6

EMBRAPA: Institutional Building and Technological Innovations Required for Cerrado Agriculture

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Introduction

A solid and highly effective institution was considered to be essential to achieve the required innovations for the development of Cerrado agriculture. In this regard, the Brazilian Agricultural Research Corporation (EMBRAPA) was the key entity in the establishment of a strong innovation system for Cerrado agriculture. Therefore, this chapter first discusses the main principles that guided EMBRAPA and constituted the core of the 'EMBRAPA model' (Section 6.1). This aspect is important to show that EMBRAPA was ready for mature cooperation with the government of Japan through JICA, which will be discussed later. A summary of the EMBRAPA development process in terms of researchers and different types of expenditures follows (Section 6.2). The policy of Cerrado agriculture development is briefly explained in order to clarify the role that EMBRAPA has been expected to accomplish in this context. The government of Brazil chose to develop the Cerrado, and policies targeting this goal encompassed agriculture, infrastructure, research, universities (especially graduate programs), and rural and urban infrastructure. It was an all-inclusive regional development program (Section 6.3). The chapter goes on to discuss what kind of external cooperation would have been most effective for EMBRAPA to accomplish such a role, focusing on the most important issues that needed to be taken into account in formulating EMBRAPA's institution building plan (Section 6.4). To deepen this analysis, Section 6.5 distinguishes two types of external cooperation from an institution building perspective: a 'joining institutions' type and a specialized type. In this regard, the results of cooperation should

be assessed in terms of two aspects: (a) institution building by which the recipient institution becomes prepared to face present and future challenges; and (b) new technology developed through cooperation and its dissemination to farmers. From this perspective, distinctive characteristics of the EMBRAPA–Japan cooperation are discussed (Section 6.6). Finally, concluding remarks are presented (Section 6.7).

6.1 The ‘EMBRAPA model’ and its main principles

EMBRAPA's role is to be ready with answers to society's problems in the field of agriculture. As a research institution, EMBRAPA has to answer to society quickly, because without prompt answers, investments will not be forthcoming, or will soon be discontinued. Let us look into the fundamental principles that guided EMBRAPA's development.¹

For a research institute such as EMBRAPA to be successful, it should have an organizational model that is flexible and free from bureaucratic burdens. The organization must be free to formulate, adjust and manage its budget, to select its priorities and carry out research, and to formulate and administer its human resources policies; therefore, a public corporation model was chosen for EMBRAPA according to the laws of Brazil. EMBRAPA's geographical scope was to encompass all of the national territory, and it was to carry out research cooperation with other countries. Moreover, research requires competent researchers, and so it was necessary to provide appropriate training and to pay competitive wages. The institute's leadership needed to be at an international level. To be productive, researchers need libraries and up-to-date laboratories, both of which had to be integrated with advanced global research centers. The recruiting and promotion of researchers had to be according to merit, based on objective evaluations. It was essential to establish a research career path that challenged talent, rewarded good work, and offered the conditions for comprehensive dedication to research. In research, the scarcest resource is the researcher's time. Laboratories, libraries, and research support all have the role of multiplying the researcher's time. Bureaucracy exercises an opposite effect, and for this reason it had to be minimized. The units of research (research centers) needed to effectively explain themselves to researchers and society; they had to avoid the dispersion of efforts, and facilitate interaction among consumers, farmers, and agri-businesses.

To follow these principles, EMBRAPA established national centers, each of which took care of a limited number of previously established priorities. As a result, society, farmers, extension workers, and authorities

all knew which center took care of what products, such as soybeans, corn, rice, and beans, and which center was responsible for the Cerrado and advanced biology research. This model facilitated the evaluation of successes and failures, and helped farmers to discover the technologies and knowledge they wanted, and evaluations and promotions became connected to the productive life of the researcher.

The organizational lines of authority are well defined in EMBRAPA, and its directors are free to enforce the rules, without partisan or third-party interference. Research funding is drawn from the national treasury, and treasury and budget authorities had to be aware of the economic value of research relative to other investments. To communicate with the authorities, research institutions require economists with high-level training to establish communication channels in appropriate language, and the knowledge of research impacts is crucial to show how research investments rank with alternatives. Journalists are also very important in terms of building a positive institutional image, and so they are at the same level of importance as the researchers themselves, and require training and resources to develop their work. Researchers must have access to the international research community, and the research budget should finance international travel, joint projects with international scientists, and Internet use.

Research institutions do not grow without the support and respect of politicians, party leaders of different ideological shadings, consumers, and government authorities. Legislation should encourage partnerships for mutual benefit between public and private research, free from legal risk. Finally, partisan politics and ideologies cannot dictate research priorities, research methods, and the choice of members of the board of directors.

6.2 Development of EMBRAPA

The above provided a condensed discussion of EMBRAPA's fundamental principles, which this section rounds out with data on the size of its labor force, expenditures, how it covers Brazil geographically, and its international agreements.

EMBRAPA's labor force includes researchers and research support personnel. There are also several types of arrangement, of a short-term nature, aimed at training students and non-students, but only if they have recently graduated. The detailed data document researchers and research support personnel: those who have had long-term contracts with EMBRAPA. Although short-term personnel are very important for

EMBRAPA's work, their numbers fluctuate a great deal from month to month, and hence the discussion here concentrates on researchers and support employees.

We can divide the period from 1973 to 2010 into three sub-periods. In the 1973–1990 sub-period EMBRAPA expanded vigorously: its labor force grew continuously to reach a peak in 1990. Subsequently, there was a reduction in support personnel for two reasons: first, the administration chose more efficient methods to handle its support personnel; and second, as a consequence of the economic crises, expenses had to be cut; in order to keep researchers, there was no other way than to reduce the number of support employees. This difficult period lasted from 1990 to 2005, which constitutes the second sub-period; recovery then followed in the third sub-period, which continues to the present. As EMBRAPA responds to Brazil's technology needs, its growth will advance at a slower pace than in the past, according to new demands.

EMBRAPA's short-term personnel are mainly students from the agrarian science universities, and part of their training must be undertaken outside the university in research institutions or in the private sector. In the course of their training they carry out important work supervised by senior researchers. In 2010, there were a total of 2,970 trainees, of whom 355 were postgraduate students. In December 2010 EMBRAPA had 9,248 regular employees, and so the short-term personnel accounted for 32.1 percent, or about one-third of its labor force (under contract).

Regarding researchers and support personnel, Figure 6.1 illustrates the sub-periods noted above: vigorous grow of the labor force from 1973 to 1990; a severe cut in support personnel between 1990 and 2005, with minor growth in the number of researchers; and a period of recovery from 2006 to 2010, at a pace appropriate for a mature institution where growth keeps pace with new demands.

In 1973, when EMBRAPA was inaugurated, the agrarian science universities graduated professionals at the Bachelor of Sciences (BSc) level only, but EMBRAPA required people with Master's degrees and Ph.D.s, and so it developed a vigorous program, in Brazil and abroad, to graduate researchers at the Master's and Ph.D. levels. The program was so successful that a large majority of EMBRAPA researchers were Ph.D.s by December 2010. The EMBRAPA graduate program now takes care of post-doctoral training, because Brazilian universities offer high-quality training at the Master's and Ph.D. level. As the market supplies high-level trained professionals to EMBRAPA, or to any other institutions that wish to hire them, there is no reason for EMBRAPA to invest in post-graduate training, except in a limited number of cases.

Figure 6.1 Trends in the number of researchers, research support staff, and all employees of EMBRAPA

Source: Author.

Figure 6.2 Number of researchers by graduate qualifications: BS, Master's, and PhD

Source: Author.

In December 2010, EMBRAPA's labor force comprised 9,248 employees, split between 2,215 researchers (24 percent) and 7,033 research support personnel (76 percent). Of the researchers, 1,775 were Ph.D.s (80.1 percent), 421 had Master's degrees (19.0 percent), and 19 were at

the BS level (0.9 percent). The graphic shows that EMBRAPA's research staff are converging toward being Ph.D. only. Looking at these numbers, one can see the three sub-periods, the success of the training program, the cut in support personnel, and the preservation of researcher positions.

Figure 6.3 shows the yearly variation in the rate of EMBRAPA expenditures as a percentage of the GDP of the agriculture sector. The GDP share line traces the behavior of the actual rate over time. The other line shows an index rate equal to 1 percent, on the assumption that total expenditures on agricultural research as a share of the agricultural GDP should equal at least 1 percent. Since the data do not cover expenditures by state research institutions, federal universities and institutes, or private sector research organizations, this record shows Brazil to be in a favorable position. There was vigorous and continuous growth in EMBRAPA's expenditures in its first decade, from its beginning to 1982, which was followed by a strong fall in 1983 and 1984 due to macro-economic adjustments. EMBRAPA's expenditures as a share of agricultural GDP then began to move up again and exceeded the 1 percent mark in 1991. In 1992 the share dipped, then rose again to reach the peak of the series in 1996. It stayed above the 1 percent mark in the period from 1995 to 2001. Again due macro-economic adjustments, EMBRAPA's expenditures as a share of agricultural GDP fell until 2003, and then moved up again to exceed 1 percent in 2009 and 2010.

The data show that the government has tended to align the growth of EMBRAPA's budget to growth in the GDP of the agriculture sector. Dips in the level of expenditures were consequences of macro-economic

Figure 6.3 EMBRAPA expenditures as share of agricultural GDP

Source: Author.

adjustments, and EMBRAPA's budget cuts were much less severe than those of other public organizations. This is a clear indication of the importance that economic authorities in Brazil ascribe to EMBRAPA, in consideration of agricultural modernization.

The overall and item-wise trends in EMBRAPA's expenditures are shown in Figure 6.4, divided between employees (labor force; the second line from the top), capital costs (investments in capital items; the fourth line from the top), and operational expenditures (day-to-day expenditures in support of research work; the third line from the top). Overall expenditures correspond to the 'Total' line in the figure (first line). The shape of this line is quite similar to that showing expenditures as a share of agricultural GDP (Figure 6.3), which is an additional argument in favor of the thesis that Brazil's federal government is sensitive to growth in the agriculture sector in allocating resources to EMBRAPA.

As already noted, budget cuts did not touch researchers, and there were small increases in their numbers during the period of reduced budgets. This came at the expense of resources for capital and operational expenditures, reducing EMBRAPA's ability to carry out research. In some years, labor force expenditures came dangerously close to total expenditures. Recent government efforts, mainly from 2002 onward, have been devoted to overcoming this weakness in EMBRAPA's budget.

EMBRAPA is now the leader of the Ministry of Agriculture's agricultural research system, with headquarters in Brasilia, 43 national

Figure 6.4 Trends in total and item-wise EMBRAPA expenditures

Source: Author.

research centers covering all areas of the nation, and 4 services units, for a total of 47 organizational units. In addition to these, there are 14 business offices. Outside Brazil, there are 5 virtual laboratories (Labex), in the United States, Europe, and Asia, and 6 foreign offices, in Ghana, Mozambique, Mali, Senegal, Venezuela, and Panama. There are 17 state organizations associated with EMBRAPA, with research and extension mandates, and there are frequent partnerships with federal, state and private universities, NGOs, and private organizations, some of them multinationals.

6.3 Policies to develop Cerrado agriculture and the role of EMBRAPA

The Cerrado accounts for 25 percent of the area of Brazil, and is mainly found in the Central-West region. Up to the 1960s extensive cattle ranching was the dominant activity in the context of an underdeveloped agriculture. The soil is poor and acid, and spells of drought in the rainy season are main risks facing the production of grain. The conquest of the Cerrado by modern agriculture is one of the most important achievements of agrarian sciences. It is not the objective of this section to report the complete history of modern Cerrado agriculture, but to note some facts that are relevant to Japan-Brazil agricultural research cooperation in the Cerrado.

With the inauguration of Brasília in 1960, the federal government undertook the construction of a railroad and road grid linking the capital to the main cities of the Southern, Southeastern, Northeastern, and Northern regions. It built airports and a communications infrastructure. The federal government also created a very large program of credit to support the improvement of the Cerrado's soil and the development of modern agriculture. Population density was very low in the Cerrado, which was an advantage for farmer migration from the Southern and Southeastern regions. Compared to the local gentry, the migrants were much more advanced in terms of modern agricultural knowledge. They sold their smallholdings, bought larger areas, and settled them using modern agricultural techniques. Few among the local population 'moved up' to become modern farmers. Modern agricultural knowledge and an inclination to take risks motivated the migrants to search for advanced technologies in research centers and to take advantage of subsidized credit to support their work. The Cerrado is thus a typical case of agricultural development promoted by farmers from more advanced agromonic culture, rather than the local population, and this is a point that

cannot be overlooked in dealing with Africa. In this process, the local population benefitted from technology and experiences of those newly settled farmers.

Cerrado research ranked high as a research priority of EMBRAPA, and still does so. EMBRAPA established important research centers in the Central-West region: in Brasília, the Cerrado Agricultural Research Center (CPAC; specific to the Cerrado), the National Vegetable Research Center, the National Genetic Resource and Biotechnology Research Center, and the headquarters of EMBRAPA; outside Brasília, the Rice and Bean National Research Center in Goiânia, and the Beef Cattle National Research Center in Campo Grande (MS). The Corn and Sorghum National Research Center is outside the Central-West region, but within the Cerrado, in Sete Lagoas (MG). The Soybean National Research Center played a very important role in developing soybean varieties adapted to low latitudes such as the Brazilian Cerrado, and without them, the development of the Cerrado soybean crop would not have occurred. New wheat varieties adapted to the Cerrado also played an important role. The national research centers for soybeans and wheat are in the Southern region, in Londrina (PA), and Passo Fundo (RS), respectively. The Dairy Cattle National Research Center, located in Juiz de Fora (MG), is also investing resources in improving milk production in the Cerrado. Moreover, the federal government established universities and Master's and Ph.D. programs in all the states in the Central-West region: Federal District, GO, TO, MG, and MS. It provided research incentives to universities and research institutes to find solutions to problems of the Cerrado, and hence a strong and diversified research network was created and developed in the Cerrado region.

Collaborations with Japan, the United States, France, the World Bank, and the Inter-American Development Bank were very important, as well as with the International Centers within the orbit of the CGIAR. The development of the Cerrado is a case of success in international cooperation: between governments, research institutions, universities, and international centers. But the Japanese cooperation was unique in the sense of institution building: of joining the researchers and resources of the two countries to develop a particular region. It was a case of cooperation where the two sides worked together with the same objectives.

In the 1970s, high grain and meat prices were instrumental in the take-off of the Cerrado program. When prices fell, the development of the Cerrado was firmly on the way, without any chance of retreating.

6.4 EMBRAPA's challenges and the expected role of external cooperation

This is the context in which international cooperation between EMBRAPA and multilateral and bilateral agencies was carried out. The most relevant question here is when and how external cooperation can be said to succeed, which can be answered as follows.

- (1) The recipient institution becomes prepared to face the challenges of its mandate, and learns to discover upcoming problems and how to solve them.
- (2) At the end of the cooperation, the recipient institution learns to stand on its own feet.
- (3) The external and recipient institutions both gain by working together.

Before the start of external cooperation it is important to understand the problems of the recipient institution. The following points must be looked at in formulating an institution building plan.

- ❖ (1) The bottlenecks in the way of the external cooperation: these can include a lack of counterpart funds, and problems of legal and cultural origin.
- (2) The goals of the institution.
- (3) The problems of the institution, its challenges, and its capacity to face them.
- (4) The conceptual basis of the institution, and how compatible this conceptual basis is with its goals.
- (5) The organizational model; how flexible it is, and how it adheres to the goals of the institution.
- (6) The flexibility to manage the budget and to reallocate it to new demands.
- (7) The flexibility to manage personnel, and identification of legal and bureaucratic restrictions.
- (8) The researcher career path, the flexibility to model it, and competitive wages and compensation.
- (9) In hiring, are equal rights guaranteed to those who apply for positions, and are selections based on merit? Are lack of merit and wrongdoing used to justify dismissals?
- (10) The ability to communicate with society at large, and its relationship with the media and its clients.

- (11) The capacity to establish research priorities.
- (12) The capacity to formulate a research program, considering budget restrictions, and the authority to carry it out.
- (13) The competence to evaluate itself, to estimate the returns on its investments, and to communicate its results to society, authorities, and important leaders.
- (14) The capacity to convince government and the private sector to maintain and to increase its budget.
- (15) The ability to relate to the world of politics based on the principles of mutual respect and independence.
- (16) Hiring and promotions reward competence and loyalty to the institution.
- (17) The selection of managers for research units rewards merit and managerial competence.
- (18) The competence to relate to international research institutions, universities, and the private sector.
- (19) The potential to retain outstanding researchers on the staff.
- (20) Physical infrastructure: buildings, laboratories, experimental fields, etc.

In this regard, the concept of institution building is considered to be particularly important. We distinguish two different concepts: Institution building refers to a set of actions that are performed to change the structure of an organization, or to add to its capacity to do more of the same things in the same way. One example of the latter case is when laboratory equipment is supplied by a donor country.

In the first case, there may be changes in the organizational model, in the processes of setting priorities, planning, executing research plans, conducting evaluations, and diffusing research results. It may involve setting researcher career paths, promotions, and wages so as to reward competent work and to stimulate talented researchers. It may be necessary to strengthen the capacity of the organization to communicate with budget authorities, and with executive and legislative powers, or it may be a case of improving communications with the media at the local, regional, and national levels. The relationship with private research or with international institutions may need attention, or infrastructure may be lacking or require reforms. Which of these items receive attention depends on the nature of the problem, on the recipient institution, and on the amount of money that will be invested in the cooperation. An extreme case would be one involving an all-encompassing change by which a new institution emerges, and this was the case with EMBRAPA.² Such extreme cases are

rare: it is more common to change selected points in the structure of an organization. One interesting case is to center the cooperation in a few research units, and to focus it within a region. The JICA-EMBRAPA cooperation focused on the Cerrado and was concentrated in a few EMBRAPA research units and state research and extension organizations.

In the second case noted above, human or financial resources are provided to enhance the capacity of an organization to do more of the same things in the same way: the structure of the organization is not changed. This is weaker type of institution building, which involves enlarging the capacity of an institution to do research, without changing its quality. In the real world, the two types are present at the same time. If the institution is mature, more weight will be placed on the second case; however, the first case is more common.

In every institution, small changes are always occurring, and they may be positive or negative in character. However, by 'institution building' we mean purposeful changes designed to improve the organization, and they are visible and sizable. Institution building may exist with or without external cooperation; for instance, the decision to transform National Agricultural Research Department (DNPEA) into EMBRAPA belonged exclusively to Brazil. After its inauguration, EMBRAPA sought technical and financial assistance from many places: international banks, other countries, research institutions, universities in Brazil and abroad, and Brazilian financial institutions, via Studies and Project Finance Organizations (FINEPs).

6.5 Types of external cooperation from an institution building perspective

Two types of external cooperation can be distinguished, as detailed below.

(a) *Joining institutions*

The cooperation agency (country, institution, etc.) sends staff that join the staff of the recipient organization under its rules of administration. Specialized coordination may exist to facilitate communication between foreigners and local nationals, and among the foreigners themselves. From that point on, all activities are jointly planned and carried out: as if there were an informal merging of the agencies into a unique institution for the purpose of the objectives of the cooperation project. The results of the joint work belong to both parties: it makes no sense to try to separate them. There

are many spillover effects from one party to the other, which work against splitting the outcomes of the project.

Cooperation encompasses external and internal funds: the counterpart funds. In general, the research program is carried out in the recipient country; if convenient, part of it can be performed in the donor country, or even in third countries. The training program may be carried out in the recipient or in the donor country; the latter applies, in general, to graduate training. For the acquisition of laboratory and other types of equipment, the donor part of the budget may be imported, and part may be acquired locally. The cooperation program may concentrate on research, or it may move up a step further to take care of technology transfers or even investments that facilitate the adoption of technology by farmers, such as electricity and irrigation. If the cooperation succeeds, its benefits extend far beyond the end of the agreement. There are also spillover effects into regions not included in the original agreement. A careful evaluation of the project requires looking into its results at the end of the agreement and also far ahead in time, in the defined region and in other regions that may have partaken of the benefits. There are two types of result: institutional development, by which the recipient institution becomes prepared to face present and future challenges; and research results. They are designed to solve farmers' problems and to modernize agriculture. Therefore, the evaluation of the project cannot overlook institutional development, the new technology it helped to develop, and the adoption of such technology by farmers. The JICA-EMBRAPA project exemplifies the joint type of cooperation, from which EMBRAPA, the Cerrado, and Brazil all profited.³

(b) Specialized cooperation

Most external cooperation is specialized in themes, and does not join, in an informal way, two institutions for the purpose of carrying out the terms of an agreement. It may be a case in which a foreign university opens its doors to receive graduate students, and the program expenses may be paid by a grant from the donor country, by the recipient country, or by a loan from international banks. At its own cost, the donor country may send scientists to deal with specific problems of the recipient institution, and the technical assistance that follows may be of a short- or long-term nature. There may be an agreement between two countries according to which the developing country can post a group of senior scientists to the developed country to work with counterpart scientists, under the umbrella of

specific organizations. This is the case of the Brazilian Labex experience, which can address research problems of mutual interest to the two countries. However, an agreement may not directly involve monetary expenditures: for instance, when two institutions, one in the developing country and the other in the developed country, open their doors to allow the exchange of experience among scientists via the Internet and other means of communication.

External cooperation of both types has been very important to the development of EMBRAPA and in particular to the development of research for the Cerrado. Of particular significance have been the Japanese, American, and French cooperation, that of the International Centers revolving around CGIAR, and that of international banks, the World Bank and IDB. Except for the Japanese experience, all of these were of the specialized type, in the sense that they emphasized themes and did not join with EMBRAPA in Brazil to solve a set of research problems.

6.6 Distinctive characteristics of the EMBRAPA–Japan cooperation and its results

Up to 1970 the expansion of agriculture took place in regions where the existing knowledge of agricultural practice could be applied, if necessary with few modifications, but at the beginning of the 1970s most of that type of land had been explored. The Cerrado and the Amazon region were the choices for expanding agriculture, and traditional knowledge and technology would have failed there. Hence, at that time, the expansion of agriculture required investments in science and technology: facts well understood by the Brazilian government.

At the same time, the supply of food lagged behind the growth of demand, and consequently a severe food crisis emerged in the cities. Furthermore, the country needed to increase its exports to pay international debts brought about by industrialization policies. To increase food exports, for which the international prospects were excellent, the country needed to increase its surplus over domestic consumption. Thus, domestic consumption and food for export pointed to the importance of expanding agricultural production, and traditional technology was powerless to reach that goal. Importing the technology of the advanced countries would have failed, too, because technology is locally specific. The solution was to invest heavily in the generation of knowledge, which resulted in the creation of EMBRAPA, inaugurated on April 26, 1973 (Alves, 2012).

Soon after the inauguration of EMBRAPA, its leadership understood the need to shorten the road to results, because of the strong pressure from society and the government. No other way existed than to use the knowledge of agrarian science accumulated in the developed countries to generate technology useful for Brazilian agriculture. Fortunately, EMBRAPA found the doors open for this type of cooperation. Developed countries, their universities, research institutes, and the international banks understood the importance of developing Brazilian agriculture and signed cooperation agreements. In the case of the Cerrado, however, EMBRAPA saw the need for a different type of cooperation that would go far beyond the specialized type of institution building into the informal merging of two institutions, one of which would be EMBRAPA and the other a foreign institution that would jointly work in Brazil to develop technology for the region. The government and EMBRAPA understood that the best choice was Japanese cooperation; this cooperation was requested by the Brazilian government soon after EMBRAPA's inauguration in 1973, and the technical cooperation started in 1977. The reasons for choosing Japanese cooperation were as follows.

- (a) Technical assistance should consider research, extension, and financial resources to develop the Cerrado. It should extend beyond the development of research, and institutional building must incorporate those activities, and JICA was willing to do this.
- (b) Japanese research was very strong in agrarian science: in land saving technology, in irrigation, and in the development of small-scale equipment and machinery for the mechanization of agriculture.
- (c) Japan was a major importer of food and its imports were rising.
- (d) Japan wanted to diversify the sources of its food supply, and Brazil offered good prospects.
- (e) The Japanese-Brazilian population (including their descendants) was large enough to facilitate the lives of Japanese researchers and professionals in Brazil.
- (f) JICA's model of work and of technical assistance was flexible to the point of meeting EMBRAPA's expectations of joint work.
- (g) Agrarian sciences were well developed in some Japanese universities, which was an important point for the EMBRAPA training program.
- (h) Japanese industry was very advanced in producing top research equipment. The government of Japan agreed to provide funds for the acquisition of research equipment. They allowed researchers to ask new questions and answered them without loss of time, therefore saving EMBRAPA's scarcest resource: researcher time.

- (i) EMBRAPA was a mature institution, well integrated in the development policies of the Brazilian government, and conscious of its role to develop Brazilian agriculture, of its weaknesses, and of the need for technical assistance.
- (j) Finally, JICA expressed its willingness and demonstrated its readiness to sign an agreement to experiment in an all-inclusive program of technical assistance to develop the Cerrado.

The Brazil-Japan cooperation embraced research, extension, rural credit, and investments in electrification and irrigation. The details will not be covered here, since there is an excellent report that explains the concept of the project and how it was carried out, and evaluates the results.⁴

The strongest points of Japanese cooperation from the standpoint of institution building were: the group of outstanding researchers and dedicated assistants that came to EMBRAPA, and formed a harmonious group with EMBRAPA researchers to carry out the research program; the training program in Japanese universities; the top-quality laboratory equipment that saved much researcher time and extended the questions that could not be previously answered; the support for extension work, research on the environment, soils, plants, animal diseases and insect control, and plant breeding; the work with research and extension organizations in MG, BA, MT and GO; and rural credit, electrification and irrigation financing. Most of all, thanks to the Japanese cooperation, EMBRAPA research units greatly improved their ability to answer the problems of the Cerrado.

The Cerrado Agricultural Research Center (CPAC, Centro de Pesquisa Agropecuária dos Cerrados) owes much of what it has achieved to the Japanese cooperation. The cooperation was also important for the development of other researchers units, such as the Soybean Center (Centro Nacional de Pesquisa de Soja), Vegetable Center (Centro Nacional de Pesquisas de Hortaliças), and Cenargen (Centro Nacional de Recursos Genéticos e Biotecnologia).

Clearly, not all the success of the project can be attributed to the Japanese cooperation, but the joint project was fundamental in developing EMBRAPA's research capacity, and the technology generated by EMBRAPA paved the way for the growth of production in the Cerrado.⁵

6.7 Concluding remarks

Japanese cooperation has been very useful to EMBRAPA development. It helped to build Cerrado research, and the research results contributed

to the development of agriculture in the region. In terms of the total Cerrado share of the national population and land area, Cerrado agriculture has performed very well. Since the data indicate a pattern of development largely based on productivity improvement, it is clear that new technology was the main driving force of development. Moreover, the increase in yields saved land. In this sense, the development of the Cerrado has been friendly to the environment (Martha et al., 2012).

The full impact of Japanese cooperation had much to do with the CPAC. Under the joint leadership of CPAC-JICA, the cooperation extended to other EMBRAPA units and state research organizations. It succeeded in generating the technology needed to modernize agriculture and is an excellent example of institution building, by which two countries join human and financial resources, focused on one research unit and on a specific region – the Cerrado – under a unified command. Japanese cooperation was all-inclusive: it dealt with EMBRAPA institution building; it joined Brazil in creating the implementation body CAMPO, and this company was instrumental in extension work and in settlement projects. JICA financed electrification and irrigation programs. The fact that the program encompassed all the activities required to achieve the development goals – research, extension, implementation of settlement projects, electrification, and irrigation financing – explains its successes.

One important point attracts attention: the two countries were ready to cooperate; Brazil needed to expand its agricultural output with the minimum impact on the area under cultivation, and Japan wanted to diversify its imports. The Japanese style of cooperation and expertise recognized the importance of institution building. As a consequence of the joint work, EMBRAPA is now competent to face new challenges; it has learned more in order to solve problems by itself; and both JICA and EMBRAPA have experienced immense gains.

Notes

1. This section is based on Alves (2012).
2. Up to 1973, there was a research institution in the Ministry of Agriculture (now MAPA): the National Agricultural Research Department (DNPEA). The government decided to subject it to an all-encompassing reform program, from the organizational model to planning and executing research and technology diffusion. This reform created EMBRAPA.
3. In this spirit, at beginning of the 1960s, Purdue and the Federal University of Viçosa signed an agreement to develop a graduate program, which was financed by USAID and the Ford Foundation, and was extended to other universities.

4. MAPA and JICA (2002) *Japan–Brazil Agricultural Development Cooperation Programs in the Cerrado Region of Brazil: Joint Evaluation Study* (Brasília and Tokyo: MAPA and JICA).
5. What the author can do beyond a report from the vantage point of 2011 is to confirm the real success of the cooperation in institution building and to add indirect evidence about the growth of Cerrado agriculture, which exceeds that of Brazil as a whole in the case of grains, tomatoes, and beef and dairy cattle, and which has had good performance in carrots and potatoes, as representatives of vegetable crops.

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