino Ribeiro

Sugarcane setts

Method of producing sugarcane setts from tissue cultures using a simplified version of bioreactors, which facilitates the organization of biofactories for the multiplication and dissemination of **high yield cultivars**, particularly for small dairy farmers that use sugarcane in cattle herd nutrition.

Agroenergy

Sweet cassava

Biochemical and genetic tests have confirmed the high glucose contents of sweet cassava, a natural mutant collected in Amazonia. Thus, sweet cassava is an ideal crop for ethanol production, since it forgoes the starch hydrolysis stage required with conventional cassava and expensive from the financial and energy standpoints. Sweet cassava may reduce **ethanol production** costs by more than 25%.


Veronica Massena Reis

Sugarcane in the South Region

Field tests with 224 sugarcane genotypes performed by EMBRAPA and Ridesa/UFPR have shown that stalk yields vary from 74 t/ha to 330 t/ha, with an average Brix of 18%. They have also confirmed the crop's potential for **alcohol production in the State of Rio Grande do Sul**, a net importer of that biofuel.

Inoculant for sugarcane

Biofertilizer obtained by joining, in sterile peat, five **nitrogen-fixing bacteria** that promote the growth of sugarcane, reducing the use of nitrogen fertilizers, with consequent economic and environmental gains.

Energy Forests

Production system for ***Tachigali cavipes*** and ***Acacia amazonica*** to be used in the implementation of sustainable energy forests to replace the firewood currently obtained from primary and secondary forests and used in ceramics production in Manaus. Since up to 38% less firewood would be required, the energy efficiency gains would be considerable.

Competitiveness

Cotton

BRS 293, a high plume yield (41% fiber) cultivar resistant to leaf diseases caused by fungi and viruses, recommended for large scale production in the Cerrado.

Rice

BRS Fronteira, a cultivar recommended for irrigated farming in the Paraíba River Valley, São Paulo, and the Coastal zone and Western Frontier of Rio Grande do Sul; high yield (8 ton/ha); high quality, fine long-grain rice.

BRS Sertaneja, an excellent quality, fine long-grain rice (Type 1) cultivar with high industrial yield (60% to 70% full grain), for dry farming in Minas, Goiás, Mato Grosso, Rondônia, Roraima, Pará, Tocantins, Maranhão, and Piauí.

Italian ryegrass

The yield of the **BRS Ponteio** cultivar is 7% higher than that of more traditional varieties; it has a longer cycle and better leaf/stalk ratio. This forage species is extremely important in the South Region of Brazil, where the seed market does not yet offer genetic material of known performance.


Neuza Campelo

Banana

BRS Conquista, a cultivar resistant to black Sigatoka or black leaf streak (*Mycosphaerella fijiensis* Morelet) and *Fusarium* wilt or Panama disease (*Fusarium oxysporum* f. sp. *cubense*). Good yield; reduced shipping wastage; good shape and size, color and texture of the inner pulp, and husk color; average shelf life of up to five days.

Princesa, a cultivar resistant to yellow Sigatoka (*Mycosphaerella musicola*) and tolerant to *Fusarium* wilt or Panama disease (*Fusarium oxysporum* f. sp. *cubense*). Recommended for Sergipe, Alagoas and Bahia.

Quality Beef

Integrated database and application platform for storing, processing, viewing and analyzing cattle genotype data for the purpose of identifying **Nelore cattle** genes that control the characteristics associated with meat quality, particularly tenderness; food efficiency; and animal temperament; as well as evaluating crossings with European breeds.

Coffee

Irrigation management system that subjects coffee crops to a controlled water stress period and, thus, induces a **single, even flowering** of the crop. Using this system, coffee producers can obtain 85% coffee cherries at harvest time, maximizing the production of special coffees with higher market values and reducing water and energy consumption by 33%.


Omar Rocha

Cashew

Clones of common cashew **BRS 274 (Jacaju)** and hybrid cashew **BRS 275 (Dão)**', dual purpose varieties: export quality nuts and pulp for the juice industry.


Renato Amabile

Malting Barley

BRS Deméter (Central Brazil, irrigated), **BRS Elis** and **BRS Cauê** (South Region) and **BRS Sampa** (São Paulo, irrigated) cultivars: high quality malt, high potential yield and moderate resistance to powdery mildew (Blumeria graminis f. sp. Hordei) and other pests.

Bean

BRS 9435 Cometa, a *carioca*-type cultivar, high yield (3 ton/ha), appropriate for mechanical harvesting and production in the South and Center-West regions, as well as the states of Bahia, Sergipe, Alagoas, São Paulo, and Tocantins.

BRS 7762 Supremo, a black-bean cultivar, high yield (2,4 ton/ha), good pest resistance, appropriate for mechanical harvesting and production in the states of Santa Catarina, Paraná, São Paulo, Goiás, Tocantins, and the Federal District.

BRS Embaixador, a dark red kidney bean cultivar, and **BRS Executivo**, a cranberry type cultivar, for farmers wishing to produce for the international market, whose estimated demand is 3.5 million ton/year.

Pigeon pea

The **Mandarim** pigeon pea cultivar (in partnership with Unipasto) has excellent results in animal nutrition. Its high penetration root system and easy eradication help in the recovery of compacted soils and incorporation of green matter; it also promotes biological nitrogen fixation.


Firmino Nascimento Filho

Guarana

BRS Luzéia, BRS Mundurucânia, BRS Cereçaporanga, and **BRS Andirá** cultivars, highly resistant to anthracnose and to hypertrophy of floral and vegetative buds, eliminating the need of other pest control measures. These cultivars could triple guarana production in the State of Amazonas.

Sour passion fruit

BRS Sol do Cerrado, BRS Ouro Vermelho and **BRS Gigante Amarelo** are the new passion fruit hybrids recommended for the Cerrado. They feature high production potential, tolerance to various diseases, larger fruit, and higher vitamin C contents, and are less dependent on manual pollination.


Gustavo Porpino

Corn

BRS 1040, BRS 2022 and **BRS 3025** - simple, double and triple hybrid corn cultivars – feature very short cycle, high yield and production stability, and high financial return potential. The **BRS 3035** triple hybrid corn cultivar has an extremely short cycle and is recommended for late planting in the Southeast and Center-West regions and the State of Paraná.


Paulo Kurtz

Pastures

The selective herbicide applicator called **Campo Limpo** can be regulated for plant height and provides almost 90% efficiency in controlling the South African lovegrass (*Eragrostis plana*), an important weed in Rio Grande do Sul pampas.

Pepper

Mari, a *dedo-de-moça* type pepper cultivar, responds to poor soils with very good quality fruit: high capsaicin contents (the substance that makes peppers hot), high yield, and excellent fruit quality. It features extreme resistance to the pepper yellow mosaic virus (PepYMV) and medium resistance to *Xanthomonas* and powdery mildew (*Blumeria graminis* f. sp. *Hordei*).

Soybean

Raul Porfírio de Almeida

Soybean cultivars **BRS 282** (in partnership with the Meridional Foundation), **BRS 284** and **BRS 283** are resistant to frogeye leaf spot (*Cercospora sojina*), bacterial pustules (*Xanthomonas campestris* pv. *glycines*), brown stem rot (*Phialophora gregata*), and stem canker (*Diaporthe phaseolorum* var. *caulivora*). The first two cultivars have a semi-short maturation cycle and the third cultivar, a short-cycle. Oil and protein contents are 18% and 40%, respectively. They are recommended for the states of Paraná, São Paulo, Santa Catarina, and Mato Grosso do Sul.

Sorghum

BRS 655 produces high quality forage for silage and helps meet the growing demand of meat producers for more efficient cattle nutrition.

Wheat

BRS 277 is a long cycle, dual purpose (pasture and grain) cultivar, resistant to leaf rust (*Puccinia recondita* f.sp. *tritici*) and powdery mildew (*Blumeria graminis* f. sp. *Hordei*), with an average yield of 3,700 kg/ha. This cultivar was developed for the cold weather areas in southern Brazil. It produces yellowish flour appropriate for making cakes, cookies, pizza, and fresh dough when mixed with improver wheat.

BRS Tangará and **BRS Pardela** are high yield, sturdy cultivars with high panification indexes, broad geographical adaptation and no sowing date limitations.

Viti vinifera grapes

The data have confirmed the elements necessary to define the Monte Belo region, in the Serra Gaúcha, as **geographical indication of origin** of fine wines: 400-500 m altitudes, podzols over 52% of the area and other types of soils appropriate for grape growing and wine production.

Management of Socioeconomic Clusters and Farms

Municipal planning

The Support System for Agricultural Planning and Surveying at the Municipal Level - **e-Sisplam** – helps identify the agricultural profile of the municipalities, as well as plan and monitor their activities and economic trends, environmental quality, and areas in need of public investments.

Herd accounting

Controlpec 1.0, a simplified financial control system for beef cattle farms. Its main characteristic is simplicity. It was developed to induce producers to systematically record and evaluate farm costs and revenues.

Virtual Diagnosis

An online expert system for the **remote diagnosis of diseases** that enables producers and extension workers to identify corn diseases on the basis of the symptoms, such as type, color and shape of lesions, part of the plant affected, etc. It will soon include rice, bean, soybean, wheat, tomato, and animal diseases.

Dairy Farming in Rondônia

The "Diagnosis of dairy production in the State of Rondônia" shows that small improvements in milking hygiene, appropriate pasture management, adequate use of food supplements, and genetic improvements of the dairy herd will result in **productivity gains**, while maintaining the current, low-cost, extensive grazing management system that lends competitiveness to Rondônia's dairy production.

Judson Valentin

Remaining Cerrado

The "Map of the natural plant cover in the Cerrado" records areas of intensive settlement in the Cerrado biome and the **fragmentation of the natural plant cover** and its consequences. It also identifies areas suitable for increasing food production without further deforestation.

Canola map


Paulo Kurtz

The **Agroclimatic Zoning** for canola in the State of Rio Grande do Sul, in addition to other data, indicates the canola sowing time in the various municipalities and how to use the instrument in procuring farm insurance (Proagro), which favors the growth and sustainability of the crop in that region.

Suitability for agroenergy

The map defines the farming possibilities in the **dry frontier region between the State of Mato Grosso do Sul and Paraguay**, for eucalyptus, Pinus, *Acacia mangium*, sugarcane, soybean, sunflower, peanut, castor oil plant, forage turnip, and physic nut (*Jatropha curcas*).

Western Pará

Ecological-Economic Zoning (ZEE) of Western Pará identifies new farmable areas and farm loans and crop insurance possibilities, as well as management system recommendations that permit abatement of the legal reserve area (from 80% to 50%) for the purpose of promoting more intensive use of areas already altered and, thus, reducing the pressure on the native forest.

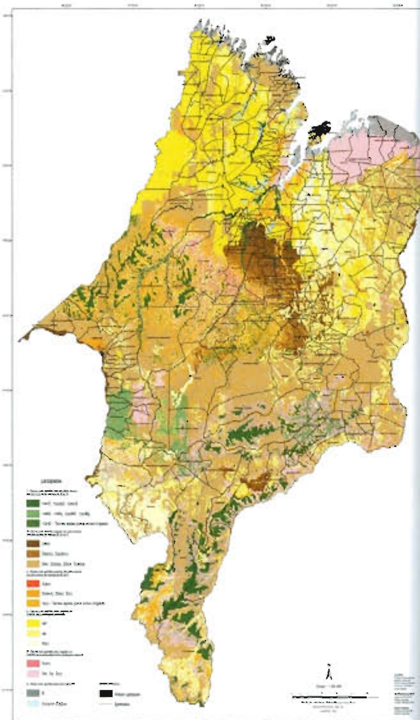
Risk of the *Brachiaria* death syndrome

Zoning of the entire Legal Amazon Region indicating which areas have low, moderate, high, and extremely high risk of occurrence of the ***Brachiaria* death syndrome**. The designation is based on factors associated with soil characteristics that affect the adaptation, productivity and persistence of *Brachiaria brizantha*.

Farmable lands

Study evaluating the impact of the laws on environmental protection and preservation and on reservation of lands for ethnic minorities on the **availability** of land for future expansion of Tropical Agriculture.

EMBRAPA Satellite Mon



Land in the State of Maranhão

Set of maps and reports containing an analysis of the suitability of land use and land cover in the State of Maranhão, indicating and quantifying the various cases of **suitability and unsuitability**: critical areas in terms of settlement, underused areas and areas inappropriately used or settled throughout the state.

Value of the Pantanal

In an initial approach, a study (in partnership with the Federal University of Pernambuco, Brazil, and University of Colorado, USA) has estimated that the Pantanal is worth from US$ 112 billion to US$ 242 billion per annum. The study also pointed to **environmental services** as the most important economic asset of the region and estimated their worth at between US$ 8,113 and US$ 17,490 per hectare, per year.

Southern Climate

The Climate Atlas of the South Region of Brazil contains 218 maps with 17 climatic variables and temporal scales compatible with farming activities. It characterizes the spatial variation of distinct climatic variables in **a single information plane**, with data from 125 meteorological stations and 566 pluviometric stations.

Coconut trees in the Tabuleiros

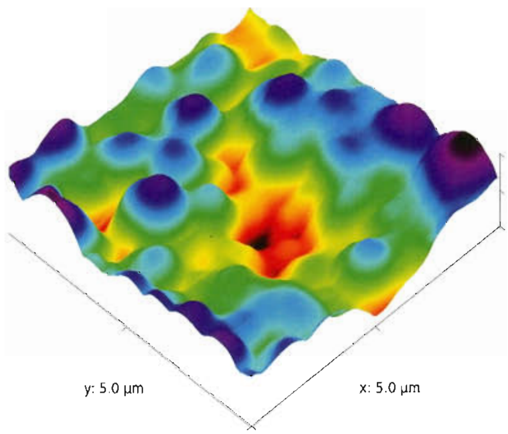
Climatic risk zoning to guide the migration of the giant coconut tree plantations from the coastal foothills in Northeastern Brazil, where the species is endogenous, to the coastal tablelands. The migration is a consequence of the urban expansion into the coastal areas.

Management of Natural Resources

Propolis vs. Bacteria

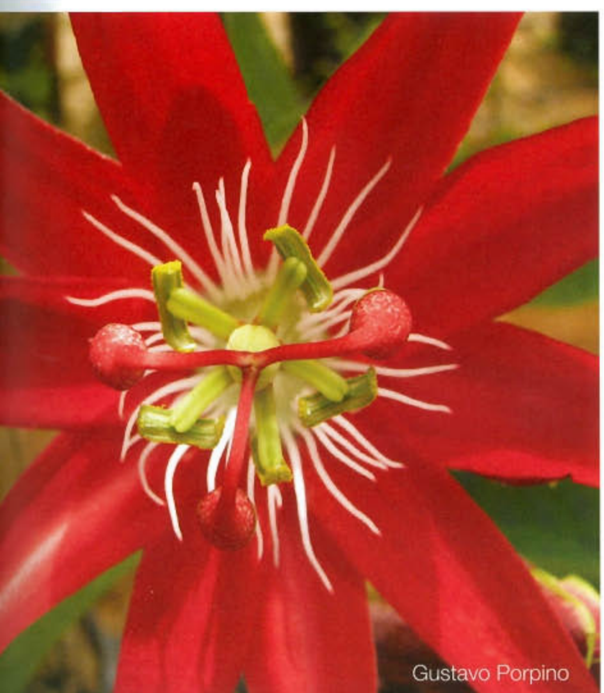
Confirming popular wisdom, high precision studies using force spectroscopy have proven the **bacteriostatic action** of propolis against *Staphylococcus aureus*, a bacterium that causes intestinal and respiratory infections. The studies also help determine the correct dosage that inhibits the development of bacteria. Contrary to what common sense suggests, high concentrations of propolis do not prevent the growth of the microorganism. The yellowish-red areas of the graph indicate propolis action on the surface of the bacterium.

Rubens Bernardes F°



Carbon sequestration

Studies monitoring the behavior of Cerrado soils along 27 years have revealed that areas covered with ***Brachiaria decumbens* pastures** sequester more carbon than the native Cerrado vegetation, whether the pastures are fertilized (94 ton/year) or unfertilized (45 ton/year), provided no overgrazing or burning occurs.



Gustavo Porpino

Ornamental passion fruit

Ornamental passion fruit hybrids named **BRS Estrela do Cerrado, BRS Rubiflora and BRS Roseflora** have been recommended for landscaping large areas (fences, walls and pergolas). These hybrids are hardy and bear flowers all year round, albeit more intensely from June to November, under the prevailing conditions of the Federal District.

More efficient phosphorus

The best soil preparation method is **direct sowing**, in which phosphorus uptake exceeds 7%, when compared with conventional planting systems. As regards farming systems, the phosphorus uptake efficiency of **crop-livestock integration** systems is 50% higher than that found in monocropping.

Claudio Bezerra

Brachiaria and *safrinha* corn

The purpose of the *Brachiaria ruziziensis* and *safrinha* corn **consortium** is to improve the physical and chemical properties of the soil and provide the ideal soil cover for subsequent direct sowing of soybean on the *Brachiaria* straw after the corn harvest, as well as to obtain a higher economic return from the succession crop.

Ultraflex engine

Although less powerful than traditional gasoline, alcohol, or diesel engines, the ultraflex engine transforms **any renewable fuel**, whether solid, liquid, or gas, into heat to produce work. The ultraflex engine was designed for tasks that do not require much power.

Native bacury stands

Bacury (*Platonia insignus*) stand management, including the use of the root buds and adjustment of the number of trees per unit area, for secondary forest areas awaiting new growth, with a view to improving tree density for the next felling operation. The system helps **reclaim altered areas** transforming them into sources of wood and income, as well as carbon sequestration.

MODELAD: flood forecasts for the Pantanal

MODELAD is an **analysis model** for estimating the magnitude and date of occurrence of the maximum level of the Rio Paraguay annual flood. With a relatively small margin of error, the model helps predict the extreme events (droughts and floods) from which all economic activities in the Pantanal depend, at Ladário (Mato Grosso do Sul).

Resistance to anaplasmosis

Inventory of the protein-encoding genes that could potentially control the Brazilian subtypes of ***Anaplasma marginale*** (a rickettsial parasite of ruminants that causes bovine anaplasmosis) and of the expression characteristics of said genes, together with an antigenic analysis of recombinant proteins, for the purpose of developing vaccines.

Efficient water management

Four new **electronic spreadsheets** for the efficient management of water in different irrigation systems. The management techniques can improve water use efficiency by 25% in the rice farming areas of Rio Grande do Sul, which consume approximately 12,000 m3 /ha, on average, over 1.2 million hectares.

Simplified water management operations and water requirement parameters that enable farmers to use tensiometers – a research instrument for determining soil humidity – in 35 different vegetable crops, for the purpose of increasing irrigation efficiency and avoiding recurrent excess-water or water-deficit events.

Food Security

Peanut

Integrated Production System for Peanut in the states of Ceará, Paraíba and São Paulo, whose purpose is to ensure top quality crop and is based on recommendations on environmental protection, food safety (pesticide residues), working conditions, human health (detection and prevention of aflatoxin), and economic viability.


Sebastião Araújo

Rice

Two cultivars - **BRS Pepita** and **BRS Monarca** – the former being a long-grain, fine-texture, high-yield type, widely adapted to dry farming in the Center-West, North and Mid-North regions of Brazil, and the latter, also long-grain fine-texture type, recommended for crop-cattle integration systems in the states of Mato Grosso, Rondônia and Pará, where it doubles dry-farming crop yields (2,000 kg/ha).

Long-grain, fine-texture, rice cultivar - **BRS Jaçanã** – validated for paddy farming in the states of Tocantins, Pará and Roraima; its yield is 7% higher than that of previously available genetic materials. Because of its higher proportion of unbroken grains and excellent cooking characteristics, the rice comes to the table exactly the way consumers like it.


Veridiano Cutrim

Cashew bar

Nutritious energy bar whose formula includes 90% cashew byproducts – nut, peduncular fibers, cashew honey, and nut oil – with vitamin C content six times higher than that of orange, three times as much protein as traditional fruit bars and shelf life of about one year.

Bean

Two cultivars - **BRS Agreste** and **BRS Pontal** – the former being a high yield *mulatinho*-type bean recommended for the Federal District and the states of Goiás and Sergipe, while the latter, a *carioca*-type bean, commercially classified as "pearl" grain, highly resistant to anthracnose and recommended for the Center-West Region; as winter crop in Tocantins; summer crop in Sergipe, Alagoas and Bahia; and year-round crop in Santa Catarina and Paraná.

Cowpea

BRS Xique-Xique, a cultivar recommended for all the states in the Northeast Region of the country. It features high iron and zinc contents, high yields and good acceptance among farmers.

Flower and vegetable quality

Wiltmeter®, a device to measure water pressure inside vegetable leaves and flowers to identify possible water stress and the need for irrigation and to ascertain the commercial quality of said products.

Meat quality

A quick (more than 1,000 samples per hour) and unintrusive method of analyzing **intramuscular fat** in beef. The method is based on low-resolution nuclear magnetic resonance and detects saturated fats associated with cardiovascular disease, cancer and diabetes.

Pasta with carrots

Industrial process for manufacturing pasta enriched with a **flour made of carrot** scrapings, which is a significant residue (30% of the raw material) of carrot processing, extremely rich in carotenoids and other nutrients, and usually discarded or used in feedstuff. The process opens prospects for other residues from the minimum processing of other vegetables.

Black Sigatoka

Sequencing of the genome of the *Mycosphaerella fijiensis* fungus that causes black Sigatoka, the most serious and destructive disease of *prata*-, *nanica*- and *nanicão*-type bananas. The genome sequencing will help identify all the mechanisms used by the fungus to infect the plants.

Flood plain pastures

Rotational management techniques that include enrichment with more productive native or naturalized forage species and more appropriate weed control methods, and increase animal production four-fold per unit area, in traditional mixed cattle operations on flood plains in the Amazon Region.

Environmental Security

Corn pests

Synthetic **sex pheromone** traps for efficient, integrated management of the corn earworm (*Helicoverpa zea*), since it is possible to increase the precision of pest control by determining pest density and inferring its developmental stage and, thus, reduce farming costs and negative impacts on the environment.

Reniform nematodes

Corn farming or pastures in rotation with cotton during a two-year period **controls and reduces**, by more than 90%, the population density of reniform nematodes (*Rotylenchulus reniformis*) in the soil, increasing cotton fiber yield by 26%, when compared with monocropping, and reducing the need for pesticides. The efficiency of the method surpasses that of nematocide application in furrow planting.

Bioinsecticide

Ponto.Final, a biological insecticide, developed from *Bacillus thuringiensis* (Bt) to control various crop pests, such as the velvetbean caterpillar (*Anticarsia gemmatalis*), diamondback or cabbage moth (*Plutella xylostella*) and corn leafworm (*Spodoptera frugiperda*). Ponto.Final was developed in partnership with Bthek Biotecnologia. It is harmless to humans and preserves beneficial insects, such as seven-spotted ladybugs (*Coccinella septempunctata*) and earwigs (*Doru luteipes*).

Phytotherapy against ticks

A bioactive extract made from **eucalyptus essential oils** whose phytotherapeutic action controls cattle ticks (*Riphicephalus microplus*), reduces conventional pesticide use, environmental contamination and parasite infestation in herds, and increases animal production.

PET bottles and sugarcane bagasse

A study seeking to reuse urban and agro-industrial wastes has obtained a **composite mix** of polyethylene terephthlate (the material in PET bottles) fibers and sugarcane bagasse with satisfactory appearance, as well as processing and use characteristics adequate to industrial applications that do not require high mechanical performance.

The new tropical R&D agenda

Climate changes, the energy and food supply crisis, new scientific and technological parameters, and the growth of Tropical Agriculture are some of the factors forcing developed and developing countries to review their technological strategies and agricultural research programs in order to compete in world agribusiness.

The First Symposium on Scientific Creativity and Innovation, which discussed the technological evolutionary paths of Tropical Agriculture and attracted 200 papers, was EMBRAPA's response to that challenge.

One hundred twenty new theme proposals and research approaches were selected, half of which discussed the possibilities of technological evolution within the so-called "state of the art" in agricultural science, while the other half analyzed the evolutionary paths to be found "beyond the state of the art".

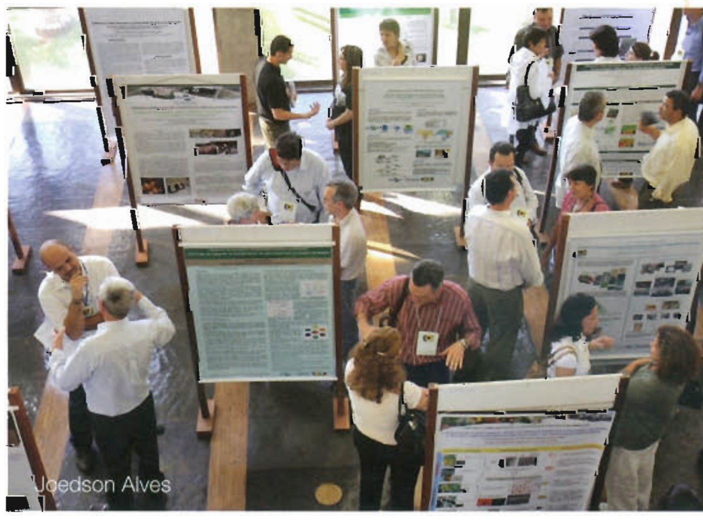
Atoxic, biodegradable and edible polymer coatings, made possible by nanotechnology, may be used to protect food sold fresh or after minimum processing and, thus, increase their shelf life and reduce waste, because of their bactericidal and fungicidal properties. There are food safety and appearance (right) gains: the uncoated sample (left) has changed color and lost water, and has an uneven aspect.

The best research proposals will participate in a special call for projects to obtain financing. Nanotechnology, genomics, bio-informatics, neural networks, biofortification, semiochemistry and physiology of plants and animals are some of the areas fraught with possibilities of developing new technological standards likely to provide comparative advantages to Brazilian agribusiness.

Researchers seek new technological pathways for the evolution of Tropical Agriculture.

Philosopher Domenico de Masi explains how to eliminate red-tape to enable the eclosion of scientific creativity.

Researchers check the new technological pathways proposed for the solution of future problems in Tropical Agriculture.



The best research projects, among 200 proposals, presented at the 1st Creativity Symposium, will receive direct financing for immediate execution.

International partnerships

The relevance of Tropical Agriculture in solving world problems associated with the production and supply of food, fibers and energy has driven the demand for the participation of Brazilian scientists in the international agricultural research networks, with an immediate impact on the scope of the EMBRAPA Laboratory Abroad Project, also known as Labex.

In 2008, EMBRAPA concluded negotiations and began expanding Labex Europe by creating a new post at Rothamsted, England, that will focus on climatic change, soil and integrated pest management research. In addition, the company began negotiations and has made initial contacts toward the future installation of Labex Korea.

One of the more promising outcomes was the intensification of networking between Labex Europe and Labex USA and their European and North American partners, enabling the consolidation of a transatlantic agricultural research network to study and solve the technological problems arising from major themes.

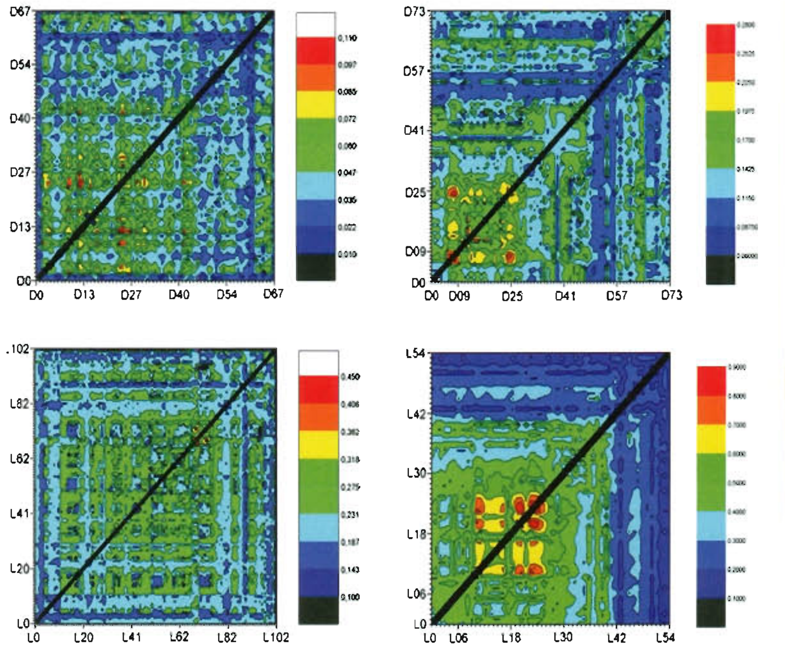
One of such themes is citrus diseases: from the ten projects presented, four will be financed by the Florida Citrus Production Research Advisory Council, one by CIRAD (France) and five by CNPq-Brazil. Six of those projects focus on the diagnosis and control of HLB (formerly known as citrus greening): one of them, on the use of biophotonics in the early diagnosis of HLB, brings together the University of Florida, Labex USA and the Campinas Agronomic Institute Citrus Research Center.

Research at Labex USA in 2008 also dealt with the diagnosis, molecular characterization of infectious agents and possible development of vaccines for pig diseases, and alternative biomasses for the production of cellulosic ethanol, such as pastures and aquatic plants like the water hyacinth (*Eichhornia crassipes*), which makes up whole islands in the Pantanal. The areas of interest include possible ways of controlling the crimson dye bug (*Dactylopius coccus*), which attacks forage cacti in the Northeast Region of Brazil.

EMBRAPA's PAC support to the Labex project

- Incorporation of two researchers to Labex USA
- Incorporation of two researchers to Labex Europe

Luciano Paulino da Silva e Carlos Bloch Júnior



Co-localization mosaics of molecules obtained from mass spectrometry imaging data. The four patterns represent different molecule sets in a tissue analyzed under different metabolic states. These mosaics are used in basic research as patterns to diagnose the physiological state of plants and animals.

Labex Europe, in turn, concentrates its efforts on tropical fruit and agroenergy research. In 2008, Labex Europe conducted experiments on the African palm and citrus genomes, African palm breeding, multiple uses of sorghum, apple breeding from the climate standpoint, and aggregating value to Brazilian fruits.

Other projects being negotiated and awaiting approval by European financing agencies include *Jatropha curcas*; African palm sustainability; evolutive genomics of rice; and citrus and banana genomics, the latter in association with Labex USA.

Social Balance – 2008

103,151 NEW JOBS

CREATED IN 2008 BY THE EVALUATED TECHNOLOGIES

STRATEGIC MANAGEMENT OF COMMUNICATION AND TECHNOLOGICAL BUSINESS

For the different technological maturation cycles to succeed one another continuously, an essential element of the sustainability of innovation in Tropical Agriculture, it is essential to guarantee that all the knowledge and technologies created by EMBRAPA researchers reach society at large.

It is particularly important that such knowledge and technologies be appropriated by the determining players, such as other scientists, students and technical assistance professionals working in agricultural and agro-industrial production: they will be using the technologies, adjusting them to the various realities and demanding improvements, and, thus, promoting technological, economic and social gains.

The process requires an equally continuous effort of communication and of knowledge and technology transfer. In 2008, EMBRAPA invested almost R$ 46 million in communication and technology transfer infrastructure, actions and events, of which R$ 11.7 million were allocated by EMBRAPA's PAC.

Joedson Alves

The EMBRAPA evaluation system recorded that, in 2008, its operational units hosted 1,400 field days; set up 3,840 demonstration units; delivered more than 16,000 hours of technical conferences and training courses; and released 741 new technical publications, 291 basic information booklets and leaflets, and 23 technical videos; as well as organized or participated in 1,985 agricultural and industrial fairs.

EMBRAPA's technical staff also published more than 7,000 scientific articles and abstracts, some of which are part of a list of 1,466 contributions published in indexed periodicals. They wrote 818 book chapters and acted as advisor in 236 postgraduate theses or dissertations. The purpose of all that effort is to ensure that society becomes aware of the existence of the knowledge or technology and, then, appropriates it, both theoretically and practically.

EMBRAPA's PAC & Technology Transfer

- Incubation of two new technology-based companies and selection of three companies for incubation in 2009;
- Licensing three cultivars and three patents;
- Incorporation of a researcher to the EMBRAPA-Africa cooperation agreement.

Among the actions that aim at providing the population at large information about the technologies available, special emphasis should be given to the following:

- Almost 22,000 insertions (825 signed articles) in periodicals, magazines, sites, and blogs;
- 492 presentations on commercial television stations;
- 43 weekly episodes of *Field Day on TV*, generated by EMBRAPA and transmitted directly to parabolic aerials in farms, roadway stores, municipal administration buildings, parishes, workers unions, cooperatives, etc.;
- Creation of the South Region module of the *Prosa Rural* (Farm Talk) radio program and expansion of the number of radio stations in the retransmission network to 1,068 educational and commercial radio stations;

Picture of the thematic stand "The Present of the Future", a part of the Science for Life Fair, one of the numerous events organized by EMBRAPA to disseminate knowledge among the population.

- Delivery of the sixth edition of the Science for Life Fair, which resulted from the efforts of 12 institutions in the National Agricultural Research Systems and 28 public and private partners of EMBRAPA. The 2008 Science for Life Fair, celebrating the 100th anniversary of the Japanese migration to Brazil, received close to 65,000 visitors (20,000 students from 169 schools), who bought 4,239 publications, became acquainted with 400 new technologies and experimented 50 new recipes with agricultural products;

- Receiving and guiding 126,000 students from fundamental and middle schools through the EMBRAPA&School events at the company's headquarters and 29 research centers;

- Receiving and providing information to more than 160,000 people at the stands of the Technology Showcase Fair, held in Brasília (Science for Life); Palmas, Tocantins (Agrotins 2008); Araçatuba, São Paulo (Feicana/Feibio 2008 and Expo 2008); and São Luiz, Maranhão (Amazontech 2008);

At the Technology Showcase, in Brasília, Fundamental School students check the new cultivars released by EMBRAPA in 2008.

- Participation in 22 major agricultural and agro-industrial events, such as Agrishow, Copavel Rural Show, Expointer, and the National Grape Festival, for the purpose of disseminating technological knowledge and information.

As regards the initiatives to facilitate the theoretical and practical appropriation of knowledge and technologies by the users, the following stand out.

Support to Government Programs

- More than 300 technologies for rice, bean, corn, cassava, milk, wheat, soybean, coffee, poultry, pig, onion, and fruit production, appropriate for family-based faming conditions, were transferred within the scope of the More Food Program, in partnership with the Ministry of Land Development (MDA) and state agricultural research and rural extension organizations.

- EMBRAPA printed 103 titles on recycled paper to conclude the rural mini libraries project that contemplated schools in the Semi-Arid Northeast Region. With the support of the Ministry of Social Development, MDA/Incra and the Banco do Brasil Foundation, the rural mini libraries network has been expanded to 750 additional municipalities. At the present time, 1,279 municipalities are being served throughout the country.

- With the support of the Inter-American Development Bank's Agrofuturo Project, the EMBRAPA Information Agency was expanded with the creation of four additional "knowledge trees" organized under the "territory" approach, to meet the needs of family-based agriculture: Grande Dourados (Mato Grosso do Sul), Sisal (Bahia's semi-arid), Northeastern Pará, and Mata Sul (Pernambuco) Territories.

- Two hundred thousand saplings of native species were produced for the reclamation of the gallery forests along the Rio São Francisco.

Katia Pichelli

- With the support of the Ministry of Land Development, EMBRAPA produced 2,000 tons of BRS Caatingueiro, BRS Sertanejo and BR 106 corn seeds; 950 tons of BRS Marataoã and BRS Guariba cowpea seeds; and 50 tons of *carioca*-type BRS Pérola bean seeds for distribution to 200,000 small farmers in the states of Piauí, Ceará, Alagoas, Paraíba, Bahia, and Minas Gerais.

- EMBRAPA trained farmers from 18 rural communities in the states of Sergipe, Pernambuco and Maranhão to produce their own seeds and distributed 32.4 tons of BRS Caatingueiro corn seeds and 18.8 tons of BRS 113, BRS Requinte and BRS Marataoã cowpea seeds to 920 families in those communities.

- Within the scope of a program that serves the ethnic communities in the Xingu Park and the Krahô people, 20 Native Brazilians were trained as multipliers of agroforestry management technologies and another 20, as multipliers of seed collection techniques, for the purpose of setting up and enriching agroforestry systems in the villages.

- EMBRAPA launched the Technological Update Program – PROATEC – by training of 180 extension workers from EMATER-Federal District. The purpose of PROATEC is to provide permanent training and updating to technical assistance professionals of the state agencies.

Support to society at large

- EMBRAPA launched the EMBRAPA Digital Video Collection, which features 150 documentaries on technology, with free online access.

- In the Internet, the EMBRAPA Information Agency was expanded with the publication of two additional "knowledge trees" on sugarcane and wheat.

- EMBRAPA increased its editorial production by 150%: 60 new books were published and 35 were reprinted, for a total of almost 2.5 million copies. Overall, EMBRAPA's researchers and technicians organized or edited 163 works in 2008.

The public examines new technical books published by EMBRAPA.

- EMBRAPA installed 90 technological reference sites, disseminated information to almost 100,000 potential users and trained 1,300 technicians and extension workers on the integrated crop-livestock-forestry system, which has already been adopted by 20,000 farmers and has helped reclaim almost 3 million hectares of degraded pastures.

- EMBRAPA produced 5,196 tons of basic seeds, obtained from the multiplication of 147 cultivars released for the certified seed industry.

- EMBRAPA produced more than 1,180,000 cuttings and other vegetative material from 36 fruit cultivars for plant nurseries.

- EMBRAPA licensed private companies to produce 333,600 tons of certified seeds from the basic seeds of 174 cultivars owned by the company, as well as 707,000 banana, grape and passion fruit cuttings, for which the company received approximately R$ 29 million in royalties, an almost 50% increase when compared with the 2007 royalty revenues.

- EMBRAPA set up public-private partnerships with 28 hybrid corn companies, 17 soybean seed companies and nine vitiviniculture nursery operators for the purpose of developing cultivars, validating genetic selections and producing seeds and young plants;

Fostering Innovation

In compliance with the Law on Innovation, in 2008 EMBRAPA intensified its intellectual property protection efforts, in Brazil and abroad, submitting 70 new requests: 22 patent applications; 23 cultivar protection applications; 19 mark registration requests; and six computer program protection applications.

In addition, EMBRAPA officially submitted 43 cultivar registration requests. An extremely relevant initiative in that regard was the training of researchers and technicians of 27 research centers in the dispatching and transportation

The Intellectual Property Portfolio

- 739 intellectual property protection filings
- 222 requests of Brazilian patents
- 132 requests of international patents
- 340 cultivar protection filings
- 210 requests for brand registration
- 44 computer program protection filings

procedures to be followed when sending genetic assets and associated traditional knowledge.

These topics have been discussed at international meetings, in which EMBRAPA has consistently participated, such as the Cartagena Protocol on Biodiversity, Convention on Biological Diversity and International Conference on Traditional Knowledge. Such procedures will facilitate EMBRAPA's operations when transferring knowledge to technology-based companies.

In fact, in 2008 EMBRAPA engaged in negotiations aiming at the incorporation of eight specific-purpose companies, as stipulated in the Law on Innovation, whose objective is to transfer knowledge and produce items, such as lignocellulosic ethanol, biofertilizers, bioinsecticides, ornamental flowers and plants for the Cerrado and Caatinga biomes, pest resistant banana genotypes, tropical mineral fertilizers, cattle breeding for meat and skin for export purposes, and risk analysis of agricultural and forestry activities.

EMBRAPA negotiated directly with Petrobrás a royalty contract regarding the validation of schistose water for agricultural purposes and the cession of the "Xisto Agrícola" (agricultural schist) brand With the company Biosoja Biotecnologia Ltda, EMBRAPA signed a cooperation agreement to develop a biological control product against white mold (*Sclerotinia sclerotiorum*) of bean and soybean. In addition, five regional coordination units were created to broaden the implementation of Proeta, EMBRAPA's business incubation program.

Seeking new arrangements to multiply the initiatives destined to promote innovation, EMBRAPA created ParcInTec – Technological Innovation Partnership – to facilitate joint enterprises with the public and private sectors linked to agribusiness. Two pilot experiments have already been set up, at Ituverava and Franca, in the State of São Paulo, and negotiations have been initiated on the implementation of another 17 similar initiatives. In addition, EMBRAPA collaborates in an initiative called Technological Parks in Minas Gerais (Juiz de Fora, Uberaba and Varginha), São Paulo (Campinas and São Carlos), Sergipe (Aracaju), Rio Grande do Sul (Passo Fundo), and the Federal District (Brasília).

International Expansion of Tropical Agriculture

The consolidation of Tropical Agriculture as a way to solve the world food, fiber and energy supply problems requires that its technological platform be submitted to the test of other ecological conditions in the tropical world.

Different from the Labex project, which explores the frontiers of science of interest to agribusiness, the purpose of the technological cooperation projects called EMBRAPA Africa and EMBRAPA Venezuela set up in 2008 is to test and adjust, to the tropical conditions of Africa and Latin America, plant and animal management; techniques of biological control of pests and diseases; plant and animal germplasm (cultivars and studs); machinery and implements; fertilizers; and biological additives for agricultural used in Brazil.

The highlights of the work program organized for Africa are listed below.

- Visits of the technical team, for *in loco* diagnoses, to 19 of the 54 African countries, namely, South Africa, Angola, Benin, Botswana, Burkina Faso, Burundi, Ethiopia, Gabon, Ghana, Liberia, Mozambique, Kenya, St. Thomas and Principe, Senegal, Sierra Leone, Tanzania, Togo, Uganda, and Zambia.

- Implementing 14 training projects on production and/or processing of cassava, cashew, biofuels, meat and dairy cattle, rice, corn, soybean, vegetables, tropical fruit, forestry, conservation agriculture, and biotechnology, with the support of the Brazilian Cooperation Agency of the Ministry of Foreign Relations (ABC/MRE) of Brazil, totaling approximately US$ 2.8 million, in Angola, Benin, Burkina Faso, Cape Verde, Chad, Mali, Mozambique, Nigeria, and Senegal.

- Negotiating 38 short-term projects involving corn, soybean, sugarcane, bean, rice, sorghum, dairy and meat cattle, tropical fruits, cassava, and vegetables, to be implemented in South Africa, Angola, Benin, Burkina Faso, Cape Verde, Chad, Democratic Republic of the Congo, Congo, Gabon, Ghana, Guinea Bissau, Mali, Mozambique, Namibia, Nigeria, Kenya, Rwanda, St. Thomas and Principe, Senegal, Sierra Leone, Tanzania, and Zambia, with the support of the Brazilian Cooperation Agency of the Ministry of Foreign Relations (ABC/MRE), totaling approximately US$ 1.35 million.

- Implementing an experimental field at Sotuba, in Mali, for a long-term (five years), US$ 1.5 million project aiming at the modernization and strengthening of cotton farming in Benin, Burkina Faso, Chad, and Mali (average plume yield of 400kg/ha); the work involves testing high yield Brazilian varieties, soil reclamation, pest control, and coexistence with droughts.

- Providing technical assistance to the Odebrecht Corporation in the implementation of the initial stage (4,500 ha) of a rice, bean, corn, and soybean production project that will extend over 26,000 hectares, at the Pungo Andongo farm, in Angola.

- Implementing, in Ghana, the initial stage of an irrigated rice farming project that will cover 3,000 hectares.

African rural workers participate in a field day to become acquainted with new soy cultivars and their management at the Pungo Andongo farm, in Malange, Angola.


Felesmina Lageslau Soares

- Implementing, in partnership with the Angola Farmable Land Management Office (Gesterra) and the Odebrecht Corporation, a technology showcase and delivering a field day for the purpose of observing and comparing cultivars of corn (4), rice (6), bean (5), cowpea (5), soybean (12), pumpkin (2), carrot (2), sweet potato, eggplant, cabbage, and sorghum, in the province of Malanje, Angola.

- In partnership with the University of Viçosa, which will handle the post-graduate level qualification of researchers, organizational restructuring of the Angola Agronomic Investigation Institute after the EMBRAPA model, comprising 16 national research centers – a US$ 32 million investment by the Government of Angola.

In Haiti, EMBRAPA has set up a 23-ha experimental station at the Fond des Nègres farm, in the Department of Nippes, for the purpose of transferring coffee, cocoa, rice, bean, corn, manioc, and cotton technology.

In Venezuela, EMBRAPA is beginning to implement a US$ 52 million project that includes, as regards crops, the structuring of the National Seed Service, the design of a seed production program and a forage breeding program.

In the animal area, the program seeks to define a strategy to be used in diagnosing and controlling cattle, sheep and goat diseases and the technical production of poultry at the so-called socialist production units. In addition, EMBRAPA will create a technical support program focusing on family-based agriculture, not only for the rural sector, but also for the Indigenous populations and urban communities.

Embrapa