AGRICULTURAL HIGHER EDUCATION IN BRAZIL

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by

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PREFACE

The field studies in Brazil undertaken for the preparation of this report began in late 1986 when a field team visited the Federal University of Ceara in Fortaleza. That visit was followed in April 1987 with a team study of the Federal University of Vicosa in Minas Gerais. At the same time, a small team paid a brief visit to the Luis de Queiroz Agriculture College of the University of Sao Paulo in Piracicaba. There was also a short follow-up visit to Ceara.

In 1987, a two-person team spent over a week in Brasilia interviewing Government officials about the history and impact of the projects of the Agency for International Development (A.I.D.) and also about the institutional developments that occurred during and after the projects. Finally, in 1988, the author visited the Federal University of Rio Grande do Sul for a brief visit.

As in any project of this sort, the investigators collected a large number of documents that were read and analyzed as part of the research. In addition, a number of key U.S. participants in the projects were interviewed.

SUMMARY

Agency for International Development (A.I.D.) assistance for agricultural higher education in Brazil began in 1963 and lasted until 1978. During the first 10 years, four agricultural colleges (part of larger universities) in different regions of the country received technical support, equipment and library materials, and advanced participant training in the United States with the primary purpose of establishing postgraduate programs in agriculture. In 1973, the focus of the project was broadened to include more institutions and to encourage Brazilian universities to collaborate with each other.

The postgraduate programs established with A.I.D. assistance are viable, self-sustaining programs. Several thousand students have earned M.S. degrees, and several hundred have earned Ph.D. degrees, in agriculture, veterinary science, and related fields. The graduates of these programs went on to found a number of additional undergraduate and graduate programs in agriculture in over 50 different universities. The programs also helped to establish research activities in the agricultural colleges.

Because of the rapid growth in university enrollments, increasingly large classes and many unprepared students have eroded some of the advances made by the agricultural colleges. The colleges are hard pressed to provide adequate space, facilities, and the instruction and other experiences necessary to train good agronomists and other agricultural specialists.

The A.I.D. projects had the objectives of enhancing the role of research in the universities in order to increase agricultural output, raising the income of farmers, and reducing rural-urban migration. While some gains were made, the prevailing model of Brazilian development has channeled most resources and creativity into raising the output of major export crops such as soybeans, sugarcane, and coffee. These crops do not benefit the poor so much as they do large-scale planters.

While the agricultural colleges grew and benefited from the A.I.D. projects, many observers felt that some of the colleges' vitality was taken away in 1972, when the Brazilian Corporation for Agricultural Research (EMBRAPA) was founded. EMBRAPA drew personnel and resources away from the universities into its own well-equipped centers. Its superb organization and good funding levels have allowed it to thrive, to some extent at the expense of the universities.

Finally, economic and political turbulence over the past decade or more have had an adverse impact on the universities. Working conditions and salaries have deteriorated because of a crisis in public funding. Political repression and, more recently, politicization within the universities have contributed to this deterioration. These factors have led many scientists to seek other employment, and an increasing number are leaving the country. If these conditions prevail for long, the result could be a serious setback for the universities and their role in the development of science and technology for Brazil.

Insert Map of Brazil

GLOSSARY

ABEAS	-	Brazilian Association for Higher Education in Agriculture
A.I.D.	-	Agency for International Development
ARDO	-	Agricultural Research and Development Office (USAID)
CAPES	-	Agency for Personnel Development in Higher Education
CENARAGEN	-	National Center for Plant Genetics and Biotechnology
CIBRAZEM	-	Brazilian Grain Storage Company
CNPq	-	National Council for Scientific and Technological Research
EMATER	-	Technical Assistance Agency (state level)
EMBRAPA	-	Brazilian Corporation for Agricultural Research
ESAL	-	Agriculture College of Lavras, Minas Gerais
ESALQ	-	Luis de Queiroz Agriculture College, Piracicaba
FUFMT	-	Federal University of Mato Grosso
IDB	-	Inter-American Development Bank
MEC	-	Ministry of Education and Culture (now Ministry of Education)
PEAS	-	Higher Education in Agriculture Project
PETROBRAS	-	Brazilian Petroleum Company
SUDENE	-	Superintendency for the Development of the Northeast
UFCe	-	Federal University of Ceara

UFMG	-	Federal University of Minas Gerais, Belo Horizonte
UFPb	-	Federal University of Paraiba
UFPel	-	Federal University of Pelotas, Rio Grande do Sul
UFPR	-	Federal University of Parana
UFRPe	-	Federal Rural University of Pernambuco
UFRRJ	-	Federal Rural University of Rio de Janeiro
UFRS	-	Federal University of Rio Grande do Sul, Porto Alegre
UFV	-	Federal University of Vicosa
UnB	-	University of Brasilia
UNICAMP	-	University of Campinas (Sao Paulo)
USAID	-	A.I.D. Country Mission
USP	-	University of Sao Paulo

1. THE ROLE OF THE AGENCY FOR INTERNATIONAL DEVELOPMENT IN AGRICULTURAL HIGHER EDUCATION IN BRAZIL

1.1 The Program Design

In the early 1960s, Brazil was targeted as a major recipient of U.S. development assistance. The principal focus of this assistance was human capital development in areas important to Brazil's development, including agriculture, basic and higher education, health, manufacturing, and public administration.

The decision to develop a program of assistance to higher education in agriculture was make in 1961. The Ministry of Education and Culture (MEC) held preliminary discussions with administrators at various universities. The Agency for International Development (A.I.D.) then designed a program to develop postgraduate training and research programs that could contribute directly to agricultural development in Brazil by developing and disseminating technology. The broader goals were to improve the quality of life and the economy of Brazil and, in particular, to develop a strong, productive agricultural base. One project document (Matlock and Smith 1975) described the goal of the project as follows:

> To contribute to the improvement of the agricultural economy and quality of life of rural people in Brazil by helping to build a strong, balanced agricultural school. Operating on a philosophy similar to that of the U.S. land-grant system, such an institution could produce well-educated professionals to serve in agricultural enterprises or extension, perform research to solve the many problems of the region's agriculture, and eventually develop the capacity to train new research scientists at the postgraduate level. The means used to carry out the objective were (1) advanced training for professors of the School of Agriculture, (2) purchase of laboratory and farm equipment, teaching materials, and books, and (3) technical assistance by American specialists in planning and execution of research, teaching, and extension activities (P. 3).

The model for the A.I.D. program was the U.S. land-grant university, and would combine teaching, research, and rural extension to attack basic problems in agriculture in each of four regions. There would be little involvement with undergraduate training.

The basic design of the project was to pair each Brazilian institution with one in the United States. The U.S. institution would send visiting faculty as consultants to the Brazilian

institution. Each consultant would be assigned a Brazilian counterpart, and jointly they would set up research programs and begin building postgraduate programs and extension programs in the agricultural sciences.

In each host institution, programs would be set up appropriate to the needs of the institution and its region. Scientific equipment, specialized farm equipment, and library books and journals were provided for in the project agreement. In addition, U.S. and Brazilian faculty would identify candidates for postgraduate study in the United States, and fellowship support would be provided for these students. Most of these candidates would be nominated from among recent graduates and junior faculty members at the host institution.

1.2 Selection of Institutions

In 1962, after this program had been designed, Earl Butz, then dean of the agriculture school at Purdue University, led a bilateral committee on an extended tour of Brazilian institutions to select those that would be involved in the project. This committee, composed of leading U.S. and Brazilian agricultural scientists and university administrators, sought to include universities in different regions in order to provide some coverage to most of the country. It sought out institutions where there was already some orientation to research and where there was at least a core of faculty on full-time contracts.

Four Brazilian public universities were selected to participate in the project, and each was paired with an American institution located in a state that, presumably, shared some characteristics with the host state. The following pairs were selected.

Brazilian Institution	U.S. Institution
Federal University of Ceara	University of Arizona
Federal University of Vicosa	Purdue University
Luis de Queiroz Agriculture College, University of Sao Paulo	Ohio State University
Federal University of Rio Grande do Sul	University of Wisconsin

The specific factors that influenced the selection of particular institutions in Brazil varied from case to case. Ceara, founded in 1918, had the oldest and most established agriculture school in Brazil's Northeast. This region is

characterized by extreme poverty and uneven distribution of income; farming there consists of small-scale subsistence production and technologically backward cotton production. Ceara is located in a drought-prone, semiarid state, so pairing it with the University of Arizona, located in an arid region of the United States, seemed logical.

The University of Vicosa had previous ties to Purdue University and to the U.S. land-grant system. Far from any city, it is located in a small town in the rolling hills of the State of Minas Gerais. This is a mixed farming region with a moderately skewed distribution of income.

The University of Sao Paulo (USP) is an entirely state-supported system. The Luis de Queiroz Agriculture College (ESALQ), which is part of USP, is located in Piracicaba, a prosperous regional center 180 kilometers from the state capital. When the A.I.D. program began, the ESALQ faculty was already involved in research, and plans were already under way to begin postgraduate programs. The structure of the school, and its primary ties, were more oriented toward Europe than to the United States, and the State of Sao Paulo was already the leading agricultural producer in Brazil.

The link between the Federal University of Rio Grande do Sul (UFRS) and the University of Wisconsin predated the A.I.D. program; there had been a past exchange of faculty between these two institutions. UFRS is located in the capital city of Porto Alegre in a state that was heavily settled by European immigrants and in which the distribution of income is relatively even. A university in Wisconsin, which has a tradition as a dairying State, was seen as a good match with one in the State of Rio Grande do Sul although the latter is primarily a grain and beef-cattle producer. Curiously, little or no emphasis on dairy or dairy products occurred in the joint program between the two institutions.

There were many differences among the four institutions. Sao Paulo and Vicosa were the most advanced institutions of the four, especially with regard to research and the incipient development of postgraduate programs. As has been mentioned, Sao Paulo had a system oriented along the lines of a European university while Vicosa was built on a model of a U.S. land-grant university. Vicosa had a few U.S. Ph.D.s on its faculty, and Sao Paulo had a number of faculty members with doctorates from Great Britain and Germany. The region in which Sao Paulo is located was economically more dynamic; Vicosa is located in an area of traditional agriculture, less affected by industrialization.

Ceara and Rio Grande do Sul had almost no tradition of research and no plans to begin postgraduate programs before the A.I.D. program began. Rio Grande do Sul was relatively less advanced, academically speaking, than Vicosa and Sao Paulo, although individual faculty members already had ties to U.S. or European institutions.

1.3 The Four University Subprojects: 1963-1973

The initial four university subprojects were implemented in a decentralized fashion. The Ceara project was partly administered through a special USAID Mission office in Recife serving the Northeast, and the other projects were served by the Rio de Janeiro office of USAID. The project was coordinated first from Rio de Janeiro, then Brasilia, through A.I.D.'s Agricultural Research and Development Office (ARDO). The primary control was in the hands of the project directors at each of the four U.S. institutions. These administrators assessed the needs of the host institutions, recruited and trained consultants to be sent to Brazil, programmed their tours, and made travel and other arrangements, and evaluated the progress of the project. They also helped to select the Brazilian candidates for training in the United States and provided them with support and guidance during their postgraduate training. Each project director had at his home campus a small support staff whose work was quite important to the smooth functioning of each project.

The consultants sent to the four subprojects were mostly faculty members from the four U.S. universities, but not all were regular line faculty assigned to academic departments. Some schools sent advanced postgraduate students who completed their studies while working for the project. Some visitors were extension staff who served as crop specialists, soil scientists, and so forth in Brazil.

The consultants who stayed for a year or more are remembered best and appear to have had the greatest impact. Short-term consultants were generally judged to be not as effective, although, in a few cases, their contribution was important because they provided some crucial training or orientation on a specific technical subject. This was particularly true of the technicians who came to orient Brazilians in the use of specialized laboratory equipment.

From the standpoint of the Brazilians, the relatively exclusive relationship with a single U.S. institution had both advantages and disadvantages. While the U.S. universities were permitted to use consultants from outside their universities, in

practice, nearly all the consultants were recruited from within the university system. In some cases, the Brazilians felt that they were not receiving the best, most up-to-date and experienced consultants in particular fields (see Alves and Yeganiantz 1984, 154-155).

In some cases, the Brazilians felt that the school they had been paired with might not offer the best possible postgraduate training in a particular field needed at their university. However, of those who went to the United States to study, few had had any previous experience in the United States, and they were able to find their way much more easily on campuses where other colleagues from the same institution were studying or had studied earlier.

In several cases, relationships formed between U.S. and Brazilian scientists endured far longer than the project, some to this day. Perhaps the most successful institutional relationship was that between Purdue and Vicosa. The Vicosa faculty feel that Purdue sent highly qualified visitors. Several stayed for 2, 4, or even 6 years and were made quite comfortable in Vicosa. The Brazilians who went to Purdue for postgraduate study felt well received by the Americans.

1.4 The Higher Education in Agriculture Project: 1973-1978

The original MEC/USAID agreement covered the years 1963 to 1968; it was then renewed for a 5-year term, and expired in December 1973. In January 1974, a new agreement was signed that created a new program for higher education in agriculture in Brazil, the Higher Education in Agriculture Program (PEAS). This project was the responsibility of a single U.S. contractor, Michigan State University. The other U.S. schools no longer played a formal role in institution building. One Brazilian and one U.S. administrator were codirectors of PEAS.

The four Brazilian universities that had participated in the earlier program continued as primary clients of PEAS, and many faculty members from these schools were trained in the United States (Table 1). However, PEAS permitted training at U.S. institutions other than the four original universities, and many Brazilians availed themselves of that opportunity.

Table 1. Degrees Awarded Under PEAS, 1973-1978

Degree Program	In Brazil	Abroad	Total
Ph.D.	75	173	248
M.S.	372	27	399
Specialization	74	71	145

Unlike the earlier program, which had been financed with a grant, PEAS was financed with a loan (US$7.6 million) matched by a Government of Brazil contribution ($8.3 million). PEAS was also different in that it was centrally administered by the Agriculture Office of the Department of University Affairs in the Ministry of Agriculture in Brasilia.

The objectives of PEAS were to expand and improve postgraduate programs in agriculture and to improve central planning and management in the Ministry of Education and the universities. The program began in 1973 with projects at Vicosa (UFV) and Sao Paulo. Later, it was expanded to include four more Brazilian universities with postgraduate programs: the federal universities at Minas Gerais, Ceara, Rio de Janeiro, and Rio Grande do Sul, and six more with undergraduate-only programs: Para, Mato Grosso, Paraiba, Pernambuco, Bahia, and Parana.

PEAS continued to support postgraduate study in the United States, but increasingly, as postgraduate programs were begun in Brazil, it also supported postgraduate studies by Brazilians in Brazilian institutions. PEAS also brought visiting U.S. faculty to the six Brazilian institutions with postgraduate programs.

PEAS training covered most of the principal areas of agricultural science (plant science, animal science, veterinary medicine, agricultural engineering, soil science, and forestry). Students were also trained in related areas including basic science, agricultural social sciences, food science, university administration, and library science.

Three new schools were virtually created with the assistance of PEAS: the Agronomy School in Manaus, the agricultural college of the University of Mato Grosso, and the School of Veterinary

Medicine of the Federal University of Minas Gerais in Belo Horizonte. In 1975-1976, the project developed a program to strengthen the administrative capacity in Brazilian agricultural colleges; and in 1977, it sponsored a short course in university administration, given in East Lansing, Michigan. PEAS also enabled the Brazilian institutions to acquire more than 22,000 books and reprints.

Another feature of PEAS was that it encouraged cooperation and institutional development among Brazilian institutions. A few specific pairings between Brazilian institutions were developed: for example, Vicosa with the Agricultural College of Para, and Sao Paulo with the College of Agriculture of the Federal University of Paraiba in Areias. These programs brought mixed results. In a few cases, the weaker Brazilian institutions balked at receiving assistance from the stronger ones. However, a number of faculty from the weaker institutions did receive advanced training at one of the stronger ones, and some faculty from the latter institutions spent periods as visiting faculty at the targeted schools.

PEAS was funded through December 1978, a total of 5 years. Postgraduate students who had begun their studies before that date were supported beyond that date through fellowships underwritten with Brazilian Government funds.

1.5 Impact of the A.I.D. Program

Ten years after the A.I.D. programs were completed, nearly all the postgraduate programs begun with USAID funding are still in existence. Many more postgraduate programs in agriculture have begun in the four schools originally supported and in agricultural colleges supported under PEAS (notably Rio de Janeiro and Minas Gerais). Still other postgraduate programs have been founded in institutions not directly connected to the original subprojects or PEAS, and they have relied heavily on faculty trained at the former institutions.

Today a total of 26 institutions offer 120 M.S. and 23 Ph.D. degree programs in agriculture. Since 1961, more than 3,600 master's degrees and 200 Ph.D.s in agriculture have been awarded. The impetus for nearly all these accomplishments can be found in the USAID/Brazil support.

The four agricultural colleges supported under the original A.I.D. program have become the preeminent agricultural colleges in their regions, and they account for a large share of the graduate programs available in Brazil. All of the basic

disciplines of agriculture and related fields are represented at these schools. A majority of their faculty teach full time, and 80 percent or more of their faculty hold advanced degrees.

These four colleges are consistently ranked among the top agricultural schools in the country (Mazzolenis 1988; CAPES 1987). All four of the colleges, and, to a large extent, those supported under PEAS, have laboratories equipped for research and teaching. They have libraries with small but essential collections for teaching and research. Most of them also have experiment stations with land for agricultural experiments.

From 1978 to 1983, each graduate program was rated annually by the Agency for Personnel Development in Higher Education (CAPES) on a scale from A to E, and since 1983, the ratings have been done biennially. The ratings are determined by committees comprising CAPES technical staff and specialists in the discipline being rated. The criteria for ratings include the number of faculty actually present and teaching, the formal qualifications of the faculty, the completion rate of students, and the facilities including laboratories and equipment, library resources, and so on.

Programs that participated directly in the A.I.D. project during the 1960s and 1970s generally have significantly higher ratings than those that did not participate. There are some notable exceptions, however. The Agricultural Economics Programs at Ceara and Vicosa have not performed outstandingly. The doctoral program at Vicosa has not earned above a "C" since 1979. This problem may be partly due to the fact that well-trained agricultural economists are in great demand as advisors and administrators, so that a large number of senior faculty members are away on leave of absence. This situation has hurt the ratings of these programs, those of the Ph.D. programs even more than those of the M.S. programs. The mean ratings of postgraduate programs by CAPES are as follows:

All programs	3.12
Programs with A.I.D. assistance	3.46
Programs with no A.I.D. assistance	2.65

Agricultural scientists and practitioners graduated from the original four universities and the additional universities assisted by PEAS have been highly influential in teaching, research, planning, administration, and other areas important to agricultural development. Holders of postgraduate degrees from UFV, ESALQ, UFRS, and UFCe--the original four A.I.D.-assisted universities--are among the most influential professionals in

agencies like EMBRAPA. They rank respectively first, second, third, and sixth in number among EMBRAPA's staff and account for nearly two-thirds (64.5 percent) of the Brazilian postgraduate degrees held by EMBRAPA's staff (Table 2).

Table 2. Advanced Degrees Earned by EMBRAPA Staff at Brazilian Universities

University	M.S.	Ph.D.	Total	Percent
UFV[a]	316	28	344	25.4
ESALQ[a]	262	43	305	22.5
UFRS[a]	162	3	165	12.2
UFMG	77	2	79	5.8
UFPel	71		71	5.2
UFCe[a]	60		60	4.4
UnB	46		46	3.4
ESAL	44		44	3.3
UFRRJ	33	5	38	2.8
UFSM	32		32	2.4
UFPb	38		28	2.1
UFPR	22		22	1.6
Others	133	6	139	8.8
Total	1,296	87	1,383	100

[a]Host universities in A.I.D. project, 1963-1973
Note: Acronyms are listed in the Glossary.

Source: EMBRAPA

Today, at the end of the 1980s, Brazil has perhaps the largest and most highly trained group of professional agronomists and other agricultural specialists in Latin America. This situation is due in large measure to the rapid expansion of the university system and particularly to the creation of postgraduate training programs in many parts of the country.

2. UNDERGRADUATE EDUCATION AND EMPLOYMENT

The rapid growth of the university system can be attributed largely to a rising middle class in a rapidly urbanizing and industrializing society. Beginning in the mid-1970s, the demand

from this class to expand undergraduate education led to excessively rapid increases in undergraduate enrollments that began to seriously jeopardize earlier improvements in the quality of university education. In addition, postgraduate programs proliferated rapidly after 1967, reflecting the increased demand for university faculty and for human resources at the management level--a demand that became acute as the quality of the undergraduate degree eroded. Today some critics suggest that the university has become a two-tier system in which undergraduates are taught by relatively unqualified, overworked professors in overcrowded classes, while a small elite of postgraduate professors comfortably conducts research of little practical value (Coelho 1988). While this criticism may be overly harsh as regards the agricultural colleges, it has enough truth to merit further attention.

2.1 Student Evaluations of Undergraduate Education

During the field visits for the present study, the members of the study teams spoke with undergraduate students on several occasions. Some informal discussions were held in classrooms, and two instruments were administered to elicit students' evaluations of their own experience at the university, and their hopes and expectations for employment. Unfortunately, various constraints made it impossible to repeat these queries systematically across all the campuses visited, but it is likely that the results are representative of the range of student reactions.

The questionnaire asked what main sources of information students used in their studies. The single most important source was apostilas, which are notes circulated by the instructor. The reliance on apostilas indicates the relative scarcity of published materials appropriate for undergraduates and the relative poverty of the university libraries, even Vicosa's, which is reputed to be one of the best in Brazil. The second most important source of information was purchased books, after which were listed the library, and, finally, classmates' notes.

The students indicated the kinds of activities in which they had participated during their time at the university. Nearly all the students surveyed had been in school for 3 years or more. Nearly all of them (86 percent) reported that they had some direct exposure to research methods or results through their professors. Slightly less than a third had actually participated in research projects. Just under half had participated in extension activities, and over one-half reported having had direct contact with farmers.

At Vicosa, many of the contacts with farmers probably were made through the Gilberto Melo program, which organizes small groups of student volunteers to go out and execute small community projects connected with agriculture or other community needs. Similar activities are built into the curriculum at Sao Paulo. The degree of direct exposure to research, farmers, and so on is higher at Vicosa than at most of the other universities. At Ceara, for example, a group of graduating seniors reported that they had not visited the school's experimental farm once in 5 years. They had had no direct contact with farmers, or with research and research results, nor had they had an opportunity to participate in rural extension or research activities before graduating.

Ceara students' lack of exposure to tangible research and practical problems can be explained by a number of factors, including the large size of the student body, the location of the campus and its distance from the university's experimental farms, the lack of suitable vehicles, and the lack of funds and personnel to provide these kinds of opportunities for students. It also reflects lack of faculty support for such activities. Even at Vicosa, the Gilberto Melo program is chronically underfunded.

In general, students appeared very sensitive to what they perceived as shortcomings in the curriculum, their instructors, and the institutions themselves. Many students spontaneously offered sociopolitical interpretations of these shortcomings. Such a critical attitude is typical of Brazilian university students, many of whom espouse radical causes during their university years, and is often regarded as a symptom of a stage that young people must go through before growing up. In this regard, the attitudes and slogans that many students adopt as a result of peer pressure may have influenced the responses given to the study teams.

Perhaps the most frequent comment students made was that their university training did not correspond to the nation's agricultural problems. This complaint was most often heard at Ceara, where students felt that their studies had little to do with the small-scale, technologically simple peasant farming in that state. However, similar comments were heard elsewhere. In Vicosa, students were busy organizing the second national conference on "alternative agriculture," at which they intended to explore themes that they felt are ignored in their classrooms, such as organic farming, low-energy agricultural practices, or use of native plants.

As part of the survey at Vicosa, students were asked to evaluate the quality of their education under five different

headings. Without a frame of reference, it is difficult to take the students' evaluations as an absolute indication of satisfaction. The students themselves lacked a suitable frame of reference, since few of them had experience that would qualify them to make such judgments. Within these limitations, the results are still interesting.

On the whole, the Vicosa students gave high marks to their education in terms of intellectual challenge, the quality of teaching, and the physical facilities. They rated their education lower in terms of their preparation for a career, and significantly lower in terms of its relevance to the problems agriculturalists face. The Vicosa students appeared to share the attitude expressed by students elsewhere that their education was not responsive to the most serious problems of the rural areas of Brazil.

2.2 Employer Evaluations

Although the study teams had limited contact with employers of agricultural specialists, it was possible to glean information about the expectations of such employers with regard to their professional employees. According to administrators of the State Technical Assistance Agency (EMATER) extension programs, recent graduates in the agricultural sciences have not been satisfactorily trained. These administrators felt that the recent graduates were generally well grounded technically but had little or no practical experience, little understanding of agriculture as it is actually practiced, and little ability to apply their knowledge to concrete situations. Often university graduates did not know how to talk to farmers. The EMATER administrators found it necessary to commit substantial resources to retraining recent graduates to qualify them for extension service. They also placed new recruits into internships (estagios) where they could learn alongside more experienced extension personnel.

In the private sector, employers are beginning to need more technically trained personnel. This need is being met to some extent, but not entirely, by the universities. Like public employers, private employers of agricultural specialists have also found it necessary to provide university graduates with on-the-job training. This is particularly true when graduates' duties involve such specialties as marketing, information management, or financial analysis--areas in which, until now, the agricultural curricula have been deficient.

2.3 Employment Trends for Undergraduates

There are few systematic data sources on employment in the agricultural professions. The best data on the number of university-trained professionals in agronomy and related disciplines come from a study conducted in 1986 by the Ministry of Education (Ministry of Education and Culture/SEEC 1986). The Ministry Statistical Section estimated the number of professionals by summing all the university graduates, according to discipline, over a 25-year period ("a generation"). This approach has some built-in inaccuracies because it fails to consider attrition and may also omit graduates of foreign universities, but the results of the exercise are as follows:

Agronomy	41,100
Cattle Production	313
Agricultural Engineering	1,041
Forestry	3,399
Rubber Production	68
Dairy Production	137
Veterinary Medicine	20,517
Animal Science	3,642
Food Technology	1,216
Agricultural Mechanization	26
Rural Administration	1,026
Total	72,485

Another source, the president of the Brazilian Federation of Professional Agronomist Associations, estimates the total number of agronomists in Brazil at 45,000. He further estimates that 90 percent of these agronomists are employed in the public sector (Mazzolenis 1988, 161). Many of tnese pubic sector employees are probably not practicing the profession of agronomy, but rather are involved in administration or other pursuits.

In the past, most university-trained agricultural professionals and specialists have found employment in an expanding public sector. However, there are clear signs that the public sector can no longer absorb so many agronomists. The private sector is beginning to hire more trained specialists in agriculture, but it is not clear whether this expansion will compensate for the decline in public sector employment.

2.3.1 Public Sector Employment

Until the 1950s few jobs in Brazil required a degree in agronomy. The graduates of the few agronomy schools in the country often went into secondary teaching or secured jobs in Federal and state bureaucracies in areas that may or may not have been related to agriculture. There were few Federal and state agricultural experiment stations.

During the 1950s, the demand for trained agricultural specialists rose sharply with the increased intervention of state and Federal Governments in agriculture. In many states, rural extension services were founded and expanded, creating a demand for trained agronomists and technicians. Agricultural credit expanded greatly from the early 1960s, adding to the demand for specialists in agriculture. Major credit institutions, such as the Bank of Brazil, the Bank of Northeast Brazil, and several official state banks, opened rural credit windows staffed by agricultural specialists as loan officers and inspectors. A number of agronomists familiar with Government regulations opened consulting firms to prepare proposals for farmers seeking loans.

Specialized Government agencies--for example, the Sugar and Alcohol Institute and similar institutes for export crops such as cacao and coffee--also employed substantial numbers of agricultural specialists in research, extension, and regulatory activities. The Ministry of Agriculture and some states (most notably Sao Paulo) sponsored agricultural experiment stations that conducted field trials of crops and experimented with various crops and crop treatments, generally with an orientation to a specific region.

In 1972, the founding of the Brazilian Corporation for Agricultural Research (EMBRAPA) consolidated into one agency all Federal agricultural research efforts; eventually it became a cooperative research system incorporating the agricultural research agencies of the states. Another Government agency that employs a significant number of agricultural specialists, especially agricultural engineers, is CIBRAZEM, a public corporation responsible for developing the country's grain storage capacity.

The 1960s also saw the growth of major regional development agencies, of which the largest was the Superintendency for the Development of the Northeast (SUDENE). SUDENE's rural development programs generated much employment for agronomists. For several years after it was founded, SUDENE absorbed nearly the entire graduating class of agronomists in the Northeast.

By most indications, the expansion in public sector employment of agricultural specialists is at an end. Most of the agencies just mentioned have stabilized, and at least one, the Brazilian Corporation for Rural Technical Assistance and Extension, is slated to be disbanded as of this writing. Federal hiring freezes have been imposed twice in recent years (1983 and 1987-1988). Many states have undergone severe financial difficulties, and some have hovered near insolvency. This situation has curtailed expansion, although there appear to have been relatively few actual cutbacks in the strength of Government bureaucracies.

2.3.2 Private Sector Employment

As with the public sector, the study teams were unable to locate any sources of data concerning the number of agricultural specialists employed in the private sector. They did learn, however, that there is a considerable and growing job market for university-trained specialists in agronomy and other areas.

Perhaps the largest and most dynamic area of employment is in the expanding firms that specialize in agricultural inputs--fertilizers, feed, seeds, pesticides, and the like. Such companies employ agronomists and other specialists as sales representatives who make direct contact with farmers, farm supply retailers, and cooperatives to advise them about the use of the companies' products. Often, these specialists offer general advice on various questions that range beyond the uses of the specific products they promote. In effect, these specialists provide technical assistance as other extension personnel do, although obviously their advice may be biased to encourage use of their product lines.

While agricultural inputs are sold across Brazil, by far the largest markets for them are in the central and southern portions of the country. The job market is skewed accordingly: agronomy graduates from Rio Grande do Sol, Sao Paulo, and Vicosa often take jobs with seed, feed, and fertilizer companies, while virtually none from Ceara do so, largely because there are few job openings of this sort in the Northeast.

Producer and marketing cooperatives have grown rapidly in recent years, both in specific commodities such as sugar and as "mixed cooperatives." The largest and strongest of these cooperatives provide technical assistance to their members through staff agronomists, veterinarians, and so forth. The

cooperatives are especially strong in the states of Sao Paulo, Rio Grande do Sul, Parana, and Mato Grosso do Sul.

A number of engineering consultants and major contractors employ agronomists to manage agricultural or environmental components of development projects. There is a wide variety of such projects, ranging from energy development to soil management to mining. For example, Brazil is currently experiencing rapid development in hydroelectric power and a concomitant extension of transmission lines. Construction of dams, dikes, and transmission lines involves a great deal of disturbance to natural habitats, and repair and restoration require careful management.

Financing from multilateral development banks--the World Bank and the Inter-American Development Bank--is increasingly tied to requirements for reforestation and other restorative projects. Agronomists and foresters are needed to design and implement such projects. In other cases, for example in agricultural demonstration projects pertaining to the introduction of new techniques or products, agricultural specialists provide extension services to farmers.

Agribusiness is another major private employer of agricultural specialists. This area was traditionally dominated by large multinational dealers in agricultural commodities who had little or no stake in production and hence employed few agricultural specialists. However, in the past 20 years, Brazilian firms have become dominant in agricultural commodities, and many new firms have become involved in producing and processing such products as ethanol, poultry, vegetable oil, canned fruits and vegetables, citrus concentrates, vinegar, and wine. In a few cases, firms have purchased tracts of land and gone into production. More frequently, however, firms rely on independent producers for their basic products, providing inputs and advice to achieve the quality they require.

It is becoming increasingly common for a food processor to enter into a production contract with a producer. This mode of production is common in the poultry industry: the producer receives chicks, feed, and technical assistance from a meat packer and resells the birds to the packer at a preset price. Similar arrangements can be found in the canning industry, particularly in areas of intensive production: irrigated tomato farms in the Sao Francisco valley now receive seed, fertilizer, and technical assistance from tomato product factories nearby. All such operations require the expert assistance of agricultural specialists, primarily to reach and maintain industrial quality levels.

Demand for agricultural specialists also arises from public utilities, autarchies, and industrial corporations that manage agricultural enterprises. One example is the experimental biomass fuel alcohol production facility, which uses manioc (or cassava) as a feedstock, that was founded in 1982 by the national oil monopoly, PETROBRAS. A number of private corporations have also invested in cattle in Amazonia under the tax incentives provided by the Superintendency for the Development of Amazonia.

2.4 Projected Supply and Demand

Given the fluctuations and uncertainties associated with employment opportunities for agronomists and other specialists in recent years, what are the prospects for future employment? The quality of data available makes it difficult to construct reliable estimates of future job openings. As one way to approach the problem, the study teams built a simple model to predict the behavior of the job market for B.S. graduates in agricultural sciences (including agronomy, veterinary science, animal science, forestry, and agricultural engineering). The model crudely estimates the future demand for agronomists under different rates of university employment growth, attrition from professional positions, and university enrollments and production of B.S. degree holders.

Crude as they are, these scenarios provide an idea of where the important policy decisions lie. Given the history of attrition in this area, policymakers may wish to consider salary and other incentives for keeping capable agricultural specialists within the profession. It may well be more profitable to retain agriculturalists already in the pool than to train more specialists, particularly given the high cost of adding capacity to the university system. It would be useful to begin to collect data on these topics, so that analyses of such subjects could begin.

Of five scenarios tested, only one would yield a probable excess of supply over demand. The others indicate a probable shortage of trained agricultural specialists in coming years. The model is only as valid as the assumptions it rests on, however, and the rate of employment growth in a country like Brazil is highly volatile. Over the short term (1-3 years), economic conditions would seem to prohibit any expansion in employment opportunities in the public sector. The private sector is unlikely to take up the slack. Over the intermediate and long terms, the demand for trained agronomists and related specialists is likely to continue expanding.

2.5 University Responsiveness to the Job Market

In all the schools visited, the study terms found little or no concern with gathering systematic data on the size and nature of the job market, on employers' needs, or on graduates' adjustment to their jobs. None of the agricultural colleges has a placement office for graduates, nor does any provide information to graduates on job opportunities. Individual faculty members may sometimes provide personal recommendations to potential employers for particular students. Aside from occasional personal contacts or consulting contracts, faculty members may even be unaware of the current trends in the workaday world of agriculture.

A recent curriculum reform in agronomy was carried out by an ad hoc committee of specialists recruited from leading institutions in the country. However, none of the committee members represented industry, Government, or other consumers of expert services in agriculture.

The study teams also searched in vain for surveys or other data on the employment market for agronomists and other agricultural specialists. The few indications there are suggest that demand for agricultural specialists is low to moderate compared with that for specialists in other technical fields. However, the particular fields most in demand are not necessarily those to which universities are channeling their resources.

If academic institutions were responding to the market, they would be increasing their output of students in areas of high demand. Thus, business and engineering fields should be undergoing growth, while humanities, education, the social sciences, and to a lesser degree agricultural sciences should be stable or growing slowly. However, the number of business graduates declined between 1979 and 1984, and the number of engineering graduates rose only a modest 2.7 percent. The numbers of humanities, education, and agricultural science graduates increased modestly over that period. The number of graduates in social sciences declined, reflecting primarily a drop in the output of economics departments. The drop in the number of graduating economists is curious, given the brisk demand for economists shown in the want ads.

It may be concluded that academic institutions are not tracking employer needs very closely, if at all. It would be a mistake to suggest that the market has no influence on the university curriculum: for example, the number of computer science programs in many universities has grown. Nor should

universities rely exclusively on supply and demand as a guide to allocating their resources. In our view, universities should be concerned with education and should assume that well-educated people will be equipped to contribute in a variety of professions. The evidence available, however, confirms the study groups' impression that universities are somewhat indifferent to employment trends and do not make a strong effort to keep in tune with the shifting requirements of government, business, science, and industry.

3. POSTGRADUATE EDUCATION

As has been mentioned, the growth in postgraduate training in agricultural sciences in Brazil dates from the early 1960s. This growth is due to the cumulative effects of a number of influences:

- -- The expansion in universities and faculties of agriculture
- -- The requirement that university faculty have formal postgraduate training
- -- Incentives for advanced training in the pay scales and promotion systems of universities, extension agencies, and other institutions
- -- The development of university research and institutions specializing in research support
- -- The increasing numbers of Brazilians seeking postgraduate training abroad and returning to Brazilian universities
- -- Increasing Government emphasis on agricultural research
- -- Support from international donors, especially USAID, but also the Ford and Rockefeller Foundations, the Federal Republic of Germany, and others

3.1 Graduate Applicants and Financial Support

Until recently, Brazilians usually undertook postgraduate studies when they were in early mid-career. So far as the study teams could determine, a majority of Brazilian postgraduate students in agricultural sciences are already employed when they enter a graduate program. Many of them have already been working

in a program or agency and come for graduate training with the support, financial and otherwise, of their employers.

Many employers, such as universities, extension agencies, and research centers, grant employees 2 years of leave with pay to pursue postgraduate studies. Usually, but not always, employees' studies must be in the particular field in which they are working. Apparently, some institutions invest in human capital in general terms, and not necessarily to fill a specific need. Other employers are willing to grant leave for postgraduate studies, but only at reduced pay or without pay.

About a quarter of the graduate students in Brazil receive scholarship support from the Agency for Personnel Development in Higher Education (CAPES) and the National Council for Scientific and Technological Research (CNPq). Probably an even higher proportion of students in agricultural sciences receive support. The university usually provides these students with scholarships (bolsas de estudo) funded by Federal agencies, most often CNPq or CAPES. EMBRAPA also provides scholarships for agriculture and related fields. Because there are no tuition charges in public universities, these scholarships are more like what are called "stipends" in the United States.

Students without employment, including some who only recently completed their undergraduate degrees, also enroll in postgraduate studies. CAPES and CNPq provide graduate fellowships, primarily for university faculty members, but they reserve a small number for unemployed students.

3.2 Funding Priorities for Fellowship Aid

Optimal utilization of scientific professionals depends on using established goals to allocate resources to areas and institutions where needs are greatest. So far as the study teams could determine, there were, until about 1986, virtually no specific disciplinary priorities in the two major agencies providing funding for graduate studies abroad.

Allocations of fellowship funds by CNPq and CAPES depended primarily on "application pressure." Thus, if more students applied for graduate fellowships in physics, more fellowships would be awarded in physics. The only limitation on this practice was the CAPES rating system by which, theoretically at least, more fellowship funds would be allocated to the more highly rated departments. There may have been mechanisms for allocating more funds to broad areas of science (for example, physical science versus biology), but the study teams could not

detect any mechanisms for setting priorities among particular disciplines.

Nevertheless, there has been an emerging consensus to identify priority areas in scientific development, which eventually would percolate down to the level of scholarship priorities and research funding. According to several informants, the areas to which highest priority is given are biotechnology, materials science, computer science, and chemistry. Special set-asides for postgraduate fellowships should eventually be established in these areas.

Brazil has at least five biotechnology centers in different stages of development: at Sao Paulo (ESALQ), Vicosa (UFV), Rio Grande do Sol (UFRS), the University of Campinas (UNICAMP), and EMBRAPA's National Center for Plant Genetics and Biotechnology (CENARAGEN). These centers have received priority support from their own institutions and from CNPq and other sources. A number of young researchers who earned Ph.D.s in the United States and England work at these centers. The centers at ESALQ, UFV, and CENARAGEN will probably devote most of their efforts to research that is applicable to agriculture. Research at the other two centers will probably be more general. Biotechnology applications is one the few areas in which universities seem to have taken the initiative in developing a particular area of science.

In 1987, the Ministry of Science and Technology proposed that Brazil expand the number of fellowships for postgraduate study from under 2,000 to 10,000 per year. The plan would funnel resources into the priority areas to quickly build Brazil into a world-class scientific power.

Aside from the difficulty of obtaining such a volume of resources during a period of fiscal restraint, some policy specialists raise serious questions about the wisdom of such a program. First, they question whether an adequate number of potential graduate students is ready to undertake graduate studies. Second, they question whether the teaching and research institutions of the country are able to absorb such a large number of specialists and translate their training into scientific and technological advances.

3.3 Incentives for Research and Academic Advancement

Under the University Reform Act of 1968, Federal universities came under a uniform set of rules governing personnel practices. Under these rules, new permanent positions

have to be publicly announced and filled by competitive examination (concurso). In most cases, even persons already attached to the faculty are obliged to enter the competition for a position.

The rules set minimum academic standards for promotion and tenure. A uniform system of ranks, with steps within these ranks, was established. Faculty with bachelor's degrees are eligible only for assistant professorships. Faculty with master's degrees are eligible for associate professorships. Holders of doctorates are automatically entitled to an associate professorship or higher. The doctorate is a requirement for full professorships. Other criteria for promotion include publications, attendance at scientific congresses, presentation of scientific papers, and attendance at short-term courses.

These rules gradually affected nearly everyone who was teaching in Federal universities. They created incentives for professional advancement, including additional training, and led many faculty members to enroll in postgraduate degree programs and to become active in research and publishing.

During the 1970s the universities enjoyed a period of great optimism. As enrollments expanded, new degree programs were created, and as heavy investments in human capital development were made, many faculty members had the feeling of expanding horizons and new opportunities. Salaries rose steadily until around the mid-1970s, and opportunities for postgraduate study in Brazil or abroad and for research grants, research travel, and participation in scientific meetings were never greater.

3.4 Recent Changes in Incentives for Advancement

Until 1980, professores colaboradores formed a separate career path consisting of faculty who received lower pay but could advance through a separate set of steps without the requirement of a higher degree. In 1980, responding to a demand by colaboradores, the Ministry of Education acted to erase the distinction between them and other faculty. The new system made it possible for faculty to advance through the regular faculty ranks (corresponding roughly to instructor, assistant professor, associate professor, and professor) without taking an advanced degree and lowered the incentive for advanced training.

Economic factors also reduced the overall attractiveness of university careers. Faculty salaries suffered severe erosion during the economic crises following 1982. Many university faculty, even those who were teaching full time, began to seek

other sources of income. Some reduced their work programs to half time to pursue other activities. Many faculty sought and took leaves of absence or transfers within the Federal bureaucracy. These trends detracted from teaching and research and made it less likely that faculty would enroll in postgraduate studies.

Conditions improved somewhat in April 1987 when, following a month-long nationwide faculty strike, faculty salaries at the federal universities were doubled. During 1987 and 1988, however, accelerating inflation erased much of this gain and led many faculty again to seek income to supplement their salaries.

By early 1989, conditions had deteriorated so badly that many university professors began to seek opportunities to leave Brazil. While systematic information is not available, there is a widespread perception that some of the top talent in Brazilian universities will leave the country and not return. Thus, while university salaries have improved, economic conditions in general and specific changes in the rules for advancement have reduced the attractiveness of a university career and of advancement within the university system.

3.5 Foreign Versus Domestic Postgraduate Study

As of 1988, Brazil has postgraduate degree programs, at least to the master's degree level, in all the major areas of the agricultural sciences. There are no doctoral programs in agricultural engineering or forestry.

Despite the availability of advanced degree programs in Brazil, many students still seek postgraduate training abroad. They do so principally for two reasons. First, in general, a foreign degree carries greater prestige than a domestic degree. Second, some foreign centers are considered to be more advanced scientifically than Brazilian centers. They may be better equipped and have a larger number of specialists focusing on a given set of problems.

Brazilians who wish to study abroad frequently seek out specific institutions where there are other Brazilians, or where there are faculty members with whom they have some direct or indirect contact. Not surprisingly, a tradition has grown up around attendance at the U.S. counterpart institutions involved in the USAID programs in Brazil between 1963 and 1978. Even since these programs ended, many Brazilian graduate students in agricultural science have sought out the University of Florida, Purdue University, Mississippi State, the University of

Wisconsin, and the University of California at Davis. Particularly strong ties subsist between the institutions paired in the original A.I.D. project.

Table 3 gives an indication of the foreign institutions attended by Brazilian agricultural students. It is based on a professional researcher population at EMBRAPA. A sample taken from universities might give different results, but the top institutions would probably be the same.

Table 3. Advanced Degrees from Foreign Universities Held by EMBRAPA Staff

University	Number	Percent
Florida	67	10.6
Purdue[a]	55	8.7
Mississippi	47	7.4
Wisconsin[a]	38	6.0
California, Davis	35	5.5
North Carolina	28	4.4
Iowa State	21	3.3
Michigan State[b]	18	2.8
Montpelier	18	2.8
Reading	18	2.8
Texas	18	2.8
California, Riverside	12	1.9
London	11	1.7
Arizona[a]	10	1.6
CPGC Mexico	10	1.6
Washington	10	1.6
Ohio State[a]	9	1.4
Oregon	9	1.4
Utah State	9	1.4
Cornell	8	1.3
Minnesota	8	1.3
Nebraska	8	1.3
Others	167	26.3
Total	634	100.0

[a]Lead universities in A.I.D. Program, 1963-1973
[b]Lead university in PEAS, 1973-1978

Brazilian scientists from many institutions, including those that are generally considered the best in Brazil, expressed the opinion that institutions are not yet on the cutting edge of science. Even without being asked, they often compared their institutions to foreign institutions.

Several interrelated reasons were given for the lower level of scientific training and achievement in Brazil. First, it was almost universally agreed that Brazilian science is underfunded and that basic items of equipment and library resources are in short supply and difficult to acquire. People in all the institutions visited by the study teams complained of their inability to obtain foreign currency to import books, journals, specialized equipment, and spare parts. Many scholars stated that support for advanced training and research was inadequate and inconstant.

A second reason given for Brazil's lower level of scientific training is that Brazilian institutions are immature and need more time and experience before they develop into world-class research and teaching centers. Related to this factor is the belief that most Brazilian institutions lack the "critical mass" of researchers necessary for a self-sustaining research effort, especially on the frontiers of research. Most researchers suggested that at Brazilian institutions it was possible to carry out creditable research in such areas as rangeland management, farm economics, basic soil chemistry, or animal nutrition. However, there are few centers in Brazil, that are equipped to carry out cutting-edge research in molecular biology, plant genetics, animal physiology, and other areas of science requiring major investments in human capital and equipment.

A third reason that Brazilians gave for considering foreign institutions better than their own is their isolation from the dynamic centers of research. Brazilian researchers feel separated from the mainstream of research, which they typically locate outside the country. To be sure, they have opportunities for contact with other researchers inside the country, especially at annual intradiscipline meetings and also at regional meetings, general meetings, occasional research-oriented panels, and visits to other institutions. In general, however, top researchers at Brazilian institutions seemed to feel they had little to learn from their colleagues inside the country.

Brazilian researchers do have opportunities to travel abroad. In addition to funding postgraduate study, a number of Federal and state agencies provide postdoctoral fellowships and travel grants for attendance at scientific conferences abroad. Funds are also available to bring foreign professors and lecturers to Brazil. While acknowledging these opportunities,

most of the scholars interviewed by the study teams said that their contacts with scientists and research outside Brazil were too limited. Some also felt that it was unreasonable to require Brazilian researchers to present papers at scientific congresses as a condition of having their expenses paid.

A final reason for a lack of scientific achievement in Brazil is the instability of university life there. The real value of university salaries has fluctuated wildly over the past 20 years. In the late 1980s, rampant inflation severely eroded the living standard of many salary-dependent academics and others. Working conditions for university professors and other researchers and professionals have deteriorated because of the crisis in public funding. Political repression and, more recently, politicization within the university have contributed to this deterioration. These factors have led many scientists to seek other employment, and an increasing number are leaving the country for postdoctoral study, or to take jobs. If these conditions prevail for long, the result could be a serious setback for the development of science and technology in Brazil.

3.6 The "Inbreeding" Problem

There is a tendency for faculty at Brazilian institutions to begin teaching at a particular institution and to remain there throughout their professional careers. In the agricultural sciences, at least, a majority of faculty are recruited from graduates of the same school. For example, at Vicosa, of a sample of 90 faculty members, 68 had earned their B.S. degrees at Vicosa, and 43 had earned their M.S. degrees at Vicosa as well.

Since most undergraduates attend universities in their home state, most faculty members in each institution are natives of the same state and graduates of the same university. This tendency, while understandable in the Brazilian context where family and home ties are very important, creates an "inbreeding" problem.

Brazilian universities invest heavily in training their faculty and expect that the investment will be repaid in long years of devotion to the school. The ideal is to train and retain faculty within the institution. This was particularly clear at the strongest schools like Sao Paulo and Vicosa, where there was an implicit assumption that students trained elsewhere in Brazil could not meet the high standards of these institutions.

Paradoxically, at the same schools that trained and retained much of their faculty, the study teams encountered genuine concern that the university would become stagnant and inbred. In most cases, the remedy proposed was not to bring in faculty from other institutions, but rather to continually renew and refresh their own faculty by sending them abroad.

This attitude is to some extent understandable, given the great effort and expense required to prepare a student to become a productive member of the faculty and the relatively small number of institutions in Brazil. However, it is clear that institutional rivalry also enters the picture: the faculty at the top institutions prefer not to hire faculty trained at other top Brazilian institutions even though to do so would help alleviate the problem of inbreeding.

4. UNIVERSITY-BASED RESEARCH AND EXTENSION

4.1 The Rise of a Research Orientation

Research was not a tradition at most Brazilian universities prior to the 1960s. Many agriculture colleges lacked facilities for research, and most faculty members lacked the training, stimulus, or resources to conduct research. Research was carried out under the auspices of state agricultural secretariats, state extension services, the Ministry of Agriculture, and a few commodity boards. In the poorer states, particularly in the Northeast and North, virtually no research at all was carried out. Also there was little contact or coordination among the centers that were conducting research, or between them and other research centers outside Brazil.

Today in the top universities, including all those with postgraduate programs, most of the faculty nominally engage in research. Each year, every department considers a list of research topics proposed by the faculty. Once approved, the list is forwarded to the administration for further approval. Many of the projects listed are continuations of projects that have sometimes been going on for years. Some of the projects lack funding and amount to research proposals more than actual projects. Many projects are continuations of research carried out in connection with master's or doctoral theses.

4.2 Setting Research Priorities

The field teams that visited Brazil felt that most of the projects with which they became familiar could be described as "discipline oriented"--that is, they were research topics generated from the perspective of a particular discipline and related primarily to the theoretical and empirical orientation of a peer group trained in that discipline. This term is intended to contrast with "problem-solving" research, or research oriented to solving concrete problems encountered in the production, storage, or processing of agricultural products.

Problem-solving research is motivated by an understanding of problems farmers have in a particular context, for example, water utilization by plants in an arid region with well-drained, sandy soils. Problem-oriented research, by its nature, is generally multidisciplinary. It involves feedback from farmers to determine whether it addresses the problems perceived by the producers. For this reason, it usually involves a connection with an extension network that carries research findings to farmers in a usable form and brings feedback to the researcher.

There is no absolute dichotomy between these two varieties of research; they are overlapping and interdependent. Much discipline-oriented research is eminently problem oriented. Much problem-oriented research requires thorough research within specific disciplines to be effective. The issue also needs to be understood in relation to the distinction between basic and applied research. Basic research underlies all other research, supporting it, extending its scope, setting its limits. The term "basic research" is relative. The same research viewed from one perspective may appear to have an applied focus, while, viewed from another perspective it will appear to be basic.

Within Brazilian academic institutions, discipline-oriented research usually brings the greatest rewards. Faculty are encouraged by their peers, by the promotion and tenure system, and by the system that financially supports research to carry out discipline-oriented research. There are fewer incentives for conducting problem-oriented research, which carries less prestige, takes more time, and requires collaboration with a wider range of colleagues and possibly contact with farmers in the field. In the United States, the land-grant model of many agriculture colleges was designed to overcome this tendency. Nevertheless, in the United States as in Brazil, there is a strong tendency for research to be oriented primarily toward goals set in the context of relatively narrow disciplinary debates.

The study teams could not systematically evaluate the question of how research priorities are established in Brazilian universities. However, they did ask that question of nearly every person interviewed, including faculty members, administrators, and policymakers. The consensus was that research priorities are determined by the sum of individual choices made by researchers on their campuses and are strongly influenced by the availability of funds to carry out research.

In some cases, faculty members had been induced to turn their attention to problem-solving research, generally in the context of a project organized and funded outside the university. Only rarely had university administrators (ranging from department chairs to rectors) made deliberate attempts to organize research applied to specific problems.

4.3 Research Funding

There are various sources of funding for university-based research. Some universities have managed to garner resources themselves to carry out research. They may use overhead from grants they receive, income from experimental farming operations, surplus federal funds, or other internally generated funds, but no university has funds enough to provide more than token support for a few projects.

Research expenses are generally met by grants from external sources. The two principal sources of research funds in agriculture are CNPq and the Studies and Projects Finance Agency. Both of these organizations have a system of peer review similar to that of official U.S. funding agencies such as the National Science Foundation. The Ministry of Agriculture has no regular funding for university-based agricultural research comparable to United States Department of Agriculture funding of research at U.S. land-grant colleges.

International lending agencies and other donors may also provide research funding for some purposes. Both the World Bank and the Inter-American Development Bank (IDB) have supported research activities at the Federal University of Ceara. Currently, IDB is supporting research in Ceara on oilseeds that may provide alternatives to cotton, a crop that is being decimated by the boll weevil. The World Bank contracted with the Agricultural Economics Department at Vicosa for evaluation studies of rural development projects in Minas Gerais.

Nonresearch agencies may also support research. For example, CIBRAZEM, a parastatal grain storage enterprise supports

a research and training center at Vicosa. Support also comes from state agencies such as the Sao Paulo extension service (which is separate from the Federal services).

State, regional, and national banks also support research. Until 1986, the Bank of Northeastern Brazil supported a broad program of research on crops and animal production at the Federal University of Ceara. The Bank of Brazil also has a program from which several universities receive grants. These bank-sponsored programs depend on bank profitability. The Bank of Brazil program, for example, is funded by a regular contribution of 2.5 percent of net profits. Poor economic conditions in 1987 led to a complete cutoff of such funds.

In some cases, agribusinesses have contracted with specific researchers in a university to provide consulting services or to conduct specific kinds of trials to solve particular problems they may have. For example, a very large soybean producer in the State of Mato Grosso has a contract with the Plant Science Department at Vicosa under which the department assembles a multidisciplinary team every year to work on specific problems. The team members propose and supervise field trials on the planter's own fields, working with agronomists from the plantation. They also conduct experiments at the university.

As far as the study teams could determine, there is no broad-based research funding by private industry, that is, a corporation providing resources to support a research institution or department.

It is difficult to determine the total volume of research funding at any university. Each of the universities the study teams visited had a foundation to administer external funding. However, only a fraction of the external funding received by any university was channeled through that foundation. Budget data from UFV, for example, indicate that only about 10 percent of the annual budget comes from external sources (that is, other than the regular operating budget furnished by the Ministry of Education). This amount includes grants and contracts for various purposes, including training and research. The ultimate source of much of these funds is the Federal Government. Although there is no breakdown, it appears that the Federal Government is by far the largest source of funds in agricultural research.

4.4 Facilities and Equipment

The USAID programs provided a stimulus to the development of facilities for research and instruction. Nowhere was this more evident than at the Federal University of Ceara. Early in the project, work was begun on new facilities for the College of Agronomy, which later grew into the Center for Agricultural Science. Over the life of the project, nine new buildings were built, including laboratory and classroom buildings for plant science, soil science, animal science, home economics, agricultural engineering, and central administration. Construction was not supported by the USAID program, but A.I.D. funds were used to purchase more than $110,000 in imported equipment to partially or wholly equip 18 laboratories (Matlock and Smith 1975). A.I.D. also helped develop an experimental farm at Pentecoste, and project funds were used to acquire vehicles, including a bus, to facilitate travel to the farm. The project also provided for setting up a central agriculture library and for purchasing thousands of new books and dozens of journal subscriptions for the library.

At the other universities involved in the A.I.D. projects, the facilities, equipment, and libraries were all improved, both with the A.I.D. funds directly and with non-A.I.D. funds that were invested as a result of the A.I.D. program. In all the universities, the USAID program was praised for the high-quality scientific equipment that it brought to the campuses, especially in areas like soil science and plant physiology. By all reports, this equipment was used and well maintained as long as the A.I.D. program was in place. Maintenance was easy because experienced U.S. consultants were on hand to diagnose problems as they arose, and the projects had a procurement component that allowed direct purchase of imported spare parts and consumable supplies.

After the projects ended, most of the colleges did not perform routine maintenance. Spare parts and supplies became very hard to acquire because of import restrictions and limits on foreign exchange. In many cases, equipment broke down and was never repaired or replaced. Much of the remaining equipment is now obsolete. Faculty at Sao Paulo indicated that this problem is now being overcome, particularly through new programs to train technicians in equipment maintenance.

The Catholic University at Piracicaba, Sao Paulo, has a special 3-month course to train equipment technicians, and CNPq now offers scholarships for training in this field. However, the equipment shortage is acute at all the other schools the study teams visited.

Similar problems exist with respect to library acquisitions. All advanced research and teaching depend on access to up-to-date research literature, and, of course, universities typically maintain a library collection available to faculty and students. In case after case, the study teams were told that libraries had been obliged to curtail or cut their subscriptions to foreign journals and their acquisitions of books from abroad. Funds were generally not sufficient even to acquire domestically sold books. Rarely do libraries have sufficient copies of textbooks. Students rely on photocopies of texts, often from outdated editions, or on notes prepared and sold by faculty members. Faculty members keep abreast of the literature by using their own funds to acquire books and journals. But these materials are not widely available, and they are particularly inaccessible to students. Also, individual faculty members are unable to keep abreast of developments in fields outside their own narrow specialties. Libraries are falling further and further behind. It is unclear why libraries occupy such a low priority in university budget allocations.

4.5 Dissemination of Research Results

There are several channels through which scientists can communicate research results. Perhaps the single most important vehicle is the journal article. Another is scientific papers, which are presented at annual or biannual meetings of scientific societies. The master's or doctoral dissertation is also an important source of scientific knowledge in Brazil. Finally, numerous channels of communication in agricultural extension are being explored in Brazil.

A number of research publications in agriculture are published in Brazil. Several of them are published by university departments, notably those involved in the A.I.D. project. One example is the journal Ciencia Agronomica (Agricultural Science) published by the Center of Agricultural Science at the Federal University of Ceara. This journal, which has been published continuously since 1971, covers all areas of agricultural science. An example of a more specialized journal is Revista Brasileira de Zootecnia, the official journal of the Brazilian Animal Science Society, published since 1972 by the Animal Science Department at Vicosa.

The host institutions of these journals tend to be overrepresented, in that most of the journal contents are contributed by scholars from the same university. For example, the editors of the Revista Brasileira de Zootecnia estimated that 60 percent of the contributors are either faculty members or

students in the Animal Science Department at Vicosa. Articles based on master's or doctoral theses seem to be the kind of article most frequently published in these journals. They also publish reviews of recent books, a particularly valuable service where it is difficult to get access to the recent literature.

A growing number of scientific societies in Brazil hold annual or biannual meetings. These meetings provide an opportunity for specialists in a given discipline, who may be quite isolated from major research centers, to meet and exchange information and ideas. They provide perhaps the only regular opportunity for researchers and practitioners to meet. Typically, research papers are read and discussed at these meetings. Panel discussions and short courses on specialized topics are also held in these meetings, and some participants may receive credit toward promotion by attending such sessions. Often the sponsoring societies invite special guests from abroad to lecture at a plenary session on some topic of widespread current interest. CNPq and other Government agencies frequently subsidize scientific congresses.

In the universities visited by the study teams, a great deal of emphasis is placed on M.S. and Ph.D. dissertations. Dissertations appear to be accorded more attention than at most U.S. institutions, both as vehicles for professional advancement and as contributions to knowledge. Several institutions print dissertations and distribute them as widely as possible. In recent years, however, there has been a strong expectation that new degree holders will publish their dissertations as articles. It would appear that well over half the articles appearing in Brazilian scientific journals devoted to agriculture are based on dissertation research and often are excerpted from master's or Ph.D. theses.

The implications of this practice may merit further investigation, because it suggests that relatively little research is reported in the scientific literature aside from research toward academic theses. This might be interpreted to mean that agricultural scientists make significant contributions to knowledge only once or twice in their professional careers. This does not gainsay the importance of the research conducted in connection with dissertations. It does, however, raise a question about how much other research is performed outside the relatively special conditions under which thesis research is undertaken and the results are published.

4.6 Extension Activities

Unlike U.S. land-grant colleges, Brazilian universities do not normally maintain extension services off campus. Instead, extension in Brazil is managed by Federal and state agencies separate from the universities. Ties between the extension network and the university research system are tenuous. While research results may sometimes be communicated to extension workers and, through them, to producers, there are few mechanisms for bringing feedback from the farm to the scientist in the university.

In some areas such as Minas Gerais, where the state extension service retrains its personnel at the universities, there is a fairly close tie between universities and the extension service. At Sao Paulo, Rio Grande do Sul, and Ceara there does not appear to be such a close tie.

The only direct extension activities normally undertaken by universities are limited training or demonstration projects. At Vicosa, for example, the Gilberto Melo program has been operating in the immediate environs of the university since 1980. Individual projects, ranging from livestock improvement to designing and building such community projects as bridges, are proposed by community leaders. Each semester, the Gilberto Melo program involves 200 student volunteers who work under professional supervision and travel to the field two or three times per week. The program receives financial assistance from the Central Bank. Faculty participate in the program as advisors to specific projects where their expertise is required.

Sao Paulo's Rural Sociology Department has had a long-term experiment in extension in several small farming communities in the general vicinity of Piracicaba. The early phases of this project endeavored to improve farming methods, health, and nutrition by transferring technology and knowledge to small-scale producers and their families. After two experiments, the directors of this project have taken a new approach. Rather than encourage the adoption of new technologies, a job for which they feel the private sector is better suited, they now work to enable communities to make informed decisions on the options open to them. They only bring new ideas to the community when the private sector fails to introduce the alternatives.

Besides the Gilberto Melo program, Vicosa also has an active extension information service centering around the Technology Diffusion Center. It publishes an extensive series of pamphlets on a host of topics ranging from apiculture to fruit-tree pruning. These pamphlets are generally prepared in response to

queries mailed to the university. The center responds to thousands of letters a month and sends out hundreds of pamphlets in response to requests. The center has also helped to prepare a number of segments for the national television program "Globo Rural," which airs every Sunday and focuses primarily on crop and livestock production.

Vicosa is also well known for its Farmer Week, which brings thousands of rural producers to the campus for one week every year. At these events, held annually since 1929, professors give lectures and demonstrations on a wide variety of topics of interest to farmers. Some of the topics in 1986 were "Farm Administration and Investment in Agriculture," "Manioc and Sweet Potatoes," "Sugar Cane," "Rural Electrification," "Home-Baked Bread," "Control of Crop Diseases Caused by Nematodes," "Frog Production," and "Egg Production." It is significant, perhaps, that so far as could be determined, the faculty at Vicosa received no formal recognition or credit for collaboration on any of these extension services.

Few universities provide a range and level of extension services comparable to those of Vicosa. Of the universities visited by the study teams, the university least involved in agricultural extension activities is the Federal University of Ceara. There are relatively few activities that bring the faculty of this urban-based institution into contact with rural producers.

Of all the agriculture college faculty members interviewed, those with perhaps the closest ongoing contacts with rural populations are the social scientists (primarily rural sociologists and agricultural economists). But these faculty members have relatively little contact with their colleagues in technical areas of agriculture, and there are few collaborative research or extension projects that could allow for exchange of information or views.

5. EMBRAPA AND THE UNIVERSITIES

In 1972, the Ministry of Agriculture founded a new semiautonomous agency, the Brazilian Agricultural Research Organization (EMBRAPA). Ideas for a semiautonomous research agency had circulated for several years, but Eliseu Alves, an agricultural economist with a Ph.D. from Purdue University and a former professor at Vicosa, gave shape to these ideas. It was Alves's intention to focus scientists' undivided attention on practical problems of agricultural production. Alves felt that the universities, with their low salaries, rigid structure,

teaching demands, and other distractions, were not capable of generating new technology at a fast enough rate. Thus EMBRAPA was founded with the deliberate intention of sponsoring agricultural research outside universities and traditional Government research centers.

5.1 Building EMBRAPA's Work Force

EMBRAPA became the fastest growing and most dynamic institution of agricultural research in Latin America. Perhaps the single most remarkable aspect of EMBRAPA has been its heavy concentration of resources on developing human capital. For the first 10 years of its existence, EMBRAPA devoted much of its budgetary resources to training agricultural scientists, both in Brazil and abroad. In 1978, a peak year, EMBRAPA employees earned 264 advanced degrees: 158 M.S. and 4 Ph.D. degrees in Brazil; and 60 M.S. and 25 Ph.D. degrees in foreign (mostly U.S.) universities. In 1974, only 17 percent of EMBRAPA's technical staff held advanced degrees. By 1985, 83 percent of the 1,650 technical staff members held M.S. or Ph.D. degrees (Alves and Contini 1987).

It is germane to this study to note the specific schools in which much of this training took place. An EMBRAPA survey of its staff in early 1987 found a total of 1,991 advanced degrees (many staff members hold two degrees). Of the 1,353 degrees awarded at Brazilian universities, nearly two-thirds (64.5 percent) had been awarded by one of the four host universities to the original USAID program (Table 2). Clearly the strengthening of these universities, and of several more under PEAS, contributed heavily to the formation of human capital by EMBRAPA.

EMBRAPA staff members earned an additional 634 advanced degrees at foreign universities (Table 3). U.S. universities awarded about 85 percent of the degrees EMBRAPA staff earned from foreign universities. Of these, the lead U.S. universities in the two A.I.D. projects were prominent in their contribution to training EMBRAPA staff members. EMBRAPA itself sponsored most of the Brazilian students who began postgraduate studies after 1972.

5.2 EMBRAPA's Research Operations

The core of EMBRAPA's research program lies in more than 20 separate research centers devoted to research and development of one or more agricultural commodities, including both crops and

livestock. There are centers for studies of the following agricultural disciplines:

Cotton	Soybeans
Rice and beans	Wheat
Forestry	Wine and grapes
Vegetables	Goats
Manioc and fruit	Beef cattle
Maize and sorghum	Dairy cattle
Rubber and dende (oil palm)	Poultry and swine
Coconut	Temperate fruit production
Sheep and goats	Cashews

EMBRAPA also has regional centers that conduct research on problems common to certain climatic zones and soils in the Pantanal, the Cerrados, the semiarid zones, the humid tropics, and the temperate lowlands.

Finally, EMBRAPA sponsors centers to conduct research on genetics and biotechnology, pesticides and herbicides, agricultural and food technology, soils, and irrigation. Each center has a staff specific to the kinds of projects it conducts. Examples of research projects are one designed to breed dairy cows that produce more milk, one on biological control of a manioc pest, and one that studies ways to introduce soybeans into human diets. The centers also conduct research of a more basic nature, such as micromanipulation of embryos in connection with a cattle-breeding program. EMBRAPA has developed elaborate protocols for field testing to ensure that its technological packages will be acceptable to farmers, processors, and consumers.

5.3 EMBRAPA's Impact on the Universities

Ties between EMBRAPA and the universities are few and tenuous. The typical arrangement occurs when a particular university researcher is linked on a personal, informal basis to an EMBRAPA researcher and they agree to cooperate on certain aspects of their investigations. EMBRAPA is generally much better integrated into the local and regional agricultural scene than many universities are.

Given EMBRAPA's well-organized and well-financed structure, it is small wonder that the university community has shown considerable resentment toward it. EMBRAPA recruited many of its first scientists from among the top research scientists in the universities, and it still seems to have an edge over the universities in recruiting top-level people.

Scientists who select EMBRAPA over a teaching career point out that EMBRAPA salaries have historically been higher than university salaries, working conditions are better, and, most important, it is possible to devote full time to research without the distractions of teaching, administration, dissertation supervision, and so forth. EMBRAPA's research facilities are generally superior to those available at most universities. Thus, EMBRAPA drains some of the most talented researchers and other resources from the universities.

A second general cause for friction between universities and EMBRAPA is the belief that EMBRAPA competes for research funding from the same sources. Some university scholars believe that EMBRAPA enjoys an unfair advantage in the competition for research funding.

Perhaps the most serious problem raised by EMBRAPA's growth and success is its impact on teaching. The diversion of resources and talent in agricultural research to EMBRAPA may mean that, at least in some cases, advanced agriculture students have no access to the best minds and the most up-to-date research in their fields. Students may not have exposure to an interdisciplinary research model or to state-of-the-art equipment and techniques because they are unavailable in the schools. All of these factors could lower the quality of training, particularly at the postgraduate level.

It is paradoxical, then, that while EMBRAPA strengthens agricultural research in Brazil, it may lower the quality of university training. Over the long run this situation may have negative repercussions on research itself. It also slows the development of specialized education in Brazil. One consequence may be that a larger proportion of EMBRAPA's own staff and of the universities' staffs will consider it necessary to go abroad for postgraduate degrees.

EMBRAPA's leadership is aware of this problem, and they are implementing some remedies. There are mechanisms for bringing university professors into EMBRAPA's laboratories for fixed periods. There is a program under which graduate students serve internships in EMBRAPA research centers (Ramagem and Quirino 1988). EMBRAPA also encourages its researchers to teach occasionally in universities. But these linkages are difficult to establish and, so far, have only rarely been put into practice.

One basic problem is that only a few EMBRAPA research centers are located near universities with agriculture schools. In addition, there is no strong incentive for EMBRAPA staff to

teach. Their productivity, like that of faculty, is evaluated in terms of publications and grants, and teaching is likely to be a distraction from that.

There is little doubt that EMBRAPA will achieve its basic goal: enabling world-class agricultural research to take place outside the restrictions of the university setting. The speed with which EMBRAPA was built into a functioning research and development entity, actually generating technology for Brazilian agriculture, is remarkable. The costs of its success, particularly in terms of the diversion of resources away from agricultural higher education and university research, may only become apparent some time in the future.

6. THE POLICYMAKING CONTEXT OF AGRICULTURAL EDUCATION AND RESEARCH

Brazil has a history of centralized decision-making stretching back into the imperial period. Centralized decisions have been characteristic of development efforts since the 1930s, and the tendency was reinforced during the authoritarian military regime from 1964 to 1985 (Skidmore 1985). There has never really been a period in which regionalized or decentralized decision-making was favored as a policy; decentralized decision-making was more an artifact of isolation and poor communication or of the ability of particularly strong local leadership to resist central power. Paradoxically, programs have not always gained greater coherence through central control because agencies have tended not to cooperate across bureaucratic boundaries.

The first area in which centralized decision-making is evident is that of budgeting. Each Federal university prepares a budget submission for the Ministry of Education, which studies, modifies, and approves it for the coming fiscal year. University administrators have only a limited power to reallocate funds among categories. Even relatively well-off universities generate only a small part of their funds independently of the Federal budget. For example, Vicosa receives perhaps 10 percent from all sources other than the Ministry of Education.

From the perspective of the Ministry of Education, the universities' primary concern is to hire faculty to teach students. Therefore, most budget discussions concern enrollment and payroll issues. There are few opportunities for discussions of research or educational goals or for long-range planning.

Because of the sometimes chaotic fiscal situation and inflation in Brazil, actual disbursements may bear little

resemblance to projected budgets. In fact, budgets are adjusted throughout the fiscal year as administrators negotiate with the Ministry of Education for additional subventions to compensate for inflation, meet new opportunities, or overcome shortfalls. Under the strictures of the budget system, the universities have little margin for maneuvering.

In the area of curriculum, as in that of finances, Brazilian universities have little room for innovation. University degree programs in all the institutions in the country must follow a uniform curriculum prescribed by the National Education Council. Schools are free to add optional courses and additional degree requirements, but the prescribed curriculum for each degree is quite detailed. Postgraduate degree programs must also be approved, but specialized programs can be proposed and, if approved, implemented at the local level.

Decision-making in most Brazilian institutions, as in the Government, is concentrated at the top of the organization. It is common for the head of an agency to be required to sign off on virtually every document that circulates through that agency. For example, the rector of a large university must personally approve a janitor's vacation request. Again, however, concentration of decision-making power does not confer coherence on an organization. In general, except in EMBRAPA, there is little strategic planning for research and human resource management within such organizations as universities and Federal research and development agencies. The Ministry for Industrial, Scientific, and Technological Development has yet to implement a plan for achieving research and development goals. Fellowships and other resources are still being allocated basically in response to applicant demand. Decision-makers are forced by the vagaries of funding to be somewhat opportunistic and decisions may be rushed by a sudden financial windfall.

Besides being highly centralized, public institutions also tend to be rather insulated from other institutions in their environment, and this situation creates major problems with respect to interorganizational coordination. At least eight different Federal agencies, subordinate to several different ministries, make significant decisions in the areas of higher education and research in agriculture. Numerous quasi-public and private organizations also have a stake or role in agricultural education and research. There is considerable overlap and occasionally competition or friction among these various agencies, and there are few occasions on which they attempt to coordinate their efforts. Nor do they have regular lines of communication for dealing with their mutual concerns. The study teams were unable to learn of a single standing committee dealing

with questions of interagency coordination of agricultural education and research.

There is a growing number of nongovernmental organizations concerned with agricultural education and research. The agriculture faculties have an organization, the Brazilian Association for Higher Education in Agriculture (ABEAS), headquartered in Brasilia, which holds an annual meeting, publishes a professional journal, and produces educational materials for use in agricultural training. ABEAS is not an independent organization, however, because it is subsidized by the Ministry of Education. There are also national and state associations of agronomists and other agriculture professionals, as well as the scholarly societies mentioned previously. As far as the study teams could determine, these organizations are not set up to systematically study matters of concern to their membership, nor do they act as lobbies for their members' interests.

What is most remarkable is that there are no visible national farmer organizations in Brazil. The closest approximation seems to be some of the larger producer and marketing cooperatives; but if these groups are attempting to affect policy in agricultural education and research, the study teams are unaware of it. Some large-scale producers of sugar and alcohol and large beef cattle operators demonstrably have considerable clout in agricultural policy formation, but they do not use it to affect education or research in any obvious way. In general, there is remarkably little involvement of nongovernmental organizations in the issues under discussion here.

7. CONCLUSIONS

7.1 Major Factors Influencing Research and Educational Institutions

The first conclusion to this study is typical of many impact analyses: it is not possible to disentangle the effects of USAID's projects from many other events occurring independently of them. They can only be considered together with some of the other major factors influencing the research and educational institutions in Brazil over the same period of time.

First, the general political and economic conditions in Brazil during the period of project implementation were significant. From the middle 1960s until the late 1970s, Brazil

underwent a period of rapid growth in industry and technology. The basic strategy was to use export earnings to finance importation of technology and know-how to build the industrial base. This strategy had several repercussions on agriculture, some of which reflected the thrust of the A.I.D. project. Most notable was the rapid growth in the importance of soybeans as an export crop, growth that was assisted, in part, by research conducted in Brazil. The expansion of sugarcane as a feedstock for fuel alcohol distilleries arose primarily as a way of decreasing the expenditure of currency for petroleum imports. For basic food staples, the change in productivity was disappointing. Basic changes in the food crop yield profiles will probably occur as a result of changes in the market for land and agricultural commodities; research can help, but, so long as the basic market factors are adverse, large gains are probably not to be expected.

Second, during the time of the project, Brazil made heavy investments in universities and human capital development in general. Agricultural higher education boomed during this period; at Government expense, hundreds of people pursued advanced degrees in Brazil and abroad, becoming university teachers and professional researchers. These human resource investments added to the effect of the USAID projects, although, as a whole, the valorization of human capital was not balanced with investments in university research facilities and in suitable institutional arrangements for disseminating knowledge at the farm level.

The third major development that affected the outcome of the A.I.D. project was the rise of EMBRAPA. While the effects of the A.I.D. project contributed to the development of EMBRAPA's staff, EMBRAPA itself may have weakened the universities that A.I.D. was attempting to strengthen. The rise of a separate agricultural research organization was not envisioned when the A.I.D. project was designed, nor does it appear to have been factored into the project after 1972.

Finally, the general evolution of the Brazilian university must be taken into account as a factor influencing the development of the A.I.D. project as a whole. A.I.D.'s investments in agricultural higher education came at a time when universities were rapidly expanding their enrollments and adopting a new model of instruction. This "massification" of higher education diluted the impact of a project aimed at strengthening a particular area of science, and through it, an area of the economy.

7.2 Implications for Development

The implications of the present study for development can be stated as a series of questions about the projects studied and about related issues. Where possible, implications for development in other countries are explored.

Was the project focus on postgraduate education appropriate? The question of focus must be answered in the context of the size and resources of the developing country or region. In the case of Brazil, a large country rich in human and natural resources, the decision to stress postgraduate education was a good one. According to the faculty at the universities where the four primary subprojects were implemented, the most important outcome of the project was the ability to train more students at a higher level than was possible before. The graduates of these institutions are very well represented in the major institutions for agricultural education, research, and development. The legacy of the project continues to be felt in the past and future graduates of the programs it helped to strengthen.

The impact of the project may have been diluted, however, by the massification of Brazil's universities just as the postgraduate programs got under way. The rapid increase in enrollments outstripped the increase in the numbers of scientific professionals, diverting personnel and other resources from building excellent research facilities and cohesive teams. Faculty salaries and other support increased, only to be undermined by sudden political shifts, increasing class sizes, deteriorating facilities, and high inflation. Faculty members morale rode a roller coaster dictated by factors outside their power to control. Conditions for research and training were best in universities with postgraduate programs, but even at these institutions, there were uncertainty and discouragement.

Was the project design sensitive to regional differences? In a poor region characterized by high illiteracy, large imbalances in the distribution of income and education, and low levels of investment in agriculture, postgraduate courses may exert a distorting influence. The gap between elites in the university and the rural masses may be so wide as to impede transfer of technology to farmers, and there may be no institutional structure capable of translating research results into practical improvements in the rural zones. This situation seems to have obtained at the Federal University of Ceara. Even Vicosa, arguably the most successful of the four subprojects, had little effect on farming in its surrounding hinterland, where agriculture is small scale and technologically relatively backward. These considerations suggest that in such regions

postgraduate education may need to be structured differently than in a more developed region.

These considerations lead us to the question of whether the project was equally appropriate to all regions in which it was implemented. The States of Ceara and Minas Gerais are characterized by rural production systems very different from those in the rest of the country. In both cases, the excellent high-level postgraduate training and research facilities that were put in place made little development impact in the region surrounding the universities. Although several valuable technological packages were devised at Ceara, including the use of grain sorghum, new sheep breeds, and freshwater pisciculture, they had little impact on agriculture in the region because the technology was not transferred successfully. For a variety of institutional reasons, the research leading to these innovations did not include economic feasibility studies and field testing. Several important crop varieties, especially soybeans, were developed at Vicosa, but their impact was in a distant region; agriculture in the immediate vicinity of the university languished in relative backwardness.

Attempting to modernize agriculture among small-scale, poor farmers is perhaps the most daunting challenge in contemporary development. Experience teaches, however, that excellent technology alone is not sufficient to alter the behavior and expectations of such farmers. Both Ceara and Vicosa have strong agricultural economics programs with specialists experienced in working with small farmers. However, as far as the study teams could ascertain, the agricultural economists and rural sociologists rarely collaborated with their colleagues in agronomy and other fields to develop and test technological packages or farm-management techniques for small and medium-sized farms.

In any program evaluation, the level that an institution reached prior to any program of outside assistance must be carefully considered. At Ceara and Rio Grande do Sul, many faculty members stated that prior to the A.I.D. program, they had virtually no research capability in most fields. They felt grateful for any and all guidance and assistance that they received. In the case of Sao Paulo, however, sufficient consideration may not have been given to the high level of sophistication already present in the college and to the faculty's sensitivity about outside intervention.

In all these cases, prior analysis of social and economic conditions in each region might have contributed to better design and implementation of the subprojects. These criticisms are not meant as an indictment of any of the programs in question. All

of them are preeminent postgraduate programs in agriculture in Latin America, and the most influential institutions in their respective regions.

Was the project implemented adequately? Implementation depended almost completely on the four U.S. institutions that provided consultants and participant training. They varied among themselves in terms of how carefully and conscientiously they carried out the project. In general, the four U.S. universities were scrupulous and thorough. They brought competent scientists to Brazil and provided them with the tools necessary to train students and to begin research projects. They also effectively trained many Brazilian participants in graduate programs in the United States. They stimulated many valuable projects and helped to design and create postgraduate programs in many fields. The strength and continued growth of these programs, and the proliferation of other programs that they stimulated, testify to the success of the subprojects.

However, as has been mentioned, there were problems during implementation that centered mainly around two areas: poor preparation of the consultants sent to Brazil, and insensitivity to the desires of the host institutions. Apparently, many of the consultants arrived in Brazil without a working knowledge of Portuguese, and some failed to acquire the language during long stays. It is not absolutely necessary that a visiting consultant know the language of the host country, provided there is a prior understanding that the consultant cannot use the language and suitable arrangements are made to get around that problem. Ideally, all long-term consultants would have received adequate training in basic language skills and other knowledge necessary for a smooth adjustment to the host country and institution.

In any overseas aid program, preparation of consultants should be comprehensive and should cover not only the language but also the culture, politics, and economics of the particular region to which they are assigned. It would also be desirable to provide seminars to help consultants develop an idea of their role in the overall strategy for scientific and institutional development in collaboration with the host institution. By this means, each subproject could be tailored to the specific conditions and needs of the host institution. If such training had been provided in connection with the projects in Brazil, some of the problems that arose might have been avoided.

In future projects of this sort, there could be specific provisions in the agreement with U.S. contractors obliging them to make suitable provisions for language training, cultural conditioning, and integration into the overall strategy of the visiting mission. These matters, particularly the last, should

also be the topic of regular, ongoing discussions between hosts and visitors at a suitable level.

Another question that arose with some frequency is whether the U.S. institutions selected the most appropriate consultants to send to Brazil. In several cases, the hosts felt that the consultants' fields were not those of highest priority for the host institutions, or that the consultants themselves were not the best prepared and most experienced. These problems could have been obviated by better consultation with the host institutions concerning the field of expertise, level, and experience they desired. In at least one case, the hosts recognized that the consultants who were sent were relatively young and inexperienced, but because the hosts themselves felt like beginners in the field, they did not feel shortchanged.

It is appropriate at this juncture to question whether the strict pairing of institutions is the ideal strategy. Pairing has specific advantages: it creates on both sides a focus and a locus of responsibility that reduces problems of communication and administration and maximizes accountability. However, it can be argued on the basis of the Brazil experience that pairing should be implemented more flexibly. The U.S. institution can and should make use of personnel from other institutions, particularly if the hosts feel this is important. Only occasionally will the resources of an institution--even a large and diverse university--match all the needs of a particular host institution.

Did the project contribute to agricultural development in Brazil? Again the caveat entered above must be invoked: it is not possible to separate the effect of this project from many other influences. Still, the evidence is strong that this project contributed in many ways to agricultural development in Brazil. Moreover, this project demonstrably had a considerable multiplier effect, and its impact continues to be felt in Brazil. Since these issues have been discussed in detail in this report, they are only summarized here. The major accomplishments of this project were that it (1) contributed greatly to the establishment of four major centers of postgraduate studies and research that are today among the most influential and productive programs in Brazil; (2) strengthened several other programs and added significantly to the supply of highly trained agricultural researchers and professors; (3) introduced up-to-date research techniques and equipment to Brazilian institutions; (4) launched several important lines of research, including entirely new disciplines such as home economics, and developed some influential technological packages.

Although the project was meant to introduce the model of a U.S. land-grant university to Brazil, none of the agricultural colleges involved in the project emerged resembling a land-grant college any more than it had before the project. The project strengthened institutions primarily along traditional academic disciplinary lines. The institutions involved did not apparently become any more attuned to the specific social and economic problems of their respective regions or oriented towards extension and outreach as a modus operandi.

The study teams' inquiry makes it clear that the successful transfer of a development model depends on institutional aspects beyond the limits of academic and research programs, and on institutions outside the universities themselves. This report has dwelt on the lack of feedback mechanisms between the job market and the universities. Because enrollments continue to expand rapidly, Brazilian universities are under relatively little pressure to tailor their offerings to the future needs of students and their prospective employers. Future projects aimed at improving technical education should be designed to help develop mechanisms to enhance communication between the university and the entities, public and private, that its graduates will serve. Some possible mechanisms include placement services, alumni associations, advisory councils, farmer participation in university activities, internship programs, greater involvement in extension activities, and increased involvement by the private sector in university finance. In some cases, there are U.S. models that can be transferred to other countries. In most cases, however, this kind of institution building should be undertaken with careful attention to the local context. Such an effort requires the advice of social scientists familiar with the local context and of host-country experts who, after all, will have to live with whatever institutions are created.

There is no guarantee that stronger, more focused efforts at transferring the land-grant model would have met with success. In Brazilian life, the university has not been an instrument for reaching out to the masses or promoting social change, although this rhetoric has often been used. Attempting to force this vision on Brazilian universities could well have done as much damage as good. Future strategies might consider different ways of helping universities to become responsive to social issues.

Future projects should be designed to involve institutions beyond the universities. The aim would be to strengthen the linkages between the university and other institutions concerned with agriculture, technological change, food production, and exports. One way to carry out this goal would be to strengthen the social science component of future projects and to promote a

research model that brings together social scientists, agricultural scientists, farmers, and business people within the university to work on problems.