Chapter 4

OTHER JAPANESE- BRAZILIAN COOPERATION PROJECTS FOR THE AGRICULTURAL DEVELOPMENT OF CERRADOS

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The objective of this Chapter is to present the development and execution of Prodecer, according to the conception formulated by both countries, and its main results/achievements.

The Japanese-Brazilian cooperation for the agricultural development of the Cerrados region is very important. One of the Prodecer characteristics, was concomitant execution of technical cooperation projects together with the main financial cooperation project.

The first technical cooperation for the Cerrados region started in 1977 between JICA and EMBRAPA-Cerrados (new name of CPAC – Cerrados Agricultural Research Center).

In this Chapter, this first and other technical cooperation projects are reviewed, and the manner through which the results of these research and technologies were diffused to the Prodecer areas' producers is analyzed. The results of PROFIR (Irrigation Project in the Cerrados) and of the "PROJECT OF RURAL ELECTRIFICATION IN THE STATE OF GOIÁS", both financial cooperation projects carried out by both countries in Cerrados region, are also reviewed.

4.1 TECHNICAL COOPERATION (JICA / CPAC)

4.1.1 Background and history

The way that the Cerrados region, which was considered unproductive for a long time, could start to produce, was fundamentally through the execution of research and experiments aiming at the development and consolidation of rural management, cultivation, selection of crops and varieties, soil correction, among other techniques. The concomitant granting of financing for production was also very important. Therefore, with the objective to promote the development of Cerrados region in an efficient and rational way, the governments of both countries, Brazil and Japan, decided to carry out technical cooperation projects, as follows:

(1) Phase I of technical-scientific support project for agricultural development of Cerrados

In 1977, the first phase (1977~1985) of the technical cooperation called "Project of Technical-Scientific Support for the Agricultural Development of Cerrados" started. This project lasted eight years and was executed with the strong support of EMBRAPA (Brazilian Company of Agricultural Research), through the EMBRAPA-Cerrados division. The research themes were as follows: soil, climate and utilization of Cerrados vegetal resources. Basic techniques for the rational utilization of the soil-plant-water system and grain cultivation were developed, aiming at providing the technical support for the agricultural development of Cerrados.

(2) Phase II of technical-scientific support project for agricultural development of Cerrados

As the result of Brazilian government will, expressed by the request for the technical cooperation aiming at the promotion of the agricultural development of the Prodecer II Pilot regions in Mato Grosso and Bahia States, the second phase (1985~1992) of the "Technical-Scientific Support Project for the Agricultural Development of Cerrados" was executed, with the objective of improving the technologies developed in the first phase. In phase II, research about rational utilization of the soil-plant-water system, defense against diseases and pests, and cultivation and crops management techniques adapted to the region were developed.

(3) Project of technical-scientific support for sustainable agricultural development of Cerrados focusing on management and conservation of natural resources

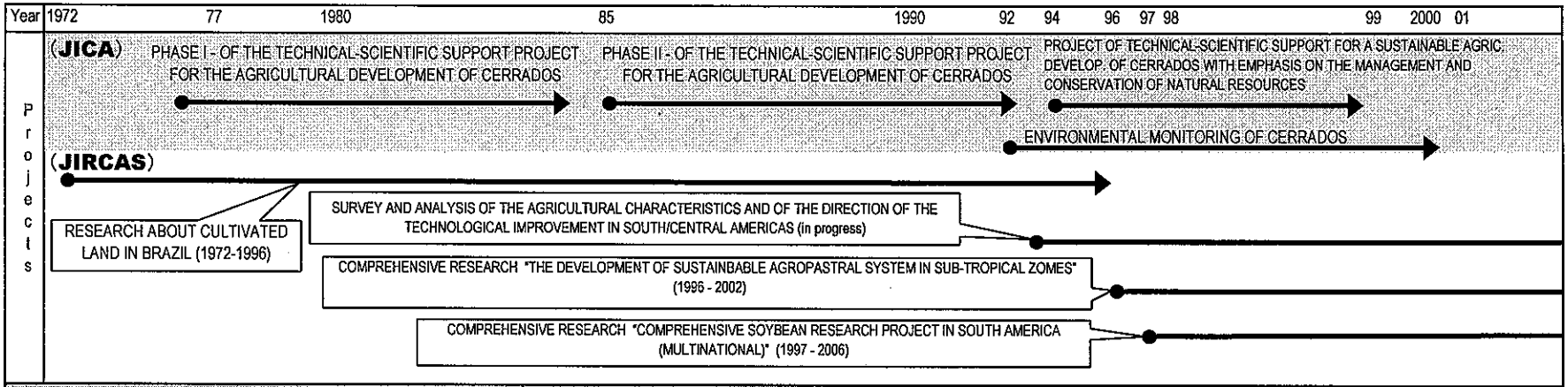
In these projects, technology development work was very intense and aimed at the increase of agricultural productivity and production. On the other hand, as the result of the accelerated process of Cerrados agricultural occupation, impacts on the environment started to be seen, such as the outbreak of pests and diseases; damage caused by the continuous cultivation of the same crop; climatic alterations; soil degradation and erosion; reduction of the region native fauna and flora; destruction of natural ecosystems, etc. Consequently (and also to promote the sustainable agriculture practice), evaluation of natural resources and the strengthening of research aiming at the promotion of the balance between agricultural development and environmental preservation was considered necessary. This situation led the Brazilian government in 1992 to request a technical cooperation project aiming at the "technical-scientific support for the sustainable agricultural development of the Cerrados region, focusing on the conservation and management of natural resources" to the Japanese government.

This Project was executed between 1994 and 1999. Various researches were carried out such as research in the vegetal protection areas, soil fertilization, remote monitoring, production systems, water quality, agricultural machinery, control of diseases and pests, in addition to the development of sustainable agricultural technologies focusing on environmental conservation.

4.1.2 Contents and achievements of technical cooperation

The cooperation project results played a fundamental role in the increase of agricultural productivity in Prodecer areas, as well as highly influencing the agricultural development process in Cerrados region. The contents of these projects and the mechanism of the diffusion of their results are presented below.

Achievements and general aspects of the JICA technical cooperation projects are shown in Figure 4.1.1.



PHASE I - FROM THE TECHNICAL-SCIENTIFIC SUPPORT PROJECT TO THE AGRICULTURAL DEVELOPMENT OF CERRADOS (1977-1985)	PHASE II - FROM THE TECHNICAL-SCIENTIFIC SUPPORT PROJECT TO THE AGRICULTURAL DEVELOPMENT OF CERRADOS (1985-1992)	PROJECT OF TECHNICAL-SCIENTIFIC SUPPORT FOR A SUSTAINABLE AGRICULTURAL DEVELOPMENT OF CERRADOS WITH EMPHASIS ON THE MANAGEMENT AND CONSERVATION OF NATURAL RESOURCES (1994-1999)
Objective: Development of basic technology for the agricultural production focused on the Minas Gerais State. **Administration**: EMBRAPA **Executing Agency**: CPAC **Coordination** Agricultural Research Company of Minas Gerais: EPAMIG Agricultural Experimental Station of Uberaba: EEAU Agricultural Experimental Station of P. de Minas: EEAP Experimental Station of Alto-Paranaíba: EEAPADAP **Investment:** **Japanese side**: Dispatch of experts: Long term - 19; Short term - 31; Total 50 experts; (Fields: phito-pathology, entomology, cultivation system, relationship among soil—crops-water resources, varieties, agro-meteorology,agricultural administration and financial analysis, agronomy, agronomic management and agro-economic analysis) Training in Japan: 33 trainees Donation of Equipment: 706 millions of Yens (including freight) **Brazilian side:** Construction of a new research area ;soil physics, plagues, research of crops; Local costs related to the benefits offered to the experts such as housing and vehicles.	**Objective**: Diffusion and development of technology generated in Phase I. The development and diffusion of new agricultural technology adapted to the site was necessary considering that the PRODECER activities expanded to the States of Mato Grosso and Bahia. **Administration**: EMBRAPA **Executing Agency**: CPAC **Coordination**: Agricultural Research Company of Bahia : EPABA Agricultural Research Company of Mato Grosso : EMPA **Investment:** **Japanese side**:Dispatch of experts: Long term - 11; Short term - 14; Total 35 experts; (Fields: cultivation system, phito-pathology, entomology, soils-crops-water resources, agricultural machinery, agro-meteorology, agricultural administration, financial analysis, soil microbiology) Training in Japan: 20 trainees Donation of Equipment: 217 millions of Yens (including freight) Local costs: 38 millions of Yens: Improvement of the irrigation equipment in the agricultural experimental station of São Francisco, BA; Realization of seminar about the agricultural study through the Japanese-Brazilian Cooperation in 3 States located within the Cerrados; Publishing of the study report for technical diffusion, etc. **Brazilian side:** Provision of the Experimental Field: 57 millions of Yens related to the costs with land and construction; Local costs related to the benefits offered to the experts such as housing and vehicles; Counterpart	**Objective**: Management and conservation of natural resources, as well as the sustainable agricultural development of Cerrados **Administration**: EMBRAPA **Executing Agency**: CPAC **Coordination**: Agricultural Research Company of Maranhão: EMAPA State University of Tocantins: UNITINS **Investment:** Japanese side:Dispatch of Experts; 10 - long term; 20 - short term; Total 30 experts; (Fields: agricultural protection, soil fertilization, remote monitoring, production system, water quality evaluation, control of diseases and plagues, agricultural machinery, etc.) Training in Japan: 23 trainees Donation of equipment: 247 millions of Yens Local costs: 43 millions of Yens - Realization of International Symposium of Tropical Savanna - Introduction of a new variety of "milheto" from ICRISAT - Repair of the experimental *Glasshouse* **Brazilian side:** Provision of land, buildings and laboratory and research facilities, as well as experimental fields; Operational cost; administrative expenses, expenses related to the realization of lectures/seminars, etc.; Counterpart
Environmental Monitoring in the PRODECER Agricultural Projects (1992 - 2000)		
Objective: Study of the environmental impact and the agricultural development areas of the PRODECER **Executing Agents**: CAMPO, EMBRAPA, CPAC	**Investment of the Japanese side**: *Dispatch of 01 long term Expert, *Dispatch of study mission once a year, * Training in Japan; 05 trainees, *Financing of 284 millions of Yens (including equipment)	**Investment of the Brazilian side**: *Operational costs; administrative expenses, locomotion expenses

Figure 4.1.1 Contents and Achievements of the Japanese-Brazilian Technical Cooperation for the Agricultural Development by JICA

(1) The main research themes and results of the phase I of "technical-scientific support project for agricultural development of Cerrados" (1977~1985) are presented in Figure 4.1.2 below.

RESEARCH THEME	RESULTS
(PHITOPATHOLOGY)	
Variety of *Stylosanthes* resistant to anthracnose.	Selection of variety resistant to anthracnose.
Diversification of parasitism and varieties of anthracnose fungus.	Identification of 2 anthracnose fungus varieties participation.
Resistance of varieties and lineages of *Stylosanthes* to anthracnose and the methodology of tests in embryo plants	Decision of design of embryo plants tests methodology for the disease control.
Research about the *Cassava Mosaic virus.*	Research for the elucidation of the virosis ecology.
Investigation about the incidence and evolution of most important diseases in Cerrados main crops.	The control technique of important diseases in main crops became evident.
Tests about the ecology of wheat main diseases in the Cerrados region.	Selection of a lineage resistant to the diseases.
(ENTOMOLOGY)	
Tests on the elasmo caterpillar (*Elasmopalus lignosellus*) control in wheat cultivation on Cerrados soils.	Elucidation of the caterpillar ecology and start of tests about the control method.
Tests about the control of bedbug in soybean cultivation in the Cerrados.	Research about the occurrences' locations, ecology, forecast of occurrences and control research method, including control experiment using chemical pesticides.
Survey about the occurrences of main pests in the Cerrados.	The main pests and their natural enemies were elucidated, and a manual was designed about how to combat against soybean pests.
Research about biological defense against mollusks and plant louse that attack citric fruits.	The main pests and their natural enemies were elucidated.
(PHITO-TECHNOLOGY)	
Study for the improvement of soybean production system in Cerrados.	The relationship between variety and volume of fertilization became clear.
Study about the elimination of weeds in the soybean cultivation.	The efficiency of the joint utilization of mechanical and chemical elimination of weeds was confirmed.
Basic research about the elimination of weeds.	Research about weeds and the characteristics of their germination.
Improvement of the soybean and wheat production systems in Cerrados.	The efficiency of the combination of fertilization in deep layers of soil, deep plowing and no-tillage cultivation was confirmed.
Method for the forecast of blossoming and maturing of soybean varieties.	The possibility of forecast through meteorological data became clear.
Influence of the type and quantity of phosphate fertilizer and cultivation density on soybean growth and yield.	The fact that the quantity of fertilizer and the cultivation density depend on the type of phosphate fertilizer became clear.
Difference of soybean varieties for the resistance to pests.	Variety resistant to soybean pests was selected.

Fig. 4.1.2 The Main Research Themes and Results of Phase I of the "Technical-Scientific Support Project for the Agricultural Development of Cerrados" (1977~1985)

(RATIONAL USE OF THE SOIL-PLANT-WATER SYSTEM)

Development of soybean roots system in Cerrados.	The effect of deep fertilization with lime and phosphorus became clear.
Development of roots systems of Cerrados crops.	The fact that the aluminum ion is the main obstacle for root growth became clear.
Analysis of the influence of phosphate fertilizer and lime utilization for soybean cultivated in Cerrados soil.	A guideline for the crop fertilization management was created.
Research about the nitrogen effect on the green fertilization in Cerrados soils.	The effect of green fertilizer and its utilization method was analyzed.
Application of remote monitoring technique in survey about agriculture and natural resources of the Cerrados region.	A guideline for the elaboration of a land use and soil classification map was created.
Cerrados soil and vegetation survey using remote monitoring technique.	Maps of soil, vegetation and land use were elaborated.

(AGRICULTURAL METEOROLOGY)

Evapo-transpiration rate in the irrigated soybean cultivation in the Cerrados.	Basic research was carried out to evaluate water resources.
Measurement of the evapo - transpiration potential based on Cerrados meteorological data.	Technology transference was carried out about the method of analysis of meteorological data.

(AGRICULTURAL MECHANIZATION)

Research about root development and soil hardness due to the use of agricultural machinery in Cerrados.	Research about the relationship between soil compaction and roots system development was carried out.
Research about the soybean roots system development and plowing practices in Cerrados soil.	Research about the soil plowing practice was carried out.
Research about the soybean cultivation mechanization in the Cerrados region.	The necessity of soil correction through the use of agricultural machinery was confirmed.

(RURAL ADMINISTRATION AND ADMINISTRATIVE ANALYSIS)

Application of the *goal programming method* to agricultural administration planning.	This method was applied in the Cerrados farm administration plan, and experiments were carried out.

Fig. 4.1.2 The main research themes and results of the phase I of the "Technical-scientific Support Project for the Agricultural Development of Cerrados" (1977~1985)

(2) The main research themes and results of phase II of "Technical-scientific support project for agricultural development of Cerrados" are presented in Figure 4.1.3 below.

RESEARCH THEME	RESULTS
(RATIONAL UTILIZATION OF THE SOIL-PLANT-WATER SYSTEM IN THE CERRADOS)	
Observation of the soil fertility level after fertilization with organic matter (green fertilizer, remains of crops, etc.).	- The confirmation method of nitrogen fertility in Cerrado soils was consolidated, reducing the fertilization cost by establishing the appropriate quantity of fertilizer. - The forms of organic matter in Cerrado soils as well as their quantitative variation were elucidated.
Estimation of the water volume supplied and the absorption volume of nutrients per plant under irrigation during drought.	- The methodology for decision making of the irrigation ideal point during drought was consolidated, resulting in a significant reduction in production cost, besides also reducing the diseases and pests and avoiding the dissolution and loss of nutrients. - Development of the measurement method of NO^2 expelled by Cerrados soils.
Improvement of the sub-soil compacted layer that is harmful for root growth.	The formation process of compacted soil due to the continuous crop mechanization was elucidated and a control method was developed.
Tracking and collection method of the useful *rhizobium*.	The *rhizobium* fixation through the development of new inoculation techniques in soybean was confirmed.
(VEGETAL DEFENSE)	
Survey on the occurrence of diseases and pests in main crops.	The survey on the occurrence of diseases and pests in main crops was carried out, elucidating the main diseases and pests and developing a survey method.
Identification of the main crops virosis and elucidation of their nature.	Some virosis of leguminous plants were identified. The contagious mechanism and the exam of the variety resistant to them were elucidated.
Research about the eco-physiological nature of diseases and pests of main crops and analysis of the control method.	The occurrence mechanism of diseases was elucidated and a control method was developed.
Survey on the occurrence of diseases and pests in main crops.	The survey and identification of bedbugs were carried out.
Elucidation of the nature of main pests.	The life cycle of the bedbugs that attack the culm panicle of rice in Cerrados region was elucidated.
Development of the biological control method of main pests.	- Two types of bees that parasitize the eggs of seven types of bedbugs were introduced. - Research for the control of pests that attack rubber trees and control of bedbugs through the utilization of microorganisms that parasitize the insects was carried out.

Fig. 4.1.3 The Main Research Themes and Results of Phase II of the "Technical-Scientific Support Project for the Agricultural Development of Cerrados"

(CULTURAL PRACTICES APPROPRIATE TO THE CERRADOS REGION)

Elucidation of the water stress influence on soybean cultivation.	- A model of soil humidity variation for the evaluation of water losses in Cerrados cultivated land was elaborated. The control measure of water stress in soybean was elucidated and a control measurement method was developed.
Improvement of soybean cultivation practices based on growth response to environmental conditions.	- The physiological characteristic of the soybean variety appropriate for the rainy and dry seasons was elucidated. - Study of the behaviour of plants' roots, with the elucidation of the soil characteristic and the root reaction to growth in Cerrados. Technology transference of the roots system survey technique was carried out, as analysis method of damage caused to the plant roots growth due to the soil compacted layer. This technology transfer was used for development of a method to solve problems caused by soil compaction. - Technology transfer of meteorological forecast of drought occurrence was carried out, through the use of topographic data, as well as agricultural productivity, drought related damage, meteorology, etc. Thus, the forecast of meteorological catastrophes became possible, allowing the presentation in the field of a method to avoid losses through the choice of ideal seeding period. - The dying method that allows the rapid and easy exam of wheat resistance to aluminum was consolidated and the existence of high resistance variety was confirmed.

(APPROPRIATE RURAL ADMINISTRATION TO THE CERRADOS REGION)

Evaluation of the rural administration form (survey of companies, cooperatives and private property administration methods).	*On site* survey was carried out in order to appraise the actual situation and to evaluate the rural administration form. The fact that the land use method is being consolidated became clear.
Agricultural mechanization (efficient use of tractors and plowing attachments).	- The automated system for experimental use agricultural machinery was developed and technology transfer about measurement and analysis practice was carried out. - The exam of tractor velocity and fuel consumption by the automated system was carried out. The mechanism of analysis of tractor indoor data was developed and technology transfer of analysis method was carried out. Thus, the consolidation of technology that allowed the reduction of energy use and increase of work efficiency became possible.

Fig. 4.1.3 The Main Research Themes and Results of Phase II of the "Technical-Scientific Support Project for the Agricultural Development of Cerrados"

(3) The Main research themes and results of "Technical-scientific support project for sustainable agricultural development of Cerrados focusing on management and conservation of natural resources" are presented in Figure 4.1.4 below.

RESEARCH THEMES	RESULTS
(EVALUATION OF AGRO-ENVIRONMENTAL RESOURCES OF CERRADOS)	
Knowledge about vegetation and land use distribution. - Quantitative evaluation of Cerrados land use and vegetal resources through ecological method and remote sensing technique.	- The evaluation of environmental resources became possible. - The method that evaluates the influence of agricultural development on the environment through vegetation was developed.
Knowledge about the erosion actual conditions. - Quantitative measurement of erosion in Cerrados cultivated land.	- The precise measurement of erosion became possible.
Evaluation of the actual conditions of water resources and water quality. - Survey about the water quality in the Cerrados hydrographic basins.	- The fact that the contamination of superficial water and groundwater in Cerrados is very small became clear. - The analysis of contaminated water with low concentration became possible.
(SEARCH FOR THE CAUSE OF SOIL DEGRADATION AND DEVELOPMENT OF CONTROL TECHNIQUES)	
Elucidation of the restraining factors for the land productive strengthening and improvement of control techniques. a) Improvement of the soil management technique to impede soil degradation. b) Development of a cultivation system that is capable to reduce the soil compaction.	- The fact that the most important restraining factor for the land productive capacity is soil compaction became clear. - The effect of sod seeding on the soil compacted layer destruction was elucidated. - The technique for soil compacted layer destruction was developed.
Elucidation of the biological and chemical degradation of soil and improvement of the soil liquid and nutrients supplying capacity. - Diagnosis of the biological and chemical degradation of the soil and an efficient improvement method.	- The technique for the chemical degradation control of soil was consolidated. - The supplying process of water and nutrients of soil in the green fertilizer crops was elucidated. - The chemical-physical relationship of the soil in no-tillage cultivation was elucidated. - The biological characteristics of small fauna and of soil microorganisms were elucidated.

Fig. 4.1.4 Main Research Themes and Their Results of the "Technical-scientific Support Project for the Sustainable Agricultural Development of Cerrados Focusing on the Management and Conservation of Natural Resources"

(IMPROVEMENT OF THE CONTROL AGAINST PESTS AND DISEASES)

Elucidation of the occurrence of pests and diseases caused by serial cultivation. - Research about the occurrence conditions of aerial transmission diseases or diseases transmitted by seeds in main crops.	- The occurrence of microorganisms caused by serial cultivation was elucidated.
Improvement of the control technique of diseases transmitted through soil and development of a control technique of diseases transmitted through seeds. - Eco-physiological research about diseases transmitted through soil and control through soil management.	- The characteristics of the damage caused by soybean stem disease and resistant fungus were elucidated. - The actual conditions of soil disease for leguminous plants cultivated in irrigated area was elucidated.
Improvement of the general control technique of the pests damages through the introduction of occurrence forecast and biological control. - Development of pests biological control technique. - Evaluation of the influence of the production system and of the cultivation system on the nematocyst and pests in the Cerrados productive region.	- The basic technique for the control of the virus that is the natural enemy of the soybean pest was consolidated. - The basic technique for the control of nematocyst through the microorganism that is its natural enemy was consolidated.

(DEVELOPMENT OF A SUSTAINABLE PRODUCTION SYSTEM)

Selection and introduction of crops adapted to the adverse conditions of Cerrados such as drought, acidity, low contents of phosphorus, etc. - Introduction of a functional crop that can contribute to the improvement of the biological or physical-chemical nature of Cerrados cultivated land.	- Crops capable to absorb the phosphorus fixed in soil were selected.
Development of the sod seeding system through the introduction of crops for green fertilization and crop rotation. - Development of cultivation technique that combines soybean with an appropriate crop for rotation.	- A crop rotation system utilizing millet with the function of contributing to the soybean production increase was developed.

Fig. 4.1.4 Main Research Themes and Their Results of the "Technical-scientific Support Project for the Sustainable Agricultural Development of Cerrados Focusing on the Management and Conservation of Natural Resources"

(4) Continuity of Projects by EMBRAPA-Cerrados

EMBRAPA-Cerrados continues to carry out research related to the environmental conservation in regard to the agricultural development of Cerrados. 27 researches are being carried out, in a continuous manner, and some of these are presented in Table 4.1.1.

Table 4.1.1 List of some Researches Related to the Environment which are Being Carried Out in a Continuous Manner by EMBRAPA-Cerrados

RESEARCH THEMES
➢ Evaluation, recuperation and management of Cerrados region biodiversity.
➢ Recuperation and conservation of the riverside forests and Cerrados vegetation biodiversity.
➢ Elaboration of the soil classification map of Tocantins and Center-West Region States.
➢ Characterization and evaluation of agricultural activities influence on Cerrados natural resources.
➢ Analysis of the environmental impact evaluation method for agro-ecological system of Cerrados.
➢ Collection and biological survey for conservation of medical species of Cerrados.
➢ Agro-forestry system in small-scale properties in Cerrados.
➢ Agro-forestry system for production of annual crops in Cerrados.

4.1.3 Environmental Monitoring of Cerrados

At the same time that research cooperation was being carried out, the awareness increased of the need for a "survey about the influences of the simultaneous process of large-scale agricultural development on the Cerrados environment." To contribute to future environmental preservation work, the "Cerrados environmental monitoring" (1992~2000) started in the Prodecer pilot-projects areas. The monitoring was carried out in Prodecer I and II areas from 1992 to 1996, and in Prodecer III areas from 1994 (even before the project began) until 2000. In this work, indicators such as soil erosion, water volume and quality, vegetation and insects were monitored. The accumulated data resulting from this monitoring effort and the work methodology can be utilized in future projects that aim at the implementation of a sustainable agricultural development process.

Such results were recently published with the title "ENVIRONMENTAL MONITORING IN THE PRODECER AGRICULTURAL PROJECTS", as a reference for the Cerrados agricultural development with environmental concerns.

As the result of the environmental monitoring work carried out through the observation of indicators in defined locations and points, a considerable amount of basic data was collected as well as the consolidation of a monitoring methodology. Both were transferred and preserved in several organizations such as CAMPO, EMBRAPA-Cerrados, etc. These results will contribute to the sustainable agricultural development process with emphasis on Cerrados environmental preservation. Figure 4.1.5 shows the monitoring survey system.

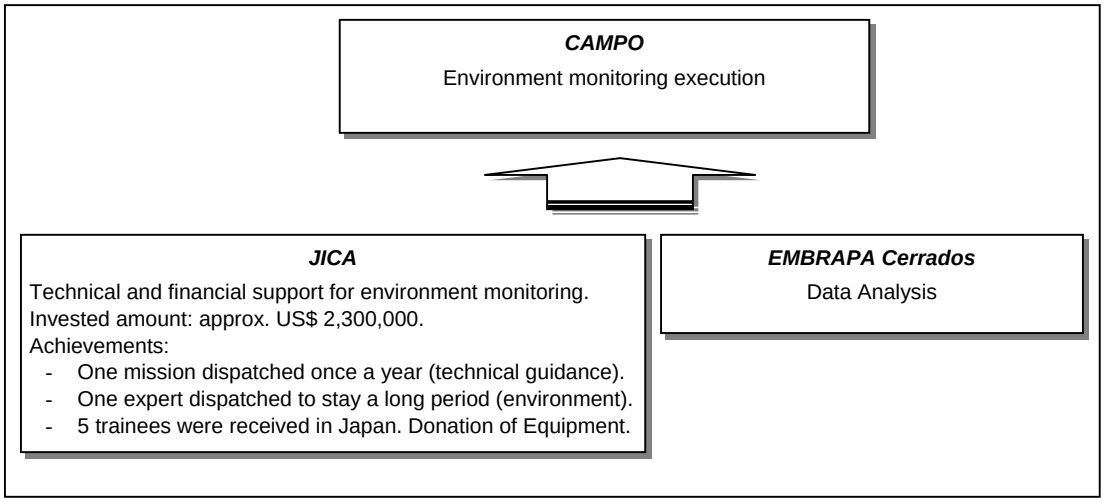


Fig. 4.1.5 Contents and Indicators of the "CERRADOS ENVIRONMENTAL MONITORING"

In the areas of Prodecer projects, the following impacts were observed according to environment monitoring results.

a) EROSION

The erosion degree varied from project to project. This is because the meteorological and the soil conditions also vary from project to project. In the Cerrados region, besides the sod seeding, the contour lines at a conventional space of 30 m in order to avoid the erosion was also used. If the spacing is larger, its effectiveness is reduced. Generally speaking, the Cerrados soil called latosol has a good drainage capacity. However, agriculture mechanization destroys the structures of the soil particles, compacting them and thus reducing the drainage capacity. As a consequence, the quantity of water that flows on the surface increases, carrying away the soil that causes erosion.

b) FLOW AND QUALITY OF WATER

In the monitored projects, deterioration in the water quality due to the Prodecer was not observed. That is because appropriate quantities of chemical fertilizers and pesticides are used and due to the strictness of the rules followed by management, soil conservation system, preservation of river side forests, and etc.

However, for water flow, in some projects (e.g. Gerais de Balsas Project) reduction of the river level was observed, due to reduction of the hydric restoration of the springs caused by the deforestation of nearby forests and by increase of the water consumption for irrigation.

c) ENTOMOLOGICAL DIVERSITY

It is possible to measure the impact on Cerrados biodiversity by understanding the variation on the species level and insects groups. During the monitoring, nocturne lepidopteran insects were caught in order to measure the impact. There are more than 11,000 species, but they represent only 10% of all insects that inhabit the Cerrados region. Through the survey carried out in Cerrados, within Prodecer, in river side forests and in 'dirty fields', it was possible to identify the diversity of each species and the differences between species.

The fact that the ecosystem is composed of a variety of species allows equilibrium between them and contributes to avoiding an abnormal increase of a specific species, turning it into a plague. That is why the ideal is to avoid trying to control the plagues using pesticides, which are easy to apply, and instead to try to manage them using their natural enemies: i.e., a biological control.

d) VEGETAL SPECIES DIVERSITY

In the Gerais de Balsas Project of Prodecer III, the area of monitored, a variation on the vegetation along the low and flat land (várzea) between the river side forests and the Cerrados vegetationwas observed.

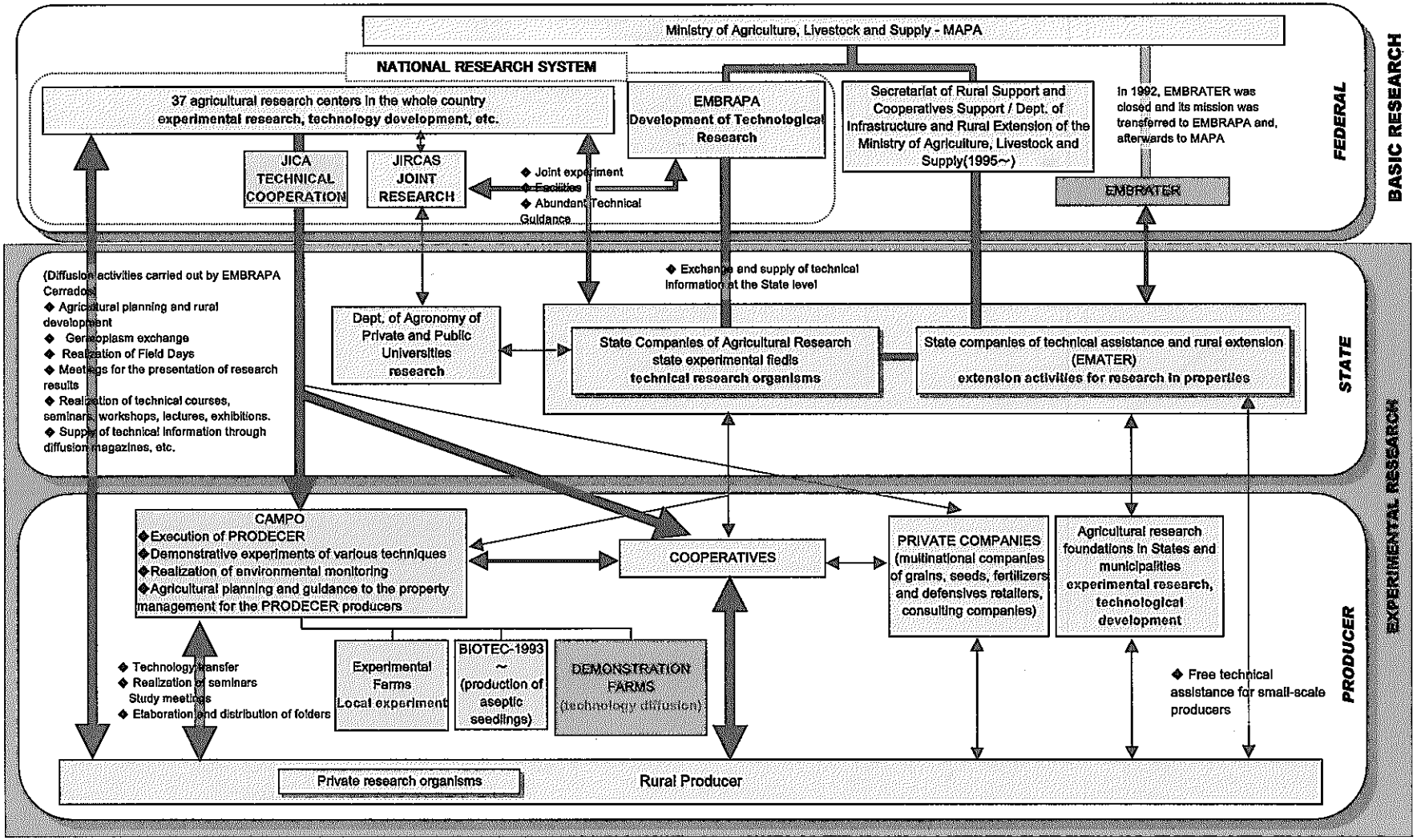
As the soil becomes dried due to decrease of the water river level, reduction of the vegetation and the typical grass from the 'várzea' was noticed, giving space for the invasion of bushes and trees (*ligneous caulis*).

That also impacts the vegetation. The use of fire on pastures, man made, causes damage to the vegetation biodiversity. In the frontiers of cultivated areas, an invasion of exotic species was observed. The exotic species eliminate the native ones and threaten the diversification of vegetation.

4.1.4 Relationship to the rural extension system

The aforementioned projects were executed before or in parallel to the effective implementation of Prodecer or other development processes in Cerrados. These projects were very important for the technical support of region agricultural development since for a long time the region was considered unsuitable for agricultural production. At this point, we will try to describe how the agricultural techniques developed through such projects were transferred/diffused to the farmers, resulting in the increase of productivity and production volume.

Figure 4.1.6 shows the structure of the Research and Diffusion System of agricultural technology and the cooperation relationships among the several agricultural related organizations in the country.



Source: Elaborated according to the DIER/SARC/MA - 2001

Fig. 4.1.6 System of agricultural technology Research and Diffusion and the cooperation relationships among the Country's several organizations related to agriculture

(1) Diffusion system at federal and state levels

1) Research activities promoted by EMBRAPA (Brazilian Company of Agricultural Research) and rural extension and technical assistance activities promoted by EMATER (Company of Technical Assistance and Rural Extension)

The developed research was shared with State research organizations through a cooperation system (National System of Agricultural Research presented in the previous figure) structured through the relationship of several existing agricultural research organizations in the country.

At the State level, rural extension is carried out by EMATER of each respective State or by the State government department responsible for rural extension (where EMATER has no presence).

The EMATER agenda is to render technical assistance to small-scale producers. It is responsible to diffuse, without charge, agricultural techniques developed by experimental fields of companies and agricultural research organizations. EMATER/MG cooperated in Prodecer I, but EMATER didn't prioritize rural extension to Prodecer producers in Prodecer II and III.

2) Research activities promoted by CPAC

The function of CPAC is to promote the development of technology, and to carry out experimental research and surveys about problems that arise during the agricultural development process in the Cerrados region. CPAC also carries out joint research with other EMBRAPA research centers and with State experimental fields with which it maintains a cooperative relationship. This activity is necessary to validate the agricultural technology developed by CPAC itself and/or adapt them to the various socio-economic, climatic, soil, and topographic conditions, etc. Consequently, the State experimental fields between CPAC and producers played an important role in this process. Within Prodecer areas, demonstration fields were implemented by CPAC on land provided by the producers. The final result of this process was that agricultural techniques adapted to several regions allowed the increase of agricultural productivity and of production volume whereas at the initial stage of the Cerrados agricultural development, there were almost no production technologies appropriate to this region and little evolution as for productivity increase.

The research cooperation projects of JICA and JIRCAS together with EMBRAPA, through which basic techniques were developed and experimental research was carried out, were very useful. The developed technology is being also transferred

to cooperatives and retail companies of seeds, fertilizers, pesticides, etc. This diffusion is not limited only to research/rural extension organizations, but also aims at the widest possible far-reaching distribution.

TRANSFERENCE AND DIFFUSION OF TECHNOLOGY BY EMBRAPA-CERRADOS

1) Object and Policy: Based on the agribusiness demand in the Cerrados region, the objective is to systematize quality technology and information so that everyone can use it at any time. Promotion of technology transfer and search for *feedback.*

Policy: Monitoring was implemented to verify that the agricultural technology was transmitted to the intended enduser producer.

2) Information Transfer and Technology Transfer:
- Published textbook
- Provided "Home Page" etc.

3) The main adopted methods of technology and information transference and diffusion were as follows:

- Realization of "FIELD days", demonstration fairs, technological exhibitions carried out in EMBRAPA-Cerrados, at experimental fields in the States or universities where several products and new agricultural technology were exhibited.
- Realization of meetings, lectures and seminars for the diffusion of research results.
- Services and consultation through telephone or e-mails (home pages were available on the Internet).
- "FIELD Day on TV". Transmitted each 15 days, for 50 minutes, with a defined theme.
- Folder's, bulletins, technical leaflets, videos, etc.

Table 4.1.2 CPAC achievements in rural extension activities – year 2000

Diffusion Manner	Frequency
FIELD Day.	28 times
Meetings for the diffusion of research results.	33 times
Training courses (there were specific courses according to the producers level, but the technology feedback is carried out regardless of the producers level).	314 hours
Seminars and workshops.	16 times
Lectures.	250 hours
"EXPO" – technological exhibitions.	25 times
Diffusion of technology through folders.	57 times

Through the dispatch of experts during the period of JICA technical cooperation project executions, technology transfer was carried out to several agricultural research and rural extension organisms, to CAMPO, cooperatives and producers, as described below:

- **Seminars and Technical Training**
  Participation in technical events of extension workers, researchers, technical guides, etc., from Federal and State governments, CAMPO, Prodecer participant Cooperatives and producers.
- **Design and distribution of folders and diffusion materials**
  Materials about agricultural techniques adapted to the Cerrados region from research reports carried out by Brazilian and Japanese experts, etc., were published in Portuguese, Japanese and English.

- **Guidance about rural management to producers**
  The experts dispatched by JICA carried out, in several regions, consultation meetings about rural administration. They also sporadically rendered guidance about rural management directly to the producers located in the regions nearby Brasilia.

(2) Diffusion system at producer level

On the Federal level, basic techniques were developed to summarize basic research. On the State and producer level, the technique were adapted to each producing regions on an experimental basis. Producers made efforts to raise their technical level and to increase the exchange of information through visits to farms and experimental fields. There were also private research foundations, formed with the participation of producer capital, for those with high awareness and interest in the increase of productivity. There were also research foundations sponsored by States and municipalities in which private companies also participated. During the *on site* visits, the research development activities that were being carried out intensively by some of these foundations could be observed. These foundations are developing, through joint research with the cooperatives, cultivation techniques and rural management, and they intend to continue to carry out research and monitoring activities.

Furthermore, among the cooperatives participating in Prodecer, there are those carrying out demonstration experiments of agricultural techniques together with State universities, foundations, research institutes, CAMPO, private companies, and others. The land on which the demonstration fields are formed are provided by Prodecer producers as already mentioned.

The technical departments of some Prodecer cooperatives render technical assistance to the producers. For instance, activities to increase the awareness about environmental preservation through guidance about cropdusting techniques and gathering of agricultural chemical packages are being carried out, among other activities. Through visits *on site*, it was possible to observe that the producers are highly aware about ecology, as well as that the technological diffusion system is working properly.

In several areas, there are also private companies specializing in technical assistance and guidance, working on a contract basis especially with medium- and large-scale producers.

BAHIA FOUNDATION

Bahia Foundation was founded in 1997, with the objectives to carry out agricultural development in the Bahia State western region and to give support to research for agricultural development of this region. At present, it is carrying out research on the following three themes:

1) Development of new varieties of soybean.
2) Research on varieties and cultivation techniques of maize.
3) Integrated management, using natural enemies to combat against pests, and seeking genetic improvement of cotton.

- The annual budget is approximately R$400,000. It has experimental fields in 5 locations, where 1 researcher, 4 agricultural technicians and 20 employees work.
- The expenses are paid mainly from monthly individual payments of R$1,000 that each of the present 30 members pay.
- Most members are large-scale farmers with more than 1,000 ha. Multinational grain companies and retail fertilizer companies also make an annual contribution. This varies from R$400 to R$500/year.
- The experimental fields have approximately 30 ha and are provided by the members. This foundation carries out joint research with EPABA (Bahia State Company of Agricultural Research). It received germ plasma from EMBRAPA and carries out 4-year research about fertilization aiming at the increase of productivity, in addition to research about soybean varieties adapted to the region.
- The research results are diffused and workshops are held.
- A new soybean variety will be released in 2001, after proper patent registration, and will become source of revenue for the Foundation.

Their role is fundamental in the increase of productivity through demonstration experiments according to basic techniques.

(3) Support given by CAMPO to rural extension

CAMPO has fulfilled its function by greatly contributing technical assistance and rural extension to producers. This company has stimulated the implementation of experimental fields within each project area – some of them directly – and carried out joint experiments together with EMBRAPA-Cerrados, other research companies, aiming at validating technologies adapted to condition at each project. The experiments of new technology are examples of applications carried out at the CAMPO experimental field in Paracatu, through cooperation among EMBRAPA-Cerrados, EPAMIG (Agricultural Research Company of Minas Gerais State) and Japanese experts. This cooperation started during Prodecer I, and is still being performed in the field of Biotechnology and soil analysis, leaves, fertilizers and fertilizers.

In the first phase of Prodecer, technical assistance for producers during the implementation of the Paracatu and Irai de Minas projects was rendered by the agronomists of EMATER/MG (Technical Assistance and Rural Extension Company of Minas Gerais State), under a contract with CAMPO. In Coromandel,

these services were directly rendered by CAMPO technicians.

In the second and third phases of Prodecer project implementation, technical assistance was rendered directly by CAMPO technicians and/or under their direct supervision. At the completion of this phase, general responsibility for this service was assumed by the cooperatives in charge of the projects. However, for several years these cooperatives had and still have the support and collaboration of CAMPO technicians.

In all Prodecer phases, CAMPO provided one technician for each 10 to 13 producers during the period in which it had direct or indirect responsibility for technical assistance.

For guidance, CAMPO prepared the "Manual for Technical Guidance to Producers" together with EMBRAPA, State research rural extension organizations, etc. These manuals were used in the design of individual plans for each producer, and also to define parameters for the technical departments of financial institutions for the analysis and approval of agricultural credit to the producers.

CAMPO – BIOTEC (Biotechnology Sector of CAMPO)

CAMPO has, in Paracatu-MG, facilities for the production of banana seedlings free from disease through vegetative micro propagation. The present production is of about 90,000 to 100,000 seedlings/month. The production is by order. The producer chooses the variety that he/she wants to plant and orders the seedlings. The selling value is R$1.20 to R$ 2.10 (US$0.60 to US$1.10) per unit. This facility also multiplies the seedlings brought by the producer. These seedlings are provided not only for Prodecer producers, but also for all interested producers. During the on site visit, seedling cultivation was observed in the Gerais de Balsas Project in Prodecer III.

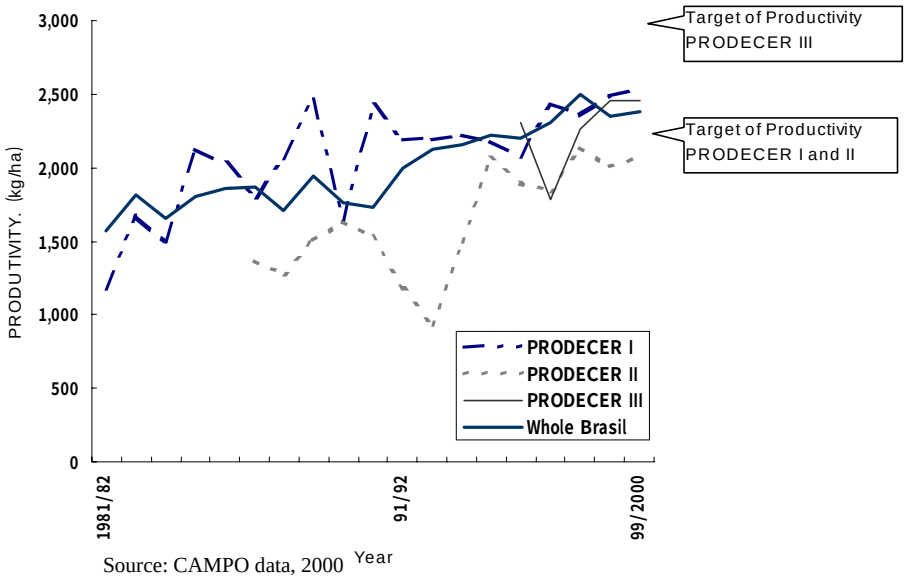
(4) Results attained in agricultural production through the diffusion of Japanese-Brazilian research cooperation

Through the execution of Japanese-Brazilian research cooperation projects, the following main results were attained:

1) Design of scientific works and methodologies of experimental research by experts.
2) Transference of research methodology.
3) Increase of the diffusion of results in production areas.
4) Significant development of research methodologies due to the use of donated equipment.

Items 1, 2 and 3 were already explained. The donation of equipment (item 4) was also one of the important factors that contributed to attainment of the results, especially for the consolidation of CPAC (today EMBRAPA-Cerrados). The modern equipment donated to this Center significantly contributed to the development of technological research for Cerrados agriculture and also promoted better quality of human resources. This fact was also observed in EMPA (Agricultural Research Company of Mato Grosso State), and in EBDA (Agricultural Research Company of Bahia State). More recently, these donations have allowed the development of biotechnology and vegetation and soil analysis in CAMPO. All this equipment continues to be efficiently utilized for experimental research and for development of technologies.

Through the technical cooperation projects carried out with JICA, agricultural techniques appropriate to the Cerrados region were developed. The basic technologies developed through this cooperation were validated, after going through demonstration experiment stages carried out by several research organizations and private companies in several areas of Cerrados, and then diffused through the rural extension system. The results of their utilization can be seen in the increase of soybean yield, as shown in the graph of Figure 4.1.7.



Source: CAMPO data, 2000

Fig. 4.1.7 Annual variation of soybean yield

Although, all the works so far developed and that represent a great joint effort of hundreds of scientists and researchers, they did not respond to all the questions and needs of the producers in a region due to the dimensions and potentials of the Brazilian Cerrados region.

In some regions and Prodecer Projects, the application of some techniques and the

implementation of some crops failed, especially perennial crops that demand a longer experimentation period. The lack of basic data at local level, especially as for meteorological and hydrological data, etc., was also a reason for some difficulties in the adaptation of techniques and crops.

UTILIZATION OF FERTILIZERS
- Research Finding of CPAC and Improvement of Crop Productivity

The lack of calcium, phosphorus and excess of aluminum, in addition to the lack of micro-elements of manganese, copper and zinc in the Cerrados soils has been the obstacle for plant roots growth. When gypsum (that contains calcium) is introduced, the root grows towards the deepest layers of the soil, allowing the absorption of water at lower depths. The root also becomes more active, increasing its absorption of nutrients. Figure 4.1.8 compares the root growth with the introduction of gypsum.

Table 4.1.3 Grains Yield with the Introduction of Gypsum

Gypsum/crop	Maize	Wheat	Soybean
Without	3.2 (ton/ha)	2.2	2.1
With	**5.5 (ton/ha)**	**3.5**	**2.4**

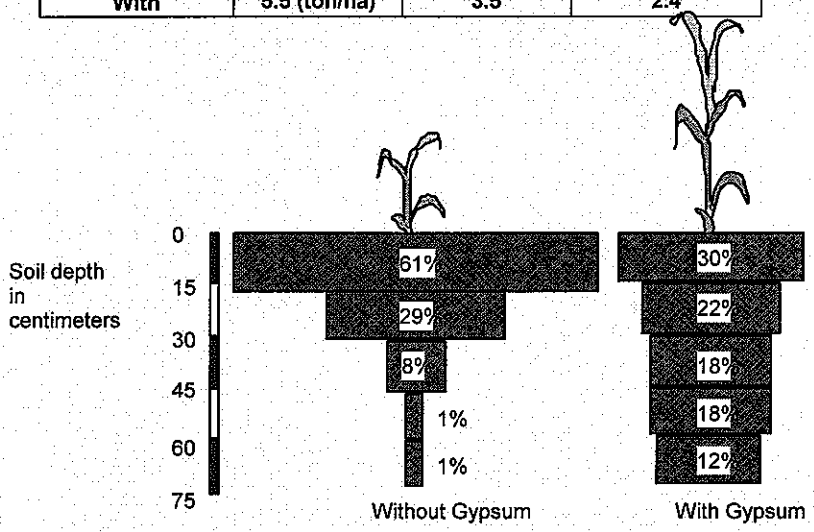


Fig. 4.1.8 Differences in Root Growth with the Introduction of Gypsum

Producers who utilize gypsum are still few, mainly because its diffusion started only about 6 years ago. However, Cerrados soils are already largely corrected using lime and phosphorus. It is already proved that lime neutralizes the soil acidity and contributes to increased yield. Table 4.1.4 compares the difference in grains yield using lime.

Table 4.1.4 Difference in grains yield using lime

Lime/Crop	Rice	Soybean
Without	1,320 kg/ha	900 kg/ha
With	**1,800 kg/ha**	**2,280 kg/ha**

The yield also increases supply of phosphorus to soil interior layers. It is proved that the supply of lime and phosphorus to soil interior layers affects soybean root system growth.

4.2 TECHNICAL COOPERATION BETWEEN JIRCAS AND EMBRAPA AND BETWEEN JIRCAS AND OTHER ORGANIZATIONS

4.2.1 Background and history

Since the foundation of its predecessor called TARC (Research Center of Tropical Agriculture), JIRCAS (Japan International Center for Agricultural Sciences), has been carrying out joint research with Brazil. Brazil is one of the most important research partners among the South/Central American countries. This research can be classified according to period and objectives, as follows:

1) Research of upland field crops production in Brazil (1972~1996)
2) Survey and analysis of agriculture characteristics and the course of technological improvement in South/Central America. (1993~)
3) Far-reaching research (1996~2002) and Research into large areas (1997~2006)

Besides these, joint research with international research organizations with headquarters in South/Central America was also carried out, and experts were also dispatched for JICA projects.

(1) Research of upland field crop production in Brazil

Since the 16th century, when the country was discovered, until recently, Brazilian agriculture expanded through the repetition of occupation and abandonment of fertile strips of land. As a result, the fertile land strips of the Atlantic forest were almost totally opened by the middle of the 20th century when problems started to arise due to the mono-cultivation and soil erosion. Consequently, new areas had to be opened for large plantations in the still wild Cerrados region, although they needed soil correction since they are in general not so fertile, and have high acidity and high contents of aluminum. At the same time, new technologies were sought with the aim to continue the use of the relatively fertile land of the center-southern region, almost completely opened, with the objectives of erosion control and soil recuperation for increased productivity. Thus, the project “Research about Cultivated Land in Brazil”(1972~1976) was carried out with the objective to support the development of agricultural technologies and to consolidate a sustainable agricultural management system in the center-southern region.

(2) Survey and analysis of the agriculture characteristics and the course of the technological improvement in South/Central America

According to the project “Survey and Analysis of the Agriculture Characteristics and the Course of the Technological Improvement in South/Central America” (1993~), several surveys covering agriculture characteristics and technological improvement in the MERCOSUL countries (Brazil, Argentine, Paraguay and Uruguay) are being carried out. Through these surveys, two facts were observed:

1) The main agricultural activities of the South/Central American countries are production of meat cattle, mainly through extensive husbandry, and grain production, mainly soybean. The restraining factors in production are low productivity of pastures and damage caused by serial cultivation.
2) The crop rotation technique with the rotation of pastures and grains (agriculture and livestock husbandry rotation) has great potential to become an advantageous technique to increase the productivity of both activities.

Based on the results this project, two other research projects emphasizing the sustainability and environmental preservation in the agriculture of the South/Central American countries and Brazil have started, and include the Cerrados region.

(3) Comprehensive research

1) "The development of sustainable agropastral systems in sub-tropical zones"

For the design and execution of this project (short named: Agricultural Rotation), an integrated approach involving multiple research areas, (including the economic and administrative evaluation) was necessary to avoid being restrained to the development of isolated technologies. The objective is to transform the large arable areas of the South American countries into the basis for food production.

2) "Comprehensive soybean research project in South America (Multilateral)"

In the previous project 'Survey and Analysis', it was concluded that soybean cultivation is an important component for crop rotation practice.

It was also concluded that, when the intention is to execute projects targeting several countries at a time, important research themes that are common to all of them is more efficient and valid. Thus, the "Comprehensive Soybean Research Project in South America (multinational)" (short named: Soybean in South America) (1997~2006) was designed. In this project, production technology integrated with soybean utilization is being developed through research relationship with JICA and multilateral research cooperation among Brazil, Paraguay and Argentina. The objective is to assure, quantitatively and qualitatively, a stable and sustainable production, reducing the erosion, damage caused by weeds, outbreak of diseases and pests in continuous cultivation areas, etc., which are problems arising in the soybean expansion process in South America. In Phase I (1997~2000), researches about the soybean composition, genetic improvement aiming at the resistance to diseases and pests, soil management, elimination of diseases and pests, and elucidation of the drought resistance structure, were carried out.

4.2.2 Contents and achievements of technical cooperation

Figure 4.2.1 shows the research themes and results, and Figure 4.2.2 shows the transition of joint research projects by JIRCAS.

(COMBAT TO DISEASES AND PESTS)

Analysis of eco-factors, identification and classification of the nematocyst and measures for to combat it.	- Produced knowledge about damage caused by the nematocyst. - Research about eco-factors, identification and classification of nematocyst was carried out, and the "Manual of Nematocyst in Soil" was elaborated. - Research about combating damage caused by the nematocyst progressed.
Physiology of upland rice and combating its pests and diseases.	The relationship between eco-physiology of upland rice and its pests and diseases was elucidated.

(ANALYSIS OF THE CULTIVATED SOIL AND SOIL MANAGEMENT ECO-FACTOR)

Characteristics of cultivated tropical soil fertility and soil management method.	The characteristics of distribution, origin, fertility and soil management were elucidated.
Nitrogen contents of cultivated soils in tropical regions during the dry and rainy seasons.	The characteristics of the "terra roxa" (purple land) soil and Cerrados soil (Latosol) were analyzed, and the relationship between cultivation practices and physical-chemical nature of the soil was elucidated.

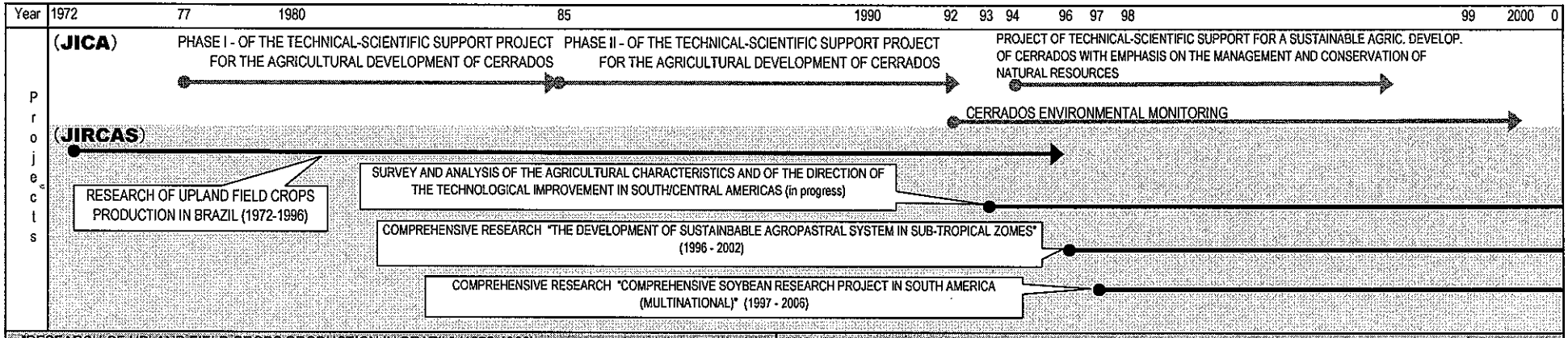
(CULTIVATION SYSTEM)

Cultivation system in tropical region during the dry and rainy seasons.	The analysis of restraining factors for production stability was carried out, and the adaptation between cultivation method and the soil-water-climate characteristic was elucidated.
Research about no-tillage cultivation technique.	The fertilization method and aptitude of no-tillage cultivation practice according to the soil were elucidated.
Soil erosion and control measures.	The effect of no-tillage cultivation on the soil conservation was confirmed.

(DISTRIBUTION AND DENSITY OF SAUBA-ANTS)

Survey about the damage caused by Sauba-ants and their control.	The changes of Sauba-ants distribution became clear and allowed the forecast of damage occurrence.

Fig. 4.2.1 Research themes and results of the project "Research of upland field crops production in Brazil"



"RESEARCH OF UPLAND FIELD CROPS PRODUCTION IN BRAZIL" (1972-1996)

Objectives:	Support for the development of agricultural technology and consolidation of the permanent production farm system in the center-south region of Brazil.
Counterpart Organisms:	Agronomy Dept. of the University of São Paulo. IAPAR – Agronomic Institute of Paraná Botucatu Faculty of the Paulista University in São Paulo State
Themes and Results:	See Figure 4.2.1

COMPREHENSIVE RESEARCH "THE DEVELOPMENT OF SUSTAINBABLE AGROPASTRAL SYSTEM IN SUB-TROPICAL ZONES" (1996 - 2002) (Short name: Agriculture-Livestock Husbandry Rotation)

Objectives:	Avoid soil degradation and damages caused by the continuous cropping, besides searching for pastures land improvement, developing and consolidating stable and sustainable agriculture and livestock husbandry rotation system (alternate cultivation of pastures and grains). Furthermore, avoid marketing risks through the production diversification, contributing to the financial stability of small- and medium-scale producers.
Counterpart Organizations:	EMBRAPA/CNPGC (National Center of Meat Cattle Production) Realization of local demonstration experiment in the experimental field of Guatapará, São Paulo State, owned by JATAK (National Federation of Agricultural Cooperatives TAKUSYOKU of Japan).
Area:	Selection of pastures varieties, management and pastures utilization techniques, soil fertility maintenance techniques, economic and administrative evaluation of new technologies, soil management techniques, and crops productivity.
Themes and Results:	"Development of pastures management and utilization techniques in the sustainable agriculture-livestock husbandry rotation system". The ideal gramineous type to be introduced in order to develop the appropriate pastures management method within the agriculture-livestock husbandry rotation system became evident. From now on, demonstration experiments shall be carried out to evaluate its utility as well as for afterwards diffusion to the producer. "Survey for the elaboration of a support system to the agricultural production planning in Brazil". To carry out administrative analysis concerning to the productive sector of soybean production in Brazil, numerically showing the economic influence of the demand for soybean products export and the economic position of the soybean products production sector.

"SURVEY AND ANALYSIS OF THE AGRICULTURAL CHARACTERISTICS AND OF THE DIRECTION OF THE TECHNOLOGICAL IMPROVEMENT IN SOUTH/CENTRAL AMERICA" (1993-)

Objectives:	To carry out survey about the conditions of South/Central American crops, pointing out problems and trying to find solutions.
Themes and Results:	The following points became clear: (1) Restraining factors for production are low pastures productivity and damages caused by serial cultivation. (2) The agriculture-livestock husbandry rotation technique which integrates pastures and grains is advantageous for the increase and sustainability of productivity.

COMPREHENSIVE RESEARCH "COMPREHENSIVE SOYBEAN RESEARCH PROJECT IN SOUTH AMERICA (MULTINATIONAL)" (1997 - 2006) (short name: Soybean in South America)

Objectives:	Development of technology for the improvement, qualitative and quantitative, of the sustainable and stable production through the minimization of erosion, of damages caused by weeds, plagues and diseases in land cultivated for too long time, due to the increase of soybean cultivated area in South America.
Counterpart Organizations:	EMBRAPA INTA – Institute of Agricultural Research of Argentine Ministry of Agriculture of Paraguay
Related organism:	JICA-CETAPAR (JICA Agricultural Experimental Field in Paraguay)
Area:	Genetic improvement of varieties, production environment, crops management, post-harvest techniques and socio-economic analysis.
Themes and Results:	"Guidance for the improvement of the soybean sod seeding technique in South America" To analyze the problems of no-tillage cultivation technique of soybeans that is rapidly spreading throughout the South American countries, showing the ways for its improvement. Together with the survey, a joint seminar of JIRCAS and JICA-CETAPAR was carried out in March 1998.

Fig. 4.2.2 Transition of Joint Research by JIRCAS

4.2.3 Relationship with the rural extension system

JIRCAS and the Brazilian government have been carrying out joint research already for some years. The results of these joint researches were transferred to the farmers through demonstration experiments carried out in several regions of the country and through the technology diffusion mechanisms of the rural extension system. The "National System of Agricultural Research" led by EMBRAPA has an excellent structure and aims at the technological development and its diffusion in an efficient and effective manner, through a far-reaching design, utilizing the network of researchers for the sharing of information.

"NATIONAL SYSTEM OF AGRICULTURAL RESEARCH"

EMBRAPA, which is the research partner of JIRCAS and JICA, is the organization responsible for agricultural research of the Federal Government of Brazil and coordinates the "National System of Agricultural Research". The system is designed for collaboration and for the exchange of technical information between more than 400 organizations over the whole country. The System is formed by EMBRAPA (which carries out research at national level), by State research companies, Universities' research organizations, agricultural research departments in private companies, etc. EMBRAPA's headquarters is in Brasília, and it has 37 Centers distributed throughout the country that carry out research in the fields of agriculture, silviculture, livestock husbandry, fish farming, environment, etc. The researchers easily carry out exchange of information regarding their research areas, through the information obtained in technical data banks.

The objective of this System is "to promote the productivity increase through the rational use of natural resources, with concern for the environment, searching for the strengthening of international competitiveness, production increase and assurance of the domestic supply of food". The system is not only focused on domestic activities, but allows the realization of technical cooperation in large part with other countries. EMBRAPA, and the whole System, permanently develop ways for the diffusion of new technologies and research results through relationship with various organizations and through rural extension and technical assistance methods.

The first joint research project of JIRCAS, called "Research about Cultivated Land in Brazil", did not target the Cerrados region, but rather the development of technologies for the center-southern region. However, there are also some Cerrados areas in this region, and several analyses were carried out on these soils, thus part of this research is useful to the Cerrados development process. For instance, the no-tillage cultivation practice that was one of the research themes is being rapidly applied in the Cerrados. In Table 4.2.1, the no-tillage cultivation area evolution is presented.

Table 4.2.1 Evolution of No-Tillage Cultivation Area in Several Countries (unit=1000 ha)

Countries	1973/74	1983/84	1996/97
Brazil	1	400	6,500
Argentina	-	-	4,400
Paraguay	-	-	500
Uruguay/Chile/Bolivia	-	-	250
USA	2,200	4,800	19,400
Australia	100	400	1,000
Whole World	2,301	2,301	38,700

Source: International Magazine of Information of the Agricultural Research Results. No. 06 – International Center of Agriculture, Forestry and Fishery Research – Ministry of Agriculture, Forestry and Fishery of Japan

Remarks: Data estimated by R. Derpschs (1998).

The integrated research on soybean, including the improvement of varieties, that is being carried out in the project "Soybean in South America", is being used in the agricultural technology development process for the Cerrados region. In the National Center of Soybean Research of EMBRAPA, located in Paraná State, efforts are being made to stimulate the direct utilization of soybean as food, in addition to the development of basic research and the realization of several demonstration experiments.

4.3 PROFIR – PROGRAM OF IRRIGATION EQUIPMENT FINANCING

4.3.1 Background and history

PROFIR (Program of Irrigation Equipment Financing) had two divisions: NATIONAL PROFIR that covers the whole country, and the PROFIR OECF, specific for the Cerrados region. (Note: OECF was the name of the Japanese financing agent, now JBIC.) The objective of this program is to contribute to economic development through the increase of basic food production (such as maize, feijão bean, etc.) as well as soybean and wheat (also searching for self-sufficiency in wheat). This section only covers PROFIR OECF that offers support to agricultural development through the financing of part of the necessary resources for the acquisition of irrigation equipment (such as central pivot, conventional sprinkler, self-propelled sprinkler, etc.) for Cerrados

PROFIR – OECF
GENERAL ASPECTS

- Name of the project: PROFIR – Program of Irrigation Equipment Financing in the Cerrados Region.
- Loan Source: Central Bank of Brazil.
- Program area: Cerrados Region
- Executing agency of the program: Ministry of Agriculture and Land Reform of Brazil (at the time)
- Signing of the financing agreement: March 1985
- Conclusion of disbursement: August 1992.
- Value of the approved contract: Yen 12.0021billion.
- Value of the carried out disbursement: approximately Yen 11.7 billion.

producers. The global target of the program was to attain 100,000 ha of irrigable land.

The executing agent at the Brazilian side was initially the Ministry of Agriculture and Land Reform (the name at the time), and the source of the foreign loan was the Central Bank of Brazil.

4.3.2 Contents of cooperation

(1) Execution structure

OECF resources were transferred to the Central Bank of Brazil. The Bank added national counterpart funds and provided the resources to the Program financing agents, that in turn extended loans to the producers, who were the final borrowers. Figure 4.3.1 shows the program execution scheme.

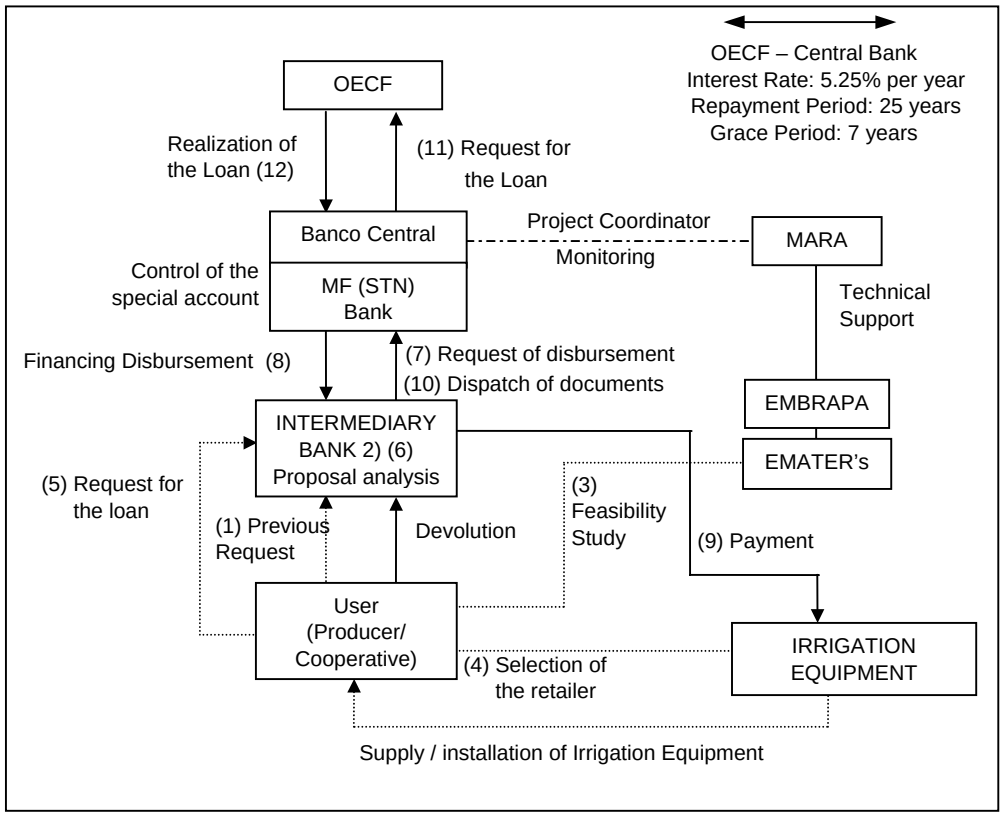


Fig. 4.3.1 Program Execution Scheme

The participants in the program execution structure at the initial stage were the Ministry of Agriculture (in charge of the program coordination / execution as a whole), the Central Bank / Ministry of Finance (Secretariat of National Treasury) (responsible for the financial control of the whole scheme), and the financing agents (intermediary financing institution). EMBRAPA (Brazilian Company of Agricultural Research) also participated in the certification of irrigation equipment,

and EMATERs (State companies of technical assistance and rural extension) designed the individual projects (feasibility study) necessary for the financing contracts.

(2) Japanese loan

The OECF loan to the Central Bank released between January 1988 and August 1992, approximately 11.7 billionyen (the authorized value was 12 billion yen), very close to the initially planned value. A total of 596 loan contracts were signed. The initial resources plan forecast a total of US$137,500,000, out of which approximately US$87,500,000 (64%) would be allocated by the Brazilian government and the remaining of approximately US$50,000,000 (36%) would correspond to the OECF loan amount.

4.3.3 Results of the program

(1) Financing

The program results, included in a report elaborated by OECF, can be summarized as follows:

Table 4.3.1 Results of PROFIR Financing

	RESULTS
Region	The financed amounts in the States of Minas Gerais, Bahia and Goiás were significant. This is due to the fact that the Cerrados development process, during the implementation of the PROFIR OECF, occurred vigorously in those States. Considering that this program targeted the good producers already installed in the Cerrado region, the producers introduced irrigation equipment with the supposed objective to modernize and make their administration more efficient.
Size of the borrowing producers	Most of Cerrados development had as model, large-scale mechanized agriculture with minimum areas of 300~400ha. Thus, a high initial investment was necessary for the clearance of areas, soil correction, and construction of infrastructure. Consequently, if the producer was not big enough, he/she would face difficulties in procuring financial resources and in attaining the economic feasibility of his/her enterprise. Apart from this, in most of the cases, new investment was necessary for the introduction of irrigation equipment. Therefore, when observing the profile of the borrowers (Table 4-3-2), we can see mainly medium- and large-scale producers. However, financing was also released for small- and mini-scale producers, when considered good producers, and who presented technical and economic feasibility projects. This financing was carried out through technical and document analysis of the applicant.
Irrigation Equipment	The most representative irrigation equipment were as follows: central-pivot, conventional equipment (semi-fixed sprinkler), and the self-propelled sprinkler. The equipment was defined according to the area topography and the crop to be irrigated; however, there was a preference for the central-pivot type. The conventional equipment and the self-propelled type were utilized, preferably, in coffee plantations and orchards. This equipment is also used for fertilization and application of agricultural pesticides.
Financing banks	Table 4.3.3 shows the number of contracts per bank. Bank of Brazil was responsible for 65% of the contracts. This is due to the fact that the Bank had experience and know-how as the main financing and agent of the Brazilian government in the agricultural sector, besides having the largest branch network in the Brazilian inland working with the agricultural sector.

Table 4.3.2 Number of PROFIR Contracts according to Producer Size

Producer	*No. of Contracts (%)*
Mini-small	77 (12.9)
Medium	217 (36.4)
Large	300 (50.3)
Others	2 (0.4)
Total	596 (100.0)

Table 4.3.3 Number of PROFIR Contracts according to Financing Bank

Producer	*No. of Contracts (%)*
Bank of Brazil	65%
BNCC	14%
CREDIREAL	11%
Others	10%
Total	100%

(2) Impact on the agricultural sector

1) Increase of irrigated area

The great merit of irrigation equipment introduction is to allow the realization of 2 to 2.5 crops per year in the same area, and to allow a higher guarantee of agricultural production during the whole year. With PROFIR-OECF financing, an estimated area of 30,000 ha (596 contracts x 50 ha) was irrigated. This represented 1% of the country's whole irrigated area (2.96 million ha) in 1991. Considering that the area irrigated through PROFIR-NATIONAL attained 70,000 ha (investment of US$ 252.4 million, out of which US$98.5 million were in the Cerrados region), in total approximately 100,000 ha of new irrigated areas were incorporated, attaining the program initial global target. The financed irrigation equipment was the sprinkling type, contributing to a more efficient use of water resources in comparison to the irrigation through ditches and inundation. Apart from this, the application of fertilizers and pesticides through water irrigation is also possible, allowing a better control and smaller losses. However, in most of the locations there was no electricity, thus the operational expenses were higher due to the use of diesel fuel.

2) Increase of agricultural productivity

The introduction of irrigation is a technology inductive factor. Apart from the more intense use of area, the assurance of water supply at the necessary time and in the necessary volume to the better development of crops stimulates producers to adopt the best available technologies, fostering production increase.

3) Increase of producer revenue

A survey showed that the average gross revenue of a producer jumped from US$389/ha to US$755/ha after the introduction of irrigation equipment. On the other hand, agricultural expenses increased from US$318/ha to US$592/ha due to the increase of production cost. Consequently, the net revenue of the producer increased significantly.

4) Increase of job opportunities

After the introduction of irrigation, what allows the almost continuous use of areas, is a considerable increase in the number of permanent jobs. At the same time, due to the increase of agricultural production volume and to the utilization of intensive manpower crops, especially at the seeding and harvest stages, the number of temporary jobs also increased.

4.4 RURAL ELECTRIFICATION PROJECT OF THE GOIÁS STATE

4.4.1 Background and history

The Rural Electrification Project of Goiás State was executed covering the Cerrados region of 200,000 km^2 (60% of the Goiás State territory). A higher priority was given to the southern part of the State, located in the Center-West Region of Brazil, with the objective of increasing the agricultural productivity through the increase of the rural electrification coverage. In concrete terms, the project aimed at the construction of electricity supply facilities expanding these services to the agricultural sector (especially expansion of electricity supply for irrigation equipment).

Rural Electrification Project of the Goiás State
General Aspects of the Project

Loaner: CELG – Electric Company of Goiás State

Executing Organization: CELG

Guarantor: Brazilian Government

Conclusion of Exchange of Notes: Nov. 1989

Signing the Financing Contract: Nov. 1991

Conclusion of Loan: Dec. 1997

Approved value: 12.832 billion yen.

Value of the released loan: 12.489 billion yen.

Procurement Conditions: general with purchase of equipment

Loan Conditions: interest rate of 4% per year (consulting expenses: 3.25%)

Repayment period: 25 years with 7 year grace period.

This project had the financial support of OECF (now JBIC). The OECF loan value (12.832 billion yen) represented the total foreign currency necessary for the acquisition of material and equipment. This project also aimed at offering an amount equivalent to almost half of the total resources for the global project called Electrification Project of Goiás State (1988~1992) calculated at 24.343 billion yen.

At the time, in 1990, while the electricity coverage rate in the urban area in Goiás State was 92.1%, the rate in the rural area was 31.8%. The percentage of rural workers in relation to the total number of workers in the State was 31.5% (IBGE, 1993), showing that agriculture was one of the most important economic activities of Goiás State. In order to increase the agricultural productivity, the installation of irrigation equipment is very important, but without electricity use is difficult. There

are farms that use diesel generators to produce their own electricity, but this increases their production cost.

4.4.2 Contents of the project

(1) Structure for execution

For project execution, a Work Group for the OECF Project directly connected to the board of directors and to the president of CELG was established, as shown in Figure 4.4.1. Apart from this, other groups such as the bidding group and technical analysis and approval groups were formed, both with 7 to 8 participants.

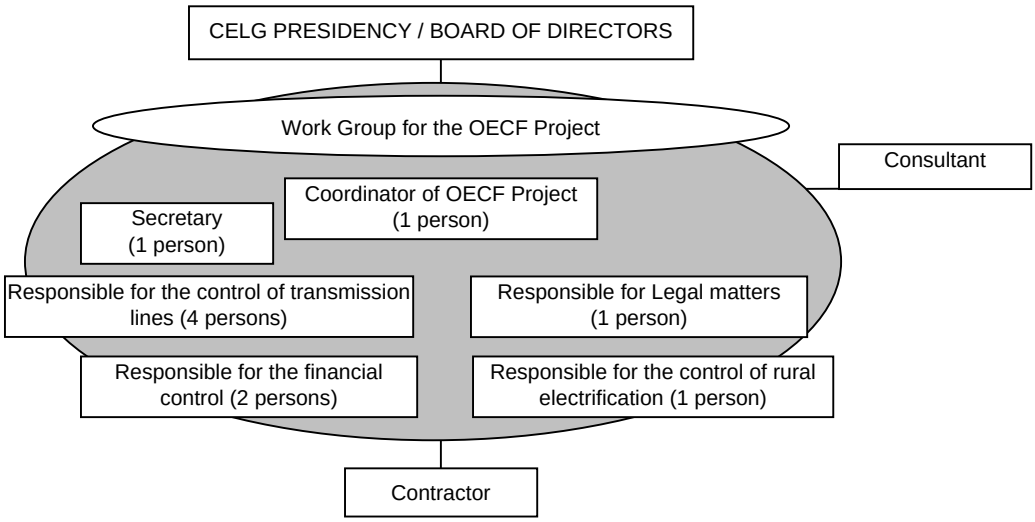


Fig. 4.4.1 Structure for the Execution of the Goiás State Rural Electrification Project by OECF

(2) Contents of the project

During the execution of this project (OECF) and of the Goiás State Electrification Project (*Master Plan*), two changes were made (one in April 1992 and the other in July 1995) due to the observed increase in electricity demand.

The first alteration in this project originated in the approximate 3 year time gap between the project analysis and exchange of diplomatic notes, and the start of execution, mainly due to internal problems in Brazil. In this period, the electricity demand in the State increased, thus a revision became necessary. The alteration in 1995 was motivated by the number of rural properties to be served by the project and by the expectation that the demand for electricity was going to increase at a fast pace due to the stabilization and growth of the country's economy.

Table 4.4.1 Comparison between the Planned and Realized Total Project Value, in Yen

Item	Planned		Realized		Difference	
	National	OECF	National	OECF	National	OECF
Equipment acquisition	12,787	9,047	24,216	7,806	11,429	-1,241
Civil works	6,276	1,512	9,835	3,705	3,559	2,193
Consulting services	1,217	1,217	1,855	0,978	0,638	-0,239
Control expenses	1,892	0	299	0	-1,593	0
Indemnification of land	0,067	0	0,038	0	-0,029	0
Reserve	2,104	1,056			-2,104	-1,056
Total	24,343	12,832	36,243	12,489	11,9	-0,343
Percentage of OECF resources		52%		34%		

Source: Data from OECF/CELG

4.4.3 Achievements and results of the project

In 1998, OECF (now JBIC) carried out an evaluation study about this project. The results, according to the evaluation report, are summarized below.

(1) Increase of the rural electrification coverage rate

As observed in Table 4.4.2, the rural electrification coverage rate increased 35 percent between 1990, before the project beginning, and its conclusion in 1997, jumping from 32% to 67%. This is extremely significant, considering that in the same period there were no other electrification projects in the coverage region; hence, the results are assumed to be exclusively due to that project implementation.

Table 4.4.2 Evolution of the rural electrification coverage rate in Goiás State

	1990	1991	1992	1993	1994	1995	1996	1997
Rate (%)	31.8	36.3	39.7	46.3	49.7	59.2	63.5	66.8

Source: CELG

(2) Development of the agricultural sector

Several factors contributed to the increase of agricultural productivity, including rural electrification in an indirect way. However, it is worthy to mention some highly significant indicators that measure the productivity increase during the project implementation years.

1) Increase of the irrigated area

In 1991, CELG provided electricity for 427 irrigation units (central-pivots). This number increased to 769 in December 1997, after the execution of the Rural Electrification Project of Goiás State. Consequently, the irrigated area in the Project coverage region greatly expanded.

Table 4.4.3 Evolution of Irrigated Area in the Coverage Region of the Rural Electrification Project of Goiás State

	1991	1992	1993	1994	1995	1996
Irrigated Area (ha)	38,162	46,829	54,607	62,066	68,71	70,767

Source: data from CELG

2) Increase of the agricultural production volume

Several factors influenced the increase of agricultural production such as expansion of planted area, climate, public policies, production planning by each producer, etc. However, we can say that electrification lowered the cost for operation of irrigation equipment (there is information that the diesel oil cost for the production of one ha of irrigated soybean was R$ 245, while the cost of electricity supplied by CELG for the same purpose was almost half, R$122/ha), and stimulated utilization of irrigated areas for 2 to 2.5 harvests a year, and substantially increased the agricultural production in the Goiás State.

In the livestock sector, there was also an increase in the production of milk and in the number of milking cows, as shown in Table 4.4.4. This has to do with the fact that electricity made the use of milk refrigerators in rural zone possible, allowing the temporary storage at the production site.

Table 4.4.4 Evolution of the Milk Production Volume and of the Number of Milking Cows in the Goiás State

Year	Number of Milking Cows	Production Volume (liters)
1990	2,340,950	1,071,966
1991	2,464,525	1,166,181
1992	2,550,140	1,276,464
1993	2,659,826	1,410,500
1994	2,636,546	1,409,351
1995	2,648,938	1,469,953

Source: Data from CELG

Table 4.4.5, shows the recent increase in the number of industrial refrigerators and cold chambers in the agro-industrial sector, as well as the increase of electricity consumption.

Table 4.4.5 Evolution of the Electricity Consumption in the Agro-Industrial Sector

Year	Industrial Refrigerators		Cold Chambers	
	Quantity	Energy consumption (Mwh)	Quantity	Energy consumption (Mwh)
1993	37	19,568	253	29,348
1994	41	31,074	267	47,664
1995	38	36,684	271	52,673
1996	42	51,098	279	52,617
1997	50	68,845	289	54,392

Source: Data from CELG