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IMPLEMENTATION COMPLETION REPORT
(CPL-42660)

ON A

LOAN

IN THE AMOUNT OF US$155.0 MILLION

TO THE

FEDERATIVE REPUBLIC OF BRAZIL

FOR A

SCIENCE AND TECHNOLOGY REFORM SUPPORT PROJECT - PADCT III

March 3, 2005

Human Development Sector Management Unit
Country Management Unit for Brazil
Latin America and Caribbean Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective March 3, 2005)

Currency Unit	=	Real (R$)
R$2.58	=	US$ 1.00
US$ 0.38	=	R$1.00

FISCAL YEAR

January 1 - December 31

ABBREVIATIONS AND ACRONYMS

CAPES	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Coordinating Agency for Graduate Education)
CAS	Country Assistance Strategy
CCT	Conselho Nacional de Ciência e Technologia (National Council for Science and Technology)
CSCG	The Colegiate of the Grupos Técnicos
CNPq	Conselho Nacional de Desenvolvimento Científico e Tecnológico (Brazilian National Council for S&T Development)
FAP	Fundação de Amparo à Pesquisa (State Foundation for the Advancement of Research)
FINEP	Financiadora de Estudos e Projetos (Brazilian National Foundation for Technology Development)
FNDCT	Fundo Nacional de Desenvolvimento Científico e Tecnológico (National Fund for Science and Technology Development)
GCCT	Grupo Consultivo de Ciência e Tecnologia (International Consultative S&T Group)
GDP	Gross Domestic Product
GOB	Government of Brazil
IBGE	Instituto Brasileiro de Geografia e Estatística (Brazilian Bureau of Census)
ICT	Information and Communication Technology
ISO	International Organization for Standardization
INPI	Instituto Nacional de Propriedade Industrial (National Institute of Industrial Property)
IPR	Intellectual Property Rights
LCSHD	Human Development Sector Management Unit, Latin America and Caribbean Region, World Bank
MCT	Ministério da Ciência e Tecnologia (Ministry of Science and Technology)
MSI	Millenium Science Initiative
MSTQ	Metrology, Standards, Testing, and Quality
NSF	National Science Foundation
MTR	Mid-term Review
OECD	Organisation for Economic Cooperation and Development
PADCT	Programa de Apoio ao Desenvolvimento Científico e Technológico (Program to Support Scientific and Technological Development)/Science and Technology Reform Support Project
PEA	Project Executing Agency
R&D	Research and Development
R&D&E	Research and Development and Non-routine Engineering
SEBRAE	Serviço Brasileiro de Apoio às Micro e Pequenas Empresas (Brazilian Support Service for Small Businesses)
SME	Small- and Medium-size Enterprises
S&T	Science and Technology

Vice President:	Pamela Cox
Country Director	Vinod Thomas
Director/Sector Manager	Evangeline Javier / Eduardo Velez Bustillo
Task Team Leader/Task Manager:	Lauritz B. Holm-Nielsen

BRAZIL
Science and Technology Reform Support Project - PADCT III

CONTENTS

Project ID: P038947	*Project Name:* BR- SC. & TECH 3
Team Leader: Lauritz B. Holm-Nielsen	*TL Unit:* LCSHE
ICR Type: Core ICR	*Report Date: March 3, 2005*

1. Project Data

Name: BR- SC. & TECH 3
L/C/TF Number: CPL-42660
Country/Department: BRAZIL
Region: Latin America and the Caribbean Region

Sector/subsector: Tertiary education (41%); Micro- and SME finance (41%); Central government administration (12%); Law and justice (6%)
Theme: Small and medium enterprise support (P); Technology diffusion (P); Education for the knowledge economy (P); Infrastructure services for private sector development (P); Law reform (S)

KEY DATES		*Original*	*Revised/Actual*
PCD:	11/27/1995	*Effective:*	06/15/1998	06/15/1998
Appraisal:	04/30/1997	*MTR:*	06/30/2000	12/12/2000
Approval:	12/18/1997	*Closing:*	05/31/2002	07/31/2004

Borrower/Implementing Agency: FEDERATIVE REPUBLIC OF BRAZIL/MINISTRY OF SCIENCE AND TECHNOLOGY
Other Partners:

STAFF	Current	At Appraisal
Vice President:	Pamela Cox	Shahid Javed Burki
Country Director:	Vinod Thomas	Gobind T. Nankani
Sector Manager/Director:	Evangeline Javier	Patricio Millan
Team Leader at ICR:	Lauritz B. Holm-Nielsen	Alcyone Saliba
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2. Principal Performance Ratings

(HS=Highly Satisfactory, S=Satisfactory, U=Unsatisfactory, HL=Highly Likely, L=Likely, UN=Unlikely, HUN=Highly Unlikely, HU=Highly Unsatisfactory, H=High, SU=Substantial, M=Modest, N=Negligible)

Outcome: S
Sustainability: L
Institutional Development Impact: SU
Bank Performance: S
Borrower Performance: S

	QAG (if available)	ICR
Quality at Entry:		S
Project at Risk at Any Time:	Yes	

3. Assessment of Development Objective and Design, and of Quality at Entry

3.1 Original Objective:

The objective of the Science and Technology Reform Support Project (PADCT III) was to improve the overall performance of Brazil's science and technology sector by undertaking activities that promoted scientific research and technological innovation. The project would support reform efforts and finance investments designed to: (a) stimulate private sector financing and execution of research and development; (b) increase and improve the stock of Science and Technology (S&T) human capital; and (c) supply support services required to increase the efficiency of public and private investments in S&T activities.

Assessment

The project's objective was consistent with the Government of Brazil's (GOB) national development strategy to accelerate private sector-led economic growth (financed and generated primarily by firms) and the World Bank Group's Country Assistance Strategy (CAS, June 1997), which supported the strategy to give high priority to raising the private sector's productivity and international competitiveness by increasing investments in human capital and by creating innovation through investments in the science and technology sector. The project was a continuation of two previous World Bank-financed projects (PADCT I and PADCT II, ICR Outcome ratings: Satisfactory) and the PADCT III Project was intended to continue to improve management and decision-making processes through open competition for research grants, interaction between government agencies and the scientific community, and greater continuity and integration in the financing of research projects.

3.2 Revised Objective:

The objective was not revised, yet the project was simplified during the Mid-term Review (MTR). The GOB decided to finance the institutional development subcomponents out of the Government budget and through the newly-established sectoral funds (see Section 3.4).

3.3 Original Components:

The project had four components financed with a US$155.0 million IBRD Loan, a GOB counterpart of US$155.0 million and an indirect private sector contribution of US$50.0 million for a total cost of US$360.0 million.

Project Component A – Technology Development (US$147.0 million; IBRD US$58.0 million). This component would finance technology development to stimulate Research and Development (R&D) activities in the private sector, focusing on (i) innovations by small- and medium-sized enterprises, (ii) ways to streamline public incentives for R&D and (iii) greater productive use of scientific and technological resources by firms. There were three subcomponents:

A1. Platforms (US$4.2 million). Support for cooperative pre-competitive research to foster partnerships among industries, universities, technological institutes, and appropriate government agencies through which economically and socially relevant problems amenable to technological solutions could be identified, and preliminary strategies for solving these problems through cooperative research projects could be formulated. The project would finance meetings and conferences to bring together relevant stakeholders to devise R&D agendas to solve technological problems.

A2. A matching grant facility, providing two types of grant programs: (i) *Publicly-led cooperative projects* (US$36.2 million) to foster partnerships between the public and private sectors for the financing and execution of R&D. This subcomponent was established to fund socially and economically relevant research and development projects that would involve public and private sector cooperation and be co-financed with

matching funds from participating firms. Proposals would be appraised and selected by advisory committees through a competitive process reviewing both technical and business merits; and (ii) *Privately-led cooperative projects* (US$73.2) to foster cooperation between individual firms and public sector R&D entities with the purpose of producing proprietary R&D outputs. This subcomponent was designed to fund R&D projects executed by one or more public sector R&D entities cooperating with individual firms or consortia of firms. The selection procedure was similar to that for publicly-led projects with minor adjustments to protect confidentiality and emphasize intellectual property contracts.

A3. Assistance for technology adoption by SMEs (US$33.4 million) to enhance their capacity to innovate. This subcomponent was established to fund the existing federal SME program, which provided small grants for initial technological problem-solving in SMEs.

Project Component B – Science and Technology Research (US$147.0 million; IBRD US$75.0 million). This component was designed to support science and technology research and increase the stock of high-level human capital in S&T, focusing, among other things, on investments in scientific research and graduate training and improvement of procedures and policies, including incentive mechanisms aimed at shifting scientists' and technicians' focus towards areas more relevant to the productive sector. The component awarded grants for scientific research and for developing regional S&T capacity. Advisory committees selected grantees on the basis of peer reviewers' rankings.

Project Component C – Sectoral Support Activities (US$44.4 million; IBRD US$15.0 million). This component was designed to improve efficiency and quality throughout the S&T system by supporting portfolio reforms, improving monitoring and evaluation systems and ensuring protection of intellectual property rights and provision of metrology, standards, testing and quality (MSTQ) services. There were five subcomponents:

C1. Support to working groups involved with sectoral reform (US$8.9 million) to ensure that rationalization of the system was based on coherent planning and management. The working groups would among others include: (i) *The MCT (Ministry of Science and Technology) Working Group on Sector Reform (the CSCG)* would have the responsibility of developing a plan to reform institutions and programs directly under the MCT's control; and (ii) *The Policy Studies and Advocacy Group.* Representing the entire federal sector, this group was established to recruit and engage the experts required as inputs into the policy making process, convene public fora and meetings on policy issues as well as commission studies on relevant topics.

C2. Support for improving sectoral monitoring and evaluation (US$10.4 million) to improve the quality, coverage, and accessibility of information about the performance of the S&T sector. This subcomponent was intended to support initiatives by the main agencies with monitoring and evaluation (M&E) responsibilities in the sector [for example the Brazilian Council for S&T Development (CNPq), the Coordinating Agency for Graduate Education (CAPES), the Brazilian Bureau of Census (IBGE), and the State Foundations for the Advancement of Research (FAP)] in order to (i) more accurately determine Brazil's gross expenditure on R&D, (ii) develop and implement standards for reporting by federal S&T institutions, (iii) complement the existing national database of active research groups and researchers with more complete information on employment patterns for S&T graduates and (iv) support evaluation of the quality and relevance of Brazilian research output. The activities would be overseen and directed by a Technical Coordinating Group, with three non-Brazilian M&E specialists as members.

C3. Support for administering and enforcing the intellectual property rights regime (US$4.0 million). This subcomponent would support part of the ongoing restructuring efforts of the National Institute of

Industrial Property (INPI), aimed at preparing the institution for effective enforcement of the 1996 industrial property law.

C4. Support for metrology and standards services (US$16.3 million) to improve the quality of the metrology, standards, and testing services available to the Brazilian productive sector. This would involve (i) enhancing the National Metrology Laboratory and the Brazilian system of reference laboratories, (ii) developing certification of reference materials, (iii) enhancing the Brazilian Network of Calibration Laboratories, (iv) training professionals in metrology, (v) modernizing the Brazilian Association of Technical Standards, (vi) consolidating the Brazilian Network of Testing Laboratories, and (vii) disseminating technology management tools within firms.

C5. Interim Fund to provide for the maintenance of scientific equipment (US$4.8 million). This fund was intended to supply researchers with maintenance funds for scientific equipment acquired under PADCT I & II (Program for the Advancement of Industrial Technology). Under PADCT III, maintenance funds were included in the grants for purchases so institutions that had received grants for scientific equipment automatically received funds for maintenance.

Project Component D – Project Management (US$9.9 million; IBRD US$2.0 million). This component would finance project management activities such as overall planning and coordination of project activities, including the preparation of the relevant Annual Operating Plan. The project was implemented by the Ministry of Science and Technology (MCT) with administrative assistance of the Brazilian National Foundation for Technology Development (FINEP), the Brazilian National Council for S&T Development (CNPq) and the Coordinating Agency for Graduate Education (CAPES), plus contracted services from several entities, including private firms, universities, non-governmental organizations and state governmental agencies.

Institutional Project Structure

The organizational framework of the project was a complex structure involving a number of players within the S&T sector. The Ministry of Science and Technology had the coordinating role, while separate agencies implemented component activities. *The Technology Development Component (Component A)* was implemented by FINEP; *the Science and Technology Research Component (Component B)* was implemented by the three federal implementing agencies: FINEP, CNPq and CAPES. These agencies were responsible for contracting, disbursing funds, and monitoring projects that fell within their jurisdiction. FINEP administered projects that focused on technological development, CNPq administered projects that focused on science and technology research and CAPES administered projects that focused on human resource training. Further, the State science funding agencies (FAPs) were encouraged to cooperate during implementation of projects pertaining to their respective state.

Assessment

The project design reflected the ambitious development objective of the project and was built on the positive experiences from the two first investments under the Program to Support Scientific and Technological Development (PADCT). The design addressed all of the significant issues facing the GOB in its efforts to improve the performance of the science and technology sector. In the aftermath of the financial crisis in 1998, the MTR played an important role in working with the Government to simplify and streamline the project in order to accelerate implementation and meet the objective. Discussions on simplifying the project were based on the Ministry of Science and Technology's "Proposal for Project Revision at Mid-term Review" (see Section 3.4).

3.4 Revised Components:

Implementation progress was reviewed during the MTR in 2000 and since the level of disbursement was low, the Bank considered cancelling the remaining loan balance. However, the GOB presented a proposal to revise and simplify the project, which did not affect the overall project objective. The reasons for the simplification of the project were: (i) implementation slow-down during the first three years of the project due to the severe fiscal crisis of 1998 and lack of sufficient counterpart funding; (ii) a devaluation of the Real to approximately a 30 percent value against the US$, and consequently much lower local expenditures as measured in US$; (iii) mobilization of funding from the private sector through a series of new sectoral funds, which were established by law during the second and third year of project implementation, and which reduced the need for Bank financing. The establishment of these funds was supported by the PADCT Component C; and (iv) restructuring of the MCT and the integration of all budget lines under the multi-year budget planning process for the national budget, which eliminated the special budget line for the PADCT.

Amendment

At the MTR, the GOB and the World Bank agreed to simplify the project (Amendment dated August 2001) to ensure successful implementation. The Federal Government had overcome the fiscal crisis of 1998 and was capable of resuming its role as a key funder of S&T research. The cost of doing research in Brazil was greatly reduced due to the devaluation. In addition, the Government, with support from the PADCT, had developed a long-term strategic plan for research. The plan included the establishment of a number of sectoral funds, which would raise money from companies working in sectors such as biotechnology, energy and fuel. These new funds would be used to finance research in each specific sector. About US$400.0 million per year was raised through these funds since 2001, and thus provided a substantial new investment from the private sector into science and technology research. Thus, the sectoral funds reduced the need for funding through the PADCT III. Finally, the restructured ministry took on more of the policy and framework conditions for the sector, which in general reduced the need for external financing of specific policy and framework related components.

As a result, several project activities were taken over by the Government and phased out of the project: C1. Support for strengthening of intellectual property rights law enforcement in conjunction with the Ministry of Justice, C2. Support for Metrology, Testing, Standards and Quality (MSTQ) services and C3. Special fund for maintenance of existing equipment. At the same time, it was recognized that the original implementation plan included a top-heavy and expensive committee structure for project management and oversight. Four high-level committees (the Supervisory Committee (CS), the Technical Advisory Committee (GTC), the International Consultative S&T Group (GCCT) and the Colegiate of the Grupos Tecnicos (CSCG), were reduced to two, namely the CS and the GCCT in an effort to simplify the project management and oversight mechanisms and create a less complicated and more efficient structure. In addition, the number of Project Executing Agencies (PEAs) was reduced from three (CNPq, FINEP and CAPES) to two by transferring CAPES's PADCT activities to the CNPq. The CNPq, FINEP and CAPES contracted and administered subprojects in their respective field of expertise: science research, technology development and human resources development. Yet, in most cases, no clear distinction existed between the science research and human development projects, and therefore it was agreed that the CNPq could take on these responsibilities for the Government. Finally, the Millennium Science Initiative (MSI) (appraised in June 2000) was included in the PADCT III Project. The central concept of the MSI was to concentrate resources on a select number of the country's best researchers, which was also central to the development objectives of PADCT's research and science component. The integration of the MSI helped to achieve the project's objective, basically by strengthening the review procedure for science research projects.

Extensions of the closing date

The original closing date was May 31, 2002. This date was first extended seven months to December 31, 2002, and then to July 31, 2004. The extensions were justified by the financial crisis itself, delays in implementation due to insufficient counterpart funding during the crisis, and the simplification of the project after the MTR.

Cancellation of funds

The final closing date extension was combined with the cancellation of US$88.8 million. As a result, the total IBRD investment was reduced from the original US$155.0 million to US$66.2 million. The remaining balance was directed at completing activities under the Science and Technology Research Component (B) and thereby ensuring full disbursement of the remaining funds. The cancellation of funds for the Technology Development Component (A) was a response to both the devaluation of the Real, which reduced the cost of local activities to between one third and half of the original price estimate; and the introduction of the 14 self-sustaining government sectoral funds for technology research in 2001, which greatly reduced the need for the project to co-finance technology R&D at that point in time. As mentioned above, the establishment of sectoral funds raised resources at the level of US$400.0 million per year from the productive sector. The development and passage of this law complex in the Brazilian congress were major tasks for the MCT. This innovation was in part supported by the PADCT, and it has greatly enhanced the sustainability of funding for Brazilian technology research.

3.5 Quality at Entry:

The project's quality at entry is rated *satisfactory*. The PADCT III was a follow-on project to two successful previous operations (PADCT I & II) and the project fully supported the CAS approved by the Board in June 1997. The project activities supporting the CAS objectives were: (i) the rationalization of the MCT's portfolio and improved sectoral M&E were intended to contribute to the objective of public sector reform aimed at *improved fiscal performance at the national and subnational level*; (ii) the matching grant subcomponent was designed to remove information and other barriers to technological investments via improved cooperation between firms and the S&T sector, thus leading to *productivity and competitiveness gains*; (iii) improved Intellectual Property Rights (IPR) administration and strengthened MSTQ services would *improve productivity and competitiveness*, especially in export-oriented firms; and (iv) technology assistance to SMEs would contribute to improvement of the *efficiency and competitiveness of the SMEs*.

The project was in line with the Brazilian Government's reform program in S&T, which was intended to develop the country's capacity to innovate through investments in the science and technology sector. The Bank had substantial experience in the Brazilian S&T sector through PADCT I & II where it had been a key partner in the evolving dialogue on S&T policies. Through these earlier projects, the GOB had also demonstrated entrepreneurship and commitment by strongly promoting the process and providing significant funding for research and innovation as well as developing an extensive policy agenda.

The lessons learned from the PADCT I and II Projects were incorporated into the design of this project. Special focus was given to: (i) the regional aspect in order to encourage cooperation with less advanced regions, and (ii) the establishment of high-level peer review committees consisting of independent prominent national and international professionals. However, as recognized at the MTR, the organizational framework was too complex and the committee structure too heavy. The project appropriately identified the main risks and included actions to mitigate these risks. The possibility of an eventual need for cancellation of uncommitted loan funds in the event of a serious macroeconomic deterioration was foreseen in the project appraisal document.

4. Achievement of Objective and Outputs

4.1 Outcome/achievement of objective:

The project's overall performance is considered *satisfactory*. There were positive results in creating a conducive environment for Brazil's S&T sector. The project stimulated and increased private sector financing by supporting the establishment of 14 sectoral funds, and execution of R&D by developing technology transfer capabilities, improving and expanding R&D capabilities in the least developed regions of the country, developing a culture of cooperation and partnerships, increasing and improving the stock of advanced human capital for S&T and simplifying and prioritizing Brazil's efforts to become a high value-added economy. The project's objective was met even in the context of a severe macroeconomic crisis and consequent budget constraints for the Federal Government. During implementation, the GOB integrated funding for the project in its *Plano Plurianual (PPA)*, which ensured that the PADCT activities were completely integrated into the range of the MCT's activities, and increased the likelihood of sustainability of the PADCT III-financed activities beyond the term of the project. The MCT's PPA for 2004-2007 includes continued funding of (i) the Millennium Science Initiative; (ii) basic science; and (iii) industrial R&D; and the full range of other activities envisaged under PADCT III.

The project contributed to the following sector outcomes:

Investment increase in R&D. Despite the financial crisis, the project contributed to a sustained focus on the R&D sector by the GOB. Investment in R&D increased from 0.77 percent of GDP in 1996 to a little more than 1 percent in 2000 and then decreased again in 2002, but still maintained the 1996 level (World Bank 2004). The private sector showed a keen interest in investing in R&D and, in addition to the new substantial sectoral funds, invested more than the annual US$50.0 foreseen at appraisal. The commitment and involvement of the private sector was essential to the development of scientific and technological outputs and for the process of technology transfer.

Improved technology transfer. The technology capabilities of research institutes and universities and the absorptive capacity of private companies were improved. Partnerships established during the project helped stimulate universities and research institutes to create technology transfer offices and companies to open new R&D divisions. Close to 60 percent of the partnerships developed during the project were maintained either informally or formally. A study based on data from "Indicators of Technological Innovation in Companies" shows that cooperation between companies, universities and technological institutes rose sharply between 1997 and 2000. Of the 108 companies included in the sample, 27 percent of companies carried out R&D activities with universities or technological institutes in 1997. In 2000, this share had risen to 44 percent (Sbragia 2002).

Increase in number of Master's and PhDs degrees. The number of PhDs and Master's degrees awarded grew from 12,000 Master's and 3,800 PhDs in 1997 to 18,500 and 5,500 respectively in the year 2000. The total number of PhD holders grew from 18,724 in 1997 to 34,349 in 2002, which indicates a remarkable growth in research over the life of the project (OECD 2004).

Increase in number of published articles. The increase in publications in scientific journals of international reputation was extraordinary and shows an impressive progress of Brazilian science. The number of articles published increased from 4,362 in 1997 to 7,205 in 2001 (NSF 2004). The citation of Brazilian S&T articles in foreign scientific research publications increased from 0.26 percent worldwide in 1996 to 0.45 percent worldwide in 2001 (NSF 2004), which implies that the quality and relevance of research in Brazil increased significantly during project implementation.

Brazil has also strengthened its *foreign scientific cooperation*. During implementation, the CNPq (Brazilian National Council for S&T Development) signed cooperation agreements with 29 countries, involving 53 research development agencies. Several of the agreements and programs are recognized for their social significance and scientific excellence. It is important to note that various private sector national companies are involved in many of these projects, particularly those that have greater technological content (CNPq 2004). The increase in international collaboration is revealed in the number of articles coauthored with foreign researchers. Between 1994 and 2001, the number of U.S. research articles coauthored with at least one Brazilian increased more than a hundred percent from 1,624 articles to 3,369 articles.

Strengthening science research. The inclusion of the Millennium Science Initiative (MSI) under the project in 2001 consolidated the institutional model for publicly funded research. The project was successful in supporting world level research groups that were capable of acting as a catalyst for a national network of laboratories (OECD 2004). The formalized networks helped improve research methodology by encouraging professionals to think in terms of viable proposals and long-term sectoral strategy.

The 14 sectoral funds are a new tool to strengthen technological research. The funds are financed by levies on income of privatized sectors, royalties and taxes on imported technology, and thus do not depend on traditional sources of budgetary revenue. Since 2001, the sectoral funds brought a major increase in funding of approximately US$400.0 million per year for technological research. Research and other activities financed by the sectoral funds are aimed at eliminating knowledge-based and technical bottlenecks in the sector from which each fund draws its finance. The sustainability of the funds is secured by a law approved by the congress in 2000. Each fund has a board and operates under the rules and regulations set forth in the legislation. The mobilization of private funding through the sectoral funds is a major accomplishment by the Government, which has reduced the pressure on the federal budget.

Increased participation of the least developed regions. The participation of the least developed regions of the country in R&D activities was increased through targeted investment. In 1997, the share of investment in R&D of the North and the North East region represented 2.33 percent and 12.14 percent respectively. By the year 2002, the share was 3.46 percent and 13.39 percent. This signals an important shift in absolute terms of a 60 percent increase in the Northern region and almost a 20 percent in the North Eastern region.

4.2 Outputs by components:

Project Component A – Technology Development Component

This component was welcomed by the private sector and its overall implementation was *satisfactory*, considering the difficult macro environment and changing sectoral legislation. In 2002, it was agreed to conclude the activities under this component since the establishment of the 14 sectoral funds made it unnecessary to continue the component. More than 140 subprojects covering SMEs, cooperative research, regional research and pre-competitive research platforms were implemented, prior to the establishment of the sectoral funds. Valuable experience was obtained, and was used by the MCT in the launch of the sectoral fund activities. The concrete results of the component were reduced due to the lack of initial funding and delays in the import of equipment. Yet, the project did provide research laboratories with imported equipment that would otherwise have been impossible to get. Independent external evaluations of each subcomponent (Passos 2002, Furtado 2002, Plonski 2002, Terra 2002) conclude that the *instruments used under the component had a high impact in the sector*:

Platforms. This subcomponent is considered *satisfactory*. Twenty-one S&T platforms were created, which helped identify and resolve specific problems in the technology sector. Previously, the lack of cooperation had been a major obstacle to technological development. The platforms helped create confidence and

facilitate communication among the main actors in the technology sector by organizing a large number of networking events, such as meetings and workshops. Through the platforms, 94 articles were published in Brazil and seven were published overseas. The subcomponent contributed to reaching the objective of a more equitable regional distribution of research funds. A total of 12 platforms were established outside of the larger cities in South-eastern Brazil.

Publicly-led cooperative projects. From a policy point of view, this subcomponent was a major success in piloting what later led into the design of the sectoral funds. Yet, from a disbursement point of view, this subcomponent is considered *unsatisfactory*. This subcomponent helped develop a large number of partnerships (45) and had an important multiplier effect in terms of diffusion of technology. The technology transfer generated by the project resulted in innovation both in public institutes and private companies. Fifty-three percent of the projects transferred technology to their partners and 39 percent of the projects were commercialized. Companies not directly involved also gained from the technology development generated by the project. In a specific case, 33 companies were using a new technology and ten of these had not participated in the project. A total of 141 publications (66 published abroad) also demonstrated an increase in research activities. The concentration of projects was in universities and public institutions yet, strong linkages were created with industry. The partnerships contributed to both a qualitative and quantitative increase in R&D activities as well as institutional changes in the participating institutes and companies. Experienced researchers achieved a higher degree of qualification and new graduates were incorporated in the research teams, ensuring a larger and more qualified pool of researchers in the institutes. A large number of professionals were allocated to the projects with a total of 86 PhDs, 65 masters, 69 graduate students and 23 technicians. Universities developed new cooperation mechanisms and new research strategies were created. Companies opened R&D departments, which increased the demand for qualified labor and extended research cooperation with external partners. Also, after the conclusion of project-financed activities, companies continued contracting R&D in cooperation with universities and technological institutes. Two-thirds of the partnerships were maintained beyond the PADCT funding. Although the level of concentration of initiatives followed the pattern of regional development, the Northeastern and Northern regions accounted for 30 percent of the initiatives.

Privately-led cooperative projects. This subcomponent is considered *unsatisfactory*. Disbursement fell significantly short of the amount foreseen in the Project Appraisal Document. Nevertheless, piloting activities under this subcomponent also contributed in a substantial way to making the case for a larger investment by the GOB in the 14 sectoral funds. Thirty-seven partnerships were developed and private companies showed a high commitment by contributing significant amounts of money to each subproject. In several cases, private companies even lent money to their public partners while their funding problems were resolved. Collaboration between public and private sector organizations proved very successful in the Information and Communication Technology (ICT) industry, which led to the establishment of the Information Society Program, financed by one of the sectoral funds. Two other projects also attracted special attention from the private sector – one in the citric industry through a publication for the citric trade organization and another in the metal mechanic sector. In total, 65 percent of the projects transferred technology to their partners and 20 percent of the projects were commercialized. A total of 178 publications (65 published abroad) also demonstrated an increase in research activities. Fifty-two percent of the companies strengthened links with their partners and planned on developing new projects in the future. In most of the companies, researchers were committed part-time to new R&D initiatives. In total, seven PhD students and 33 students in masters programs were able to complete their degrees and more than 90 percent of the companies improved and expanded their facilities and laboratories. The more developed regions of Brazil received the most support under this component. The North East only received about 6 percent of the funding. This distribution reflects a concentration of the largest companies with the capacity to participate in R&D partnerships in the most developed regions of the country.

Assistance for technology adoption by SMEs. This subcomponent is considered *satisfactory*. Private institutions initiated 13 of 37 subprojects and public research institutes and federal agencies prepared the remainder. This subcomponent generated a significant number of technological innovations. On average, one technological product, service or process was developed per subproject. Financed subprojects led to the publication of 37 published articles (14 were overseas). The modest public disclosure of achievements in technology adoption may reflect a concern that publication would hinder patenting. The organizational results in participating SMEs and public research institutions were considerable. Financed subprojects led to 13 important organizational changes, including S&T infrastructure installation such as technology transfer offices, intellectual property commissions, incubators, creation of associations and R&D departments in SMEs linked to universities. The formation and continuation of technology networks between SMEs and public research institutions was an important achievement under this subcomponent. More than 11 of the partnerships maintained formal links after the end of the subprojects. The human resources designated to the projects came primarily from the initiating institutions. Hence, the actual contribution in personnel from co-financing SMEs was relatively low. Nonetheless, the personnel development during the relatively short project duration was high. Due to support through subprojects, 13 people were able to complete their degree (4 PhDs, 4 MAs, 3 BAs and 1 specialist), demonstrating a satisfactory level of university-industry interaction in subproject implementation. Subprojects were concentrated in the most developed regions and only four were executed in the Northeastern part of Brazil.

Project Component B – Science and Technology Research Component

The implementation of this component was *highly satisfactory*. Between 1998 and 2000, four competitions were completed and the interest among researchers and research institutes was huge – the demand exceeded twofold what had been projected at appraisal. Six thousand researchers participated in the formulation of proposals, which led to the selection of more than 300 subprojects for support. Thus, the component reached its objective of a bottom-up activity and the concentration of funds to the most competitive and innovative researchers. Following a reorganization of the project in 2001 after the MTR, the Millennium Science Initiative (MSI) and new review procedures for research projects were added to this component. This led to the establishment of 17 MSI institutes. These institutes played an important role in research areas such as medicine, nanotechnology, bioengineering and land-use changes in the Amazon, all with important implications for Brazil's social and economic development. The MSI simplified and refocused the efforts and priorities of the sector with the best resources available.

Competitive grants. This subcomponent was *highly satisfactory*. The institutional impact of the science and technological research component was substantial. Transparent procedures for the award of grants were established and high-level expert committees were created in order to ensure a fair and professional selection of subprojects. The system worked well. Prior to the call for proposals, an internet-based system was set up to increase the efficiency of the selection process and allow a proper peer review process. High priority issues were addressed through the competitive grants, covering themes such as: diagnostic and treatment of colon and uterus cancer, vaccine against Dengue fever, and examination of cycles of energy, water, carbon, and nitrogen in different kinds of vegetation providing relevant data for fragile ecosystems in the country.

Millennium Science Initiative. The initial stage of the Brazilian version of the MSI was *highly satisfactory*. The introduction of the MSI enhanced the science research component, narrowed the scope of the areas to be researched and raised the level of scientific and technological competitiveness. Scholarships were included as well as internet-based follow up systems. Two types of Millennium Science Institutes were established: (i) *MSI Group I*: institutions of exceptional scientific and/or technological level within their

field or fields, which had a key role in achieving new standards of national competence within these fields; and (ii) *MSI Group II*: institutes operating in strategic fields as defined by the Science and Technology Program of the Ministry of Science and Technology. After a rigorous selection process of more than 200 proposals submitted – controlled by a high-level committee consisting of foreign and Brazilian scientists – 15 institutes were selected in Group I and two institutes in Group II. Group I was granted Brazilian Real (BRL) 60 million and Group II BRL 30 million. A total of BRL 15 million was granted in the form of scholarships to young researchers (BRL 10 million for Group I and 5 BRL millions for Group II). The 17 institutes established by the MSI represented all science and technology fields. The MSI institutes contributed to regional development by creating scientific and technological networks formed by research institutions from different regions. Examples of MSI scientific networks include:

> *Network of Global and Integrated Advancement of Mathematics in Brazil.* A MSI institute led a network of 27 centers and fostered the integration of mathematics with scientific disciplines such as climate prediction and applied medicine as well as productive sector oil extraction and electrical energy optimization. The institute also contributed to the teaching of mathematics at levels ranging from secondary to graduate school. Finally, the institute also promoted cooperation with renowned mathematical institutes overseas.
>
> *Network of Integration of Genetic Breeding, Functional and Comparative Genome of Citrus.* A MSI institute established a network of six centers, which provided industry with a solid basis for further technological development in several regions of Brazil. The institute succeeded in integrating science (classic genetic improvement, genomics, functional genomics, pathogens genomics) with the needs of citrus agrobusiness by developing new varieties of disease-resistant citrus.
>
> *Network for Integrated Strategies for Research and Control of Tuberculosis (TB) in Brazil: New Drugs and Vaccines, Diagnostic Tests and Clinical-Operational Evaluation.* A MSI institute led a network of 17 research centers that were successful in developing new technologies for the control and treatment of tuberculosis and in training high quality human resources through multidisciplinary and multi-institutional networks.

In terms of human capital, the MSI institutes provided talented young doctoral students with new research opportunities under the guidance of a principal investigator of international repute. As such, the institutes made an important contribution to the development of a new generation of world-class researchers in Brazil. The initiative was innovative since it aimed to consolidate the institutional model of high quality research through the formation of networks focused on generating knowledge that responds to national problems and increases the competitiveness of the Brazilian economy (CNPq 2004). The MSI provided a considerable increase in competence in important areas of national and regional research.

Project Component C – Sectoral Support Activities

Disbursements under this component were *unsatisfactory*, yet in real terms, the component was successful because the Government decided to consolidate its policy and framework activities for the sector. The GOB developed a completely new strategic plan during the first years of the project, established the sectoral funds, established capacity for S&T forecasting, and improved coordination across the Government. In addition, financial support of IPR activities, sectoral M&E and strengthening of metrology, testing, standards and quality (MSTQ) services were included in the *Plano Plurianual*. This component was reduced to a minimum during the simplification of the PADCT Project because the Government decided to finance the necessary activities out of GOB-budgets (PPA). The component was however, instrumental in improving the capacity of the MCT for sectoral oversight and multi-year

planning. A concrete example was an automated Internet system for soliciting research proposals, which enhanced the transparency of review procedures and reduced government red tape.

The main achievement of this component was its contributions to the establishment of *the 14 sectoral funds*. The funds are financed by levies on income of privatized sectors, royalties and taxes on imported technology, and thus do not depend on traditional sources of budgetary revenue. Research and other activities financed by the sectoral funds are aimed at eliminating knowledge-based and technical bottlenecks in the sector from which each fund draws its finance. Twenty percent of the resources of the 14 sectoral funds are transferred to finance the modernization of the public R&D infrastructure through two additional funds: The Green and Yellow Fund and the Infrastructure Fund. The first fund promotes the interaction between Academia and Industry and the second ensures adequate research infrastructure. The sustainability of the funds is secured by a law approved by the congress in 2000. About US$400.0 million was raised each year for the funds. The new funding model represented an increase of approximately thirty times the budget of the National Fund for Science and Technology Development (FNDCT) (it increased from about US$20.0 million in 1999 to about US$500.0 million in 2002). Each fund has a board and operates under the rules and regulations set forth in the legislation. The mobilization of private funding through the sectoral funds is a major accomplishment by the Government, which has substantially reduced the pressure on the federal budget.

Project Component D – Project Management

This component is considered *satisfactory*. The resources of this component were used to finance project management activities such as, overall planning and coordination of project activities, including the preparation of the relevant Annual Operating Plan as well as project implementation activities. The Management and Coordination Secretariat (SCG) within the Ministry for Science and Technology (MCT) was responsible for the management of the project with administrative assistance of the Brazilian National Foundation for Technology Development (FINEP), the Brazilian National Council for S&T Development (CNPq) and the Coordinating Agency for Graduate Education (CAPES) plus contracted services from several entities, including private firms, universities, nongovernmental organizations and state governmental agencies. Bank funding was mainly used for the advisory services of the international scientists of the Millennium Science Initiative. The project management was instrumental in organizing the transition from the original more complex project design to the simplified design of the second half of the project, and the Project Director played a pivotal role in introducing the sectoral fund law complex in congress.

4.3 Net Present Value/Economic rate of return:

An exact account of economic costs and benefits of the project is not feasible given time lags and difficulties in measuring the use and commercialization of scientific output. Nonetheless, evidence at the macro-level suggests significant returns to R&D investments, notably in a resource-dominated economy such as Brazil. At the micro-level, findings show that investments in the science base (Component B) provide the foundation for advances in applied research and contribute to the development of advanced human capital. Moreover, efforts to stimulate private sector R&D (Component A) show private returns of about 25-30 percent and estimated social returns of almost 100 percent (See Annex 3).

4.4 Financial rate of return:

N/A

4.5 Institutional development impact:

The project's institutional development impact was *substantial*. The science and technology sector became more structured, achieving its strategic goals through the funding and technology transfer capabilities of the

Millennium Science Initiative, the Sectoral Funds and the new capabilities acquired by companies and research institutes. The Millennium Science Initiative organized a network of institutes of excellence with highly qualified scientists doing high-level R&D, which had an important impact on the country's development priorities. The institutional funding capabilities of Brazil's Science and Technology sector were improved and expanded. The sectoral fund concept first introduced in Brazil in 1997 for the oil and natural gas industry was extended to other industries. During the years 2000 and 2001, the model was expanded to more industries such as Electricity, Mineral Resources, Water Resources, Space, Transportation, Aeronautics, Health, Agrobusiness, Biotechnology, Telecommunications and Information Technology in addition to the Green and Yellow Fund and the Infrastructure Fund. Each of the funds is established by law, which allows them to operate and ensures a constant flow of funds for R&D. The new funding model represents an increase of approximately thirty times the budget of the National Fund for Science and Technology Development (FNDCT) (about US$20.0 million in 1999 to about US$500.0 million in 2002). The sectoral funds supported the objective of the Technology Development Component and other substantial elements of the PADCT Project, and by establishing these funds, the Brazilian Government reached many of the PADCT's goals ahead of time and a significant amount of the Bank loan was cancelled.

Companies, academic and research institutes developed both new capabilities and were transformed institutionally. Now they are able to absorb and transfer technology through new R&D departments and external relations offices. The formation of networks and partnerships was also part of their institutional development. Over 50 percent of the partnerships funded by the Technology Component were continued, indicating that a culture of partnerships was developed. The project facilitated the use of best-practice competitive mechanisms in the Brazilian S&T system. In particular, the Millennium Science Initiative strengthened the use of transparent, merit-based resource allocation principles for advanced research. The establishment of an International Advisory Committee and obligatory peer review of funding proposals were important, with a likely long-term impact in the sector. The Brazilian Government's *Plano Pluriannual (PPA)* includes the continuation of PADCT III activities in its list of priority activities with full funding in each of the coming years, which ensures the sustainability of PADCT III activities beyond the term of the project.

5. Major Factors Affecting Implementation and Outcome

5.1 Factors outside the control of government or implementing agency:

The 1998 financial crisis affected the availability of Federal Government counterpart funds during the first three years of the project, and slowed down the initial stages of implementation. However, the simultaneous devaluation of the Real of approximately 70 percent reduced the cost of local expenditures in US$ terms. This macro shock probably accelerated the reforms of the MCT and its programs, which in turn led to the establishment of the sectoral funds and the integration of the MCT activities, including the PADCT, in the budget law and the *Plano Plurianual*. Such major changes were not foreseeable at the time of project preparation. Yet, the Government and the Bank responded in a timely manner, simplified the operation and reduced the loan to the amount needed at that time (from the original US$155.0 million to US$66.2 million).

5.2 Factors generally subject to government control:

The MCT's response to the financial crisis was to restructure its portfolio, consolidate programs, and extend the sectoral fund model developed by the oil and gas industry in 1997 to other industries of the Brazilian economy. New sectoral funds laws were approved between the years 2000-01 and 14 sectoral and two transversal funds were established. The sectoral funds raised about US$400.0 million each year and the GOB was able to achieve the project objectives with reduced support from the Bank.

5.3 Factors generally subject to implementing agency control:

The MCT decided to restructure in response to the external crisis. This led to some instability in project management, which could have become a major problem because of the complex nature of the project. However, this risk was mitigated by reducing the complexity of the project (for example, by concentrating S&T policy functions in CNPq) and FINEP would retain its role in technology development projects.

5.4 Costs and financing:

The project cost was originally estimated at US$360.0 million with IBRD financing of US$155.0 million. At the original closing date of May 31, 2002, disbursements were only US$35.0 million. During project implementation, the GOB and the Bank agreed – due to slow disbursement in the initial stages of the project and the reduced need for external financing – to cancel US$88.8 million of the undisbursed balance of the loan. The cancellation reduced the total IBRD investment in S&T from the original US$155.0 million to US$66.2 million. The remaining loan proceeds were concentrated in the most effective components for which the new resources from the sectoral funds were not available (see Section 3.4).

6. Sustainability

6.1 Rationale for sustainability rating:

The sustainability of the project achievements is *likely*. The Millennium Science Initiative, the sectoral funds, and the improved interaction between companies and research institutes in the S&T sector are likely to become permanent features of Brazil's national innovation system. These factors will increase the demand for highly qualified workers, thus encouraging the stock of highly qualified human capital. The networks developed under the MSI have a high relevance for the development of the country. The Brazilian S&T sector became more structured, strategic goals were defined and the quality of research increased. The improvement of the institutional R&D capabilities of companies and research institutes to transfer technology and demand are likely to be sustainable. About 50 percent of participants in projects showed interest in maintaining the partnerships in future new projects.

The main achievement of the project was its contribution to the establishment of *the 14 sectoral funds*. The objective to increase the private R&D efforts was achieved through these new funds. The GOB made an important effort and commitment through the MCT to fulfill this objective, and match the Bank's funds through this instrument. From 2000-01, nine different laws were approved to make the sectoral funds operational. Since 2001, the sectoral funds brought a major increase in funding of approximately US$400.0 million per year for technological research. The sustainability of the funds is secured by a law complex. The mobilization of private funding through the sectoral funds is a major accomplishment of the Government, which has substantially reduced the pressure on the federal budget.

6.2 Transition arrangement to regular operations:

The restructuring of the MCT is completed and the laws that will secure the funding and operation of the sectoral funds were enacted in 2001. Further, the pluriannual plan of the MCT for the years 2004-07 includes continued funding to the MSI, basic science and basic industrial R&D as well as sector-wide framework activities supported under the PADCT. This pluriannual budget is to be approved under the yearly budget law.

7. Bank and Borrower Performance

Bank

7.1 Lending:

Satisfactory. The project was well prepared with extensive consultations and stakeholder discussions, and

was based on international experience tailored to local conditions. The preparation was supported at the highest levels both in Brazil and within the Bank and responded well to the Government's reform strategy. The project was expected to generate efficiency gains in federal support to the sector, which would contribute to its sustainability. The Science and Technology Research and Sectoral Support Components drew on 12 years of project experience (PADCT I and II). Several major structural changes were introduced based on analyses of previous project performance. The Technology Development Component drew on successful pilot initiatives by the GOB.

7.2 Supervision:

The supervision of the project was *satisfactory*. The Bank provided consistent and timely supervision with regular supervision missions and a comprehensive MTR mission in December 2000. The technical quality of the supervision was very high using the best combination of Bank specialists and international experts. Two task managers were in charge of the lending operation and led supervision missions. The second task manager was a team member during project design, which provided for continuity on the part of the Bank. The Project Status Reports (PSRs) were realistic and informative and responded promptly to the project's disbursement problems. During the MTR, the Bank team worked in close cooperation with the Government to simplify the project under the new macro conditions in the aftermath of the financial crisis and the result was an Amendment to the Loan Agreement (see Section 3.4).

The Bank team responded positively to the Government's request to extend the loan closing date, but recommended a two-step approach to ensure that agreed milestones were met before a second extension of the closing date. The milestones were not met and the Bank requested that a second extension be combined with a partial cancellation of funds. However, the GOB requested a further extension of the project to avoid the cancellation of funds from PADCT III. The Bank maintained the final closing date and in response, suggested consideration of a possible follow-on project based on successful implementation of PADCT III.

7.3 Overall Bank performance:

The overall Bank performance was *satisfactory*. There was continuity of staff throughout the preparation and supervision of the project. The Bank responded promptly to the project's disbursement problems and took action to bring the project back on track and ensure a satisfactory implementation.

Borrower

7.4 Preparation:

The Borrower's preparation process was comprehensive and *highly satisfactory*. The GOB devoted substantial time and resources to revising the project proposal and sponsored a participatory "Logical Framework" workshop to plan the reform activities for the project. The GOB had cooperated actively with the Bank on the S&T policy agenda and sectoral analyses required for the project preparation. The Government's analytical background work was impressive and included numerous stakeholders from across the sector, and it involved the Bank's task team in site visits, and visits to businesses and institutions in many states. Further, the Government proactively provided extensive materials for consideration for the project Implementation Plan and prepared a very complete Operational Manual for this complex project.

7.5 Government implementation performance:

The Government was supportive and committed throughout implementation and its performance was *satisfactory*. However, the financial crisis, changes in Governments, restructuring of the MCT, and introduction of sectoral funds placed the project in a new context and made it necessary to simplify the project, extend the implementation phase and cancel part of the undisbursed balance. The Government showed its commitment by approving a new law complex as a foundation for the sectoral funds and by incorporating funding for project activities in its pluriannual plan (*Plano Plurianual*).

7.6 Implementing Agency:

MCT provided satisfactory implementation capacity at ministry level. At all phases of the project, the administration and processing of documentation for project management was conducted effectively by the implementing agencies (CNPq, FINEP, and CAPES). Progress reports provided prior to supervision missions were of high quality and allowed terms of references to be targeted at pressing issues.

7.7 Overall Borrower performance:

The Borrower's overall performance was *satisfactory*, especially considering the difficult macroeconomic framework under which the project was implemented. The different Governments were highly committed to reform the S&T sector and participated actively in the simplification of the project.

8. Lessons Learned

Public-private partnerships in the Technology Development Component proved to be a highly effective mechanism to benefit the Brazilian S&T market. These partnerships fostered the effective interaction of companies and academia and the majority of supported activities delivered concrete outputs. The success in delivering outputs, such as publications, services and products, encouraged the partners to acquire further technology transfer capabilities. For that purpose, companies created R&D units and universities and research centers formed incubators and technology transfer units. The institutionalization subsequently increased the demand for highly trained workers. These partnerships also reinforced the Brazilian S&T market, from both the demand and supply side.

Private funding and partnership commitment secured technology transfer in most cases. Funding mobilization and a commitment from private companies were key drivers in the fulfillment of the objectives. For example, in some cases when public funding was not available, companies lent the remaining portion to the research institute. The projects that were most successful in transferring technology were those with a high level of private sector involvement and funding.

Competitive funding in both the Technology Development and the Science and Technology Research Components was an important factor in the level of commitment and the quality of output generated. In all of the competitions, the demand for funds outnumbered the resources available by an important margin. This highly competitive environment was a critically important factor in the consolidation of quality research activities, and very important for medium- to long-term sustainability of the country's innovation system.

Complexity in project design is exacerbated during times of crisis, and may *de facto* create blocks of consolidation around critical core functions and programs. This operation was ambitious and somewhat overdesigned with a relatively high number of subcomponents. In addition, the organizational structure directly involved too many players within the S&T sector. To address these issues, the project was simplified during the MTR.

Suggestions for future programs in Brazil. In order for Brazil to become fully competitive with other advanced countries in terms of science, technology and innovation, it would be necessary to further improve the MCT's capacity for policy formulation, and in particular to reach the Organization for Economic Cooperation and Development (OECD) country level of monitoring and evaluation of the country's innovation system. It would be important to reinforce critical bench marking, and to make further strategic investments. Brazil has reached its intermediate target of 1 percent of GDP for R&D, however the next

goal would be to reach beyond 2 percent, mostly by increases in private sector R&D. The results from the PADCT III Project and Brazil's other programs provide an excellent foundation for embarking on the next phase of a program to improve Brazil's global competitiveness and the value added of its production. One immediate task would be to articulate the individual sectoral funds with Brazil's system for advanced human capital formation, its science base and the knowledge-based productive sectors, and to create a transversal program.

Brazil faces two gaps - the external gap with the more advanced economies and the internal gaps between individual states in the country. Within Brazil, the disparity of development indicates an increased focus on regional development. Although some components of the PADCT allocated funds in the least developed areas of the country, and the gap with the more developed areas was reduced, the breach between regions is still significant. The disparity is not only reflected in the number of R&D centers, the availability of companies and universities, but also in the institutional capabilities and the amount of resources mobilized. For that reason, it is important to develop new strategies and there are good national and international examples that can be used as models.

9. Partner Comments

(a) Borrower/implementing agency:
The Borrower's Contribution to the ICR is included in Annex 8.

(b) Cofinanciers:
N/A

(c) Other partners (NGOs/private sector):
N/A

10. Additional Information

N/A

Annex 1. Key Performance Indicators/Log Frame Matrix

Outcome / Impact Indicators:

Indicator/Matrix	Baseline	Actual/Latest Estimate
Investment in R&D as a percentage of GDP (SIMA 2004)	Baseline: 0.77% (1996) 0.77% (1999)	Indicator: 1.05% (2000) 0.77% (2002)
Number of published Science & Engineering articles (NSF 2004)	Baseline: 2,885 (1993) 4,362 (1997)	Indicator: 7,205 (2001)
Number of articles per 100,000 inhabitants (RICYT 2004)	Baseline: 3.1 (1992) 5.5 (1997)	Indicator: 9.1 (2002)
Citation of Science & Engineering articles (NSF 2004)	Baseline: 5,132 citations (19920 0.19 percent of world share (1992) 8,630 citations (1996) 0.26 percent of world share (1996)	Indicator: 17,365 citations 0.45 percent of world share (2001)
Internationally coauthored articles (NSF 2004)	Baseline: 85 (1994)	Indicator: 102 (2001)
U.S. international articles coauthored by at least one Brazilian (NSF 2004)	Baseline: 1,624 (1994)	Indicator: 3,369 (2001)
Average number of publications/ products per researcher (MCT 2003)	Baseline: 5.0 (1998)	Indicator: 6.2 (2001)
Average number of publications/ products per student (MCT 2003)	Baseline: 2.45 (1998)	Indicator: 2.69 (2001)
Export – import of technology (MCT 2003)	Baseline: US$54 million (1992) US$ -668 million (1997)	Indicator: US$350 million (2002)
Share of companies which carry out R&D activities together with universities and technological institutes (Sbragia 2002)	Baseline: 27% (1997)	Indicator: 44% (2000)

Output Indicators:

Indicator/Matrix	Baseline	Actual/Latest Estimate
Patent applications (RICYT 2004)	Baseline: 10,909 (1992) 20,354 (1997)	Indicator: 23,995 (2002)
Residents applying for patents in percent of total (RICYT 2004)	Baseline: 49% (1992) 35 % (1997)	Indicator: 42% (2002)
Granted patents (RICYT 2004)	Baseline: 2,548 (1992) 3,156 (1997)	Indicator: 8,864 (2002)
Patents awarded in the United States (MCT 2003)	Baseline: 57 (1993) 62 (1997)	Indicator: 110 (2001)
S&T Personnel (RICYT 2004)	Baseline : 106,024 (1995)	Indicator : 157,384 (2000)
Master graduates (RICYT 2004)	Baseline: 7,272 (1992) 10,783 (1997)	Indicator: 23,421 (2002)
Doctorates/ PhD (RICYT 2004)	Baseline:1,759 (1992) 3,497 (1997)	Indicator: 6,843 (2002)
Number of scholarships awarded for Master graduates and PhD (MCT 2004)	Baseline: 26,539 (1992) Master: 18,863 PhD: 7,676 35,498 (1997) Master: 21, 694 PhD: 13,804	Indicator: 34,567 (2002) Master: 18,645 PhD: 15,922
Number of ISO 9000 series certifications (MCT 2004)	Baseline: 18 (1990) 2,647 (1997)	Indicator: 17,319 (2004)
Number of ISO 14000 series certifications (MCT 2004)	Baseline: 2 (1999)	Indicator: 589 (2004)

Annex 2. Project Costs and Financing

Project Cost by Component (in US$ million equivalent)

Component	Appraisal Estimate US$ million	Actual/Latest Estimate US$ million	Percentage of Appraisal
Technology Development	147.00	16.39	9
Science and Technology Research	147.00	108.48	73
Sectoral Support Activities	44.40	5.60	12
Project Management	9.90	2.20	22
Unallocated	10.00		
Total Baseline Cost	358.30	132.67	
Physical Contingencies	0.70		
Price Contingencies	1.00		
Total Project Costs	360.00	132.67	
Total Financing Required	360.00	132.67	

Project Costs by Procurement Arrangements (Appraisal Estimate) (US$ million equivalent)

Expenditure Category	Procurement Method[1] ICB	NCB	Other[2]	N.B.F.	Total Cost
1. Works	27.20 (27.20)	59.00 (41.30)	62.70 (43.20)	0.00 (0.00)	148.90 (111.70)
2. Goods	0.00 (0.00)	0.00 (0.00)	44.50 (33.00)	0.00 (0.00)	44.50 (33.00)
3. Services	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
4. Training	0.00 (0.00)	0.00 (0.00)	43.80 (10.30)	0.00 (0.00)	43.80 (10.30)
5. Operating Costs	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	122.80 (0.00)	122.80 (0.00)
6. Miscellaneous	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Total	27.20 (27.20)	59.00 (41.30)	151.00 (86.50)	122.80 (0.00)	360.00 (155.00)

Project Costs by Procurement Arrangements (Actual/Latest Estimate) (US$ million equivalent)

Expenditure Category	Procurement Method[1]				Total Cost
	ICB	NCB	Other[2]	N.B.F.	
1. Works	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2. Goods	2.43 (2.43)	14.39 (5.26)	94.78 (52.92)	0.00 (0.00)	111.60 (60.61)
3. Services	0.00 (0.00)	0.00 (0.00)	12.32 (5.59)	0.00 (0.00)	12.32 (5.59)
4. Training	0.00 (0.00)	0.00 (0.00)	8.75 (0.00)	0.00 (0.00)	8.75 (0.00)
5. Operating Costs	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
6. Miscellaneous	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Total	2.43 (2.43)	14.39 (5.26)	115.85 (58.51)	0.00 (0.00)	132.67 (66.20)

[1/] Figures in parenthesis are the amounts to be financed by the Bank Loan. All costs include contingencies.

[2/] Includes civil works and goods to be procured through national shopping, consulting services, services of contracted staff of the project management office, training, technical assistance services, and incremental operating costs related to (i) managing the project, and (ii) re-lending project funds to local government units.

Project Financing by Component (in US$ million equivalent)

Component	Appraisal Estimate			Actual/Latest Estimate			Percentage of Appraisal		
	Bank	Govt.	CoF.	Bank	Govt.	CoF.	Bank	Govt.	CoF.
1. Technology Development	53.00	44.00	50.00	7.20	9.19		13.6	20.9	0.0
2. Science and Technology Research	77.00	70.00		58.30	50.18		75.7	71.7	
3. Sectoral Support	16.00	30.00		0.60	5.00		3.8	16.7	
4. Project Management	4.00	6.00		0.10	2.10		2.5	35.0	
5. Unallocated	5.00	5.00		0.00	0.00		0.0	0.0	

Annex 3. Economic Costs and Benefits

Economic analyses consistently show high social and economic rates of return to research and development (R&D) and innovation. It is well established in the literature that a broad definition of technological progress accounts for a large part of economic growth. For example, Esterly and Levine (2000) using the growth regression methodology, estimate that up to 80 percent of cross-country variation in economic growth can be attributed to technological progress. For the Latin American and Caribbean region, the World Bank study "*From Natural Resources to the Knowledge Economy*" finds that knowledge and technology is a critical determinant for growth in the region, especially because of the countries' dependence on natural resources.

Lederman and Maloney (2003) estimates returns for a panel of countries explaining economic growth by control variables – capturing the impact of initial development, physical capital and labor growth – and by policy variables related to the national innovation system. They find that the size, function and efficiency of the innovation system strongly influence economic performance. The table below presents the findings.

Returns to R&D at country level

Table 1: Returns to R&D **Dependent Variables: Growth of GDP (constant PPP (purchasing power parity), five-year from 1960-2000** **Methodology: Generalized Method of Moments (GMM) system estimator**						
Observations	53	43	43	43	43	43
Countries	162	107	107	107	107	107
Initial level of GDP per capita	0.03461***	0.00059	-0.0088**	0.00026	0.00116	0.0877***
Investment/GDP	1.29895***	0.18948***	0.32838***	0.23743***	0.2713***	0.88322***
Labor growth	0.50922***	0.59981***	0.49541***	0.7535***	0.48368***	0.7708***
R&D/GDP	3.19316***	1.39194***	0.51829***	1.02247***	9.62216***	9.29019***
Tertiary Enrollment ratio			0.05567***	0.02778*	0.05302**	0.02258**
NR-Leamer				0.00106**	-0.0059***	-0.0056***
R&D*(GDP per capita)	-0.3***				-1.09***	-0.9924***
R&D*(NR-Learmer)					0.37071***	0.32784***
Investment/GDP*(GDP per cpita)	-0.1307***					-0.0792***
Wald test for joint significance (p-value)	0	0	0	0	0	0
Sargan Test (p-value)	0.326	0.437	0.703	0.372	0.485	0.917
1st order serial correlation	0.002	0.007	0.005	0.005	0.005	0.004
2nd order serial correlation	0.23	0.984	0.625	0.721	0.798	0.885

Source: Lederman and Maloney (2003)

Three findings are key for the Brazil Science and Technology Reform Project:

- *Social Returns to R&D exceed by far the return to investment in physical capital* by a factor 6 to 10 depending upon the initial level of income per capita.

- *Returns to R&D increase with the intensity of natural resources in the economy*. Brazil, and other countries that rely heavily on natural resources, enjoy higher returns on R&D than more manufacturing-dominated economies.

- *Formation of advanced human capital* as measured by tertiary education is a prime driver of technical progress, and appears to be more important than basic education. Quality basic education, however, is a precondition for tertiary education and for equitable growth.

Returns to component on strengthening Brazil's science base. Efforts to strengthen the science base do not inevitably reflect macro-growth findings. The most common methodologies usually measure either (i) the impact of publications and citations resulting from public research or (ii) the economic value of outputs of research, in terms of production function analysis or social rates of return. However, the best available methodologies are often unable to measure completely the outputs from fundamental research (Popper, 1995) which include:

- Training new scientific and technical workers;
- Enriched expertise and experience of current researchers;
- Development of "schools" of researchers who represent an informal community focused on a particular system;
- Exploration of new experimental designs, instrumentation, and research protocols;
- Increased numbers of "guesses" about the nature of the system being explored;
- Lowering the notional price of an "option" on a prospective technological application which may or may not have some value in the future and for which the basic research finding provides an input;
- Negative results which are important in more effectively directing subsequent efforts which may then lead to positive results; and
- Intangible benefits conferred on society and the public imagination by the search itself, and/or its contribution to a culture of science that will facilitate future discoveries.

Some of these outputs are not amenable to empirical testing, or are only amenable to certain forms of qualitative assessments. In addition, time frames for the appearance of output from fundamental research are idiosyncratic and non-linear. Important findings from fundamental research have remained unused for decades until being "discovered" by coincidence. Even when results are utilized immediately after publication, time horizons for the development of applications can run ten years or more.

Private returns on private sector component. Jones and Williams (1998) review estimates of the economic gains of firm expenditure on research and development of new products and production techniques. Although, these kinds of calculations simplify the innovation process – by for instance discounting the company's stock of core-competencies prior to the measured R&D expenditure – they quantify the potential of R&D in building market power, productivity increments and profits. Table 2 below shows that most studies suggest gains from firm R&D investment to be around 25-30 percent. This compares to the average return on capital of seven percent.

Table 2: Estimates of return on R&D investments in private firms in the US

	Year	Private return (in %)	Social return (in %)
Sveikauskas	1981	17	
Griliches	1994	30	
Griliches and Lichtenberg	1984	34	
Terleckyj	1980	25	107
Scherer	1982	29	103
Griliches and Lichtenberg II	1984	30	71
Jones and Williams	1998	35	

Source: Jones and Williams (1998)

Social return on private sector component. Taking into account the impact of one firm's R&D on the entire economy through knowledge spillovers improving other companies' products and production techniques through copying, adapting and learning, the return to R&D rises several fold. Available estimates suggest a social return of about 70 to 100 percent. This is only an estimate, given the difficulties in mapping and quantifying knowledge spillovers. Nevertheless, even an over-estimation in the magnitude of two implies that investments in S&T carry a return substantially above the price of the resources provided through this project. Further, the finding demonstrates the important impact of market failure on

the market for knowledge, which – if left without public regulation, intervention and financing – would produce around one-forth to one-fifth of the social optimal knowledge for the economy.

Conclusion. An exact account of economic costs and benefits of the project is not feasible given time lags and difficulties in measuring the use and commercialization of scientific output. Nonetheless, evidence at the macro-level suggests significant returns to R&D investments, notably in a resource-dominated economy such as Brazil. At the micro level, evidence suggests that investments in the science base (Component B) provide the foundation for advances in applied research and contribute to the development of advanced human capital. Efforts to stimulate private sector R&D (Component A) show private returns of about 25-30 percent and estimated social returns of almost 100 percent.

Annex 4. Bank Inputs

(a) Missions:

Stage of Project Cycle	No. of Persons and Specialty (e.g. 2 Economists, 1 FMS, etc.)		Performance Rating	
			Implementation	Development
Month/Year	Count	Specialty	Progress	Objective
Identification/Preparation				
06/14/1996	*4*	TASK TEAM LEADER (1); SCIENCE & TECHNOLOGY SPECIALIST (2); CONSULTANT (1)		
09/17/1996	*5*	TASK TEAM LEADER (1); SCIENCE & TECHNOLOGY SPECIALIST (2); CONSULTANT (1)		
11/19/1996	*3*	SCIENCE & TECHNOLOGY SPECIALIST (2); CONSULTANT (1)		
Appraisal/Negotiation				
12/22/1996	*6*	SENIOR ECONOMIST (1); SCIENCE & TECHNOLOGY SPECIALIST (2); CONSULTANTS (3)		
03/22/1997	*3*	SCIENCE & TECHNOLOGY SPECIALIST (1); CONSULTANT (1); ASSISTANT TO TASK MANAGER (1)		
05/05/1997	*2*	TASK TEAM LEADER (1); TASK MANAGER (1)		
Supervision				
12/04/1998	*7*	TASK TEAM LEADER (1); ECONOMIST/DEPUTY TM (1); SCI RESEARCH SPECIALIST (1); TECHNOLOGY DEV. EXPERT (1); SCI & TECH POL. EXPERT (1); INDUSTRIAL ENGINEER (1); ECONOMIST (1)	S	S
02/04/1999	*2*	TASK TEAM LEADER (1); DEPUTY TASK MANAGER (1)	S	S
04/22/1999	*2*	TASK TEAM LEADER (1); SCI & TECH. SPECIALIST (1)	S	S
09/24/1999	*3*	TASK TEAM LEADER (1); INFORMATION MANAGER (1); SCI & TECH. SPL (1)	S	S
03/19/2000	*1*	SCIENCE & TECH. SPL (1)	S	S
12/12/2000	*2*	TASK TEAM LEADER (1); SCI & TECH. SPECIALIST (1)	U	S

	06/09/2001	*2*	LEAD EDUCATION SPECIALIST (1); SCI & TECH. SPECIALIST (1)	S	S
	02/21/2002	*2*	SCI & TECH. SPECIALIST (1); TASK MANAGER (1)	U	U
	07/25/2002	*2*	TASK MANAGER (1); CONSULTANT (1)	U	U
	03/18/2003	*1*	TASK TAM LEADER (1)	S	S
	07/02/2003	*1*	TASK TEAM LEADER (1)	S	S
	09/30/2003	*1*	TASK TEAM LEADER(1)	S	S
ICR	05/07/2004	*1*	TASK TEAM LEADER (1)	S	S

(b) Staff:

Stage of Project Cycle	Actual/Latest Estimate	
	No. Staff weeks	US$ ('000)
Identification/Preparation	NA	N/A
Appraisal/Negotiation	NA	411,838.00
Supervision	47	481,022.00
ICR	4	8,804.00
Total		901,664.00

Annex 5. Ratings for Achievement of Objectives/Outputs of Components

(H=High, SU=Substantial, M=Modest, N=Negligible, NA=Not Applicable)

	Rating
☐ *Macro policies*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☐ *Sector Policies*	○ *H* ● *SU* ○ *M* ○ *N* ○ *NA*
☐ *Physical*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☐ *Financial*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☐ *Institutional Development*	○ *H* ● *SU* ○ *M* ○ *N* ○ *NA*
☐ *Environmental*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
Social	
☐ *Poverty Reduction*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☐ *Gender*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☐ *Other (Please specify)*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☐ *Private sector development*	○ *H* ● *SU* ○ *M* ○ *N* ○ *NA*
☐ *Public sector management*	○ *H* ● *SU* ○ *M* ○ *N* ○ *NA*
☐ *Other (Please specify)*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*

Annex 6. Ratings of Bank and Borrower Performance

(HS=Highly Satisfactory, S=Satisfactory, U=Unsatisfactory, HU=Highly Unsatisfactory)

6.1 Bank performance	*Rating*			
☐ *Lending*	○ *HS*	● *S*	○ *U*	○ *HU*
☐ *Supervision*	○ *HS*	● *S*	○ *U*	○ *HU*
☐ *Overall*	○ *HS*	● *S*	○ *U*	○ *HU*

6.2 Borrower performance	*Rating*			
☐ *Preparation*	● *HS*	○ *S*	○ *U*	○ *HU*
☐ *Government implementation performance*	○ *HS*	● *S*	○ *U*	○ *HU*
☐ *Implementation agency performance*	○ *HS*	● *S*	○ *U*	○ *HU*
☐ *Overall*	○ *HS*	● *S*	○ *U*	○ *HU*

Annex 7. List of Supporting Documents

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Additional Annex 8. Borrower's Contribution

MINISTRY OF SCIENCE AND TECHNOLOGY

The Science and Technology Reform Support Project – PADCT

I. INTRODUCTION

Loan Agreement No. 4266-BR, March 17, 1998 between the World Bank and the Brazilian Government to finance the third phase of the Science and Technology Reform Support Project – PADCT III was executed under a technical cooperation agreement between the Ministry of Science and Technology, the Brazilian National Council for S&T Development (CNPq), the Brazilian National Foundation for Technology Development (FINEP) and the Ministry of Education through the Coordinating Agency for Graduate Education (CAPES) in accordance with directives to strengthen Brazil's scientific and technological competitiveness in strategic areas and expand the building of technological skills in the production sector.

In January 2003 US$88.8 million of the US$155 million initially agreed to was canceled. This reduced the value of the Agreement to US$66.2 million, all of which has been disbursed.

The initial closing date was May 31, 2002. Two extensions of the closing date were granted, extending it to July 31, 2004.

The World Bank then granted a "grace period" until November 30, 2004 to allow time for documentation of the funds used. On November 24, 2004 the Bank approved the final expense report and thus determined that the entire revised amount of the Agreement US$66.2 million had been disbursed.

The basic objectives of PADCT III were as follows:

- Contribution to the creation of an environment favorable to cooperation between the private sector and the various levels of government (federal, state, and local) by establishing and operating the partnership arrangements necessary and appropriate to implementation of activities to be financed by the program (as instruments of stated sectoral policy); and an increase in S&T investments by the private sector and by other areas of government.
- Training human resources to meet the needs of academia and the productive sectors by more effectively applying scientific and technological knowledge in areas relevant to the country's development. This would be achieved by financing R&D activities, including expenditures for laboratory infrastructure, overhead, and developing the private sector and other areas of government with a view to achieving the best possible adaptation of those activities to factors that determine the competitiveness of the productive sector and the best possible socioeconomic appropriation of the results produced.
- Contribution to better overall performance by the S&T sector through refinement of procedures and resources essential to accomplishment of the tasks of planning, management, monitoring, and assessment of S&T activities at both the sectoral and programmatic level. The objective is continuous identification of available opportunities and competencies as a basis for project financing and the provision of systemic elements in support of project execution, such as information services, maintenance, and other elements.

Program activities were distributed among three components:

Component 1 - Technology Development – CDT

Component 2 - Science and Technology Research – CCT

Component 3 - Sectoral Support Activities

Beginning 2001 some changes were made in the original structure of the PADCT III. Among these were inclusion of the Millennium Science Iniative under the Technology Development Component and strengthening of the Biotechnology Subprogram by extending it to include the Genome Project *(Projeto Genoma*).

II. ASSESSMENT BY THE EXECUTING AGENCIES

(a) Ministry of Science and Technology – MCT

We would like to highlight the Millennium Science Initiative, which was developed to assist research institutions in the various S&T fields implement Brazilian S&T policy and ameliorate Brazil's performance in a sector which is strategic to its social and economic progress.

The Millennium Science Initiative was launched in March 2001. It was created as a new institutional model for S&T operations using research networks and invitations for participation issued in the form of Announcements.

Projects implemented at the millennium institutes achieved their goals to a significant extent, thereby filling a void in this field by performing work that made an impact. Some of the activities received awards.

Other objectives of the Millennium Institutes are to:

- foster a considerable increase in competitiveness in important S&T fields by taking wide-ranging action in the national, regional, and international arenas;
- promote integration of the principal fields in which the institutions work with other S&T areas;
- develop research projects that are more comprehensive than the topic-specific projects normally covered by other programs;
- contribute to the country's social or economic progress and to an understanding and search for solutions to major global problems that have significant implications for Brazil;
- promote training of new researchers and encourage retention of young researchers who are recognized as talented;
- promote the coordination of networks, involving emerging research groups.

During the past three years, the Millennium Institutes achieved favorable results such as: the integration of 17 institutions of higher learning situated along Brazil's coastline; adoption of the practice of working as a network, overcoming the "rhetoric of the network"; the implementation of interdisciplinary approaches that result in the understanding and solution of problems; support for the human resources training program; strengthening the infrastructure of the institutions by purchasing equipment for setting up the research networks and fostering exchanges of knowledge, new methodologies, and the analyses of problems on a national, rather than local or regional scale.

The impressive scientific results obtained by the 17 institutes convinced us that the decision to implement the Millennium Initiative based on the Millennium Science Initiative, composed of chains of researchers working in groups at different institutions throughout Brazil, was a wise one. Individual projects adhered closely to the original goals as approved in 2001 and in general, exceeded those targets.

Scientific contributions, presented in the form of essays published in international scientific journals, in some cases, stand at the frontiers of knowledge. In all fields where immediate application of the projects was possible, cooperation from the public or private sector was obtained.

The mechanisms used to teach, train and disseminate the sciences varied in importance under the Program, but in no case were these activities overlooked and the results were always recorded.

The reports also showed that Brazilian problems can be approached by S&T research and that the scientific community involved with the Millennium Institute has world-class capability to try to resolve both fundamental matters and some of the challenges posed by the problems that were initially proposed.

One of the most innovative and positive aspects was the energizing of the work and the progress made in research because the researchers worked in groups. The entire program demonstrated significant accomplishments toward ambitious goals. In most of the cases, however, it is clear that additional time is needed to obtain more pertinent results and to transfer the knowledge into applications that could increase the scientific and social impacts of the Millennium Initiative.

The Evaluation Council (*Conselho de Avaliação*) notes with satisfaction that in most cases the working groups included new researchers working in less developed regions of Brazil. It is clear that the work groups are integrated and are part of a problem recognition organization.

We enthusiastically recommend that the Millennium Science Initiative be extended to a second phase with a higher funding level including both the budget allocated to the S&T Ministry as well as funds for other ministries and agencies that have an interest in the subject in question.

The Evaluation Committee understands that the funds available for this initiative are limited. This is why it emphasized that improvements must be made in the way that the funds are spend. The “Millennium Institute” has become a sign of quality and relevance. The initiative should be maintained, regardless of the level or even the existence of funds. Furthermore, the success of the program should be given greater visibility in the Brazilian society.

(b) The Brazilian National Council for S&T Development - CNPq

The PADCT project afforded this excellent opportunity to conduct research that should be given priority in Brazil, i.e., to support areas important for the country’s sustainable development.

Support for the continuity of the program is vital, since it has facilitated the drafting of a significant number of theses and dissertations and provided excellent opportunities for training and instruction in priority fields.

The principal criticism that can be made of the PADCT relates to the irregularity in funds transfers. This is bound to have negative effects on the conduct of the projects.

The main problems identified by the agencies executing the projects lie in the areas of project contracting, release of funds, and import of equipment.

The difficulties encountered were delays in the transfer of financial resources, as well as in the import of equipment; vagueness in procedures for project monitoring and evaluation; inflexibility in the types of grants; and the duration of the project - it took almost a year to make the network operational.

Given the success of the Millennium Science Initiative supported by the Loan Agreement, it is suggested that the program be better institutionalized within the MCT/CNPq by continuing its activities, adhering to disbursement timetables, extending the present three-year deadline for execution to five years, and adopting suitable procedures for project assessment (Example: Pronex and the NSF).

Performance Report – PADCT/CNPq Import Sector

During 2004 all efforts were devoted to closing down the arrangement with the World Bank. This proved to be an arduous task with respect to imports, since guidance had already been given by the Executive Secretariat of the MCT/PADCT as to deadlines for finalizing this.

As completion of the imports was made a priority, we had to consider the short time frame for acceptance, processing, and finalizing the imports. We notified all coordinators and institutions of the need to submit and finalize the imports, including all the deadlines for the procedures

The need to observe World Bank rules and finalize complementary data for purposes of the actual import were the problems we faced during this period.

In light of all the issues already mentioned, such as deadlines and nonobservance of the specifications necessary to actual importation, it became hard to assure the coordinators that all the items supported by the PADCT/CNPq for their projects would be purchased.

Although the PADCT/CNPq coordinating office had been faced with this situation, imports in 2004 achieved significant figures. Goals were reached, all unexpected problems circumvented as best they could be, and the quality of service to the coordinators and their teams was maintained.

Lastly, we would stress that the impossibility of monitoring the project coordinators more closely ended up creating extra problems as regards satisfactory progress of the procurement of items supported by the PADCT/CNPq. Note that the need to provide training at the institutions in compliance with World Bank rules is a constant. The absence of this has caused the coordinators in question serious problems.

(c) Coordinating Agency for Graduate Education - CAPES

The Ministry of Education, through CAPES, partnered with the S&T Ministry in projects related directly to graduate studies. It took responsibility for awarding study grants and promoting the graduate school infrastructure at the institutions of higher learning with which agreements had been signed.

During this period, 90% of the contracts were signed directly with researchers, which favorered decentralization in terms of agility and flexibility in resource management. The external expenses for the projects were recorded in CAPES. They were disbursed by FINEP, which was the financial agent for the program and responsible for paying the suppliers directly for imported equipment. At the end of Phase III execution on June 30, 2001, CAPES had executed 100% of the disbursements to contracted projects. Imports were pending on only 15 projects and those payments were made and completed by FINEP/RJ by December 31, 2003.

In terms of PADCT III management, CAPES used three computerized systems to maintain records on the control, monitoring, execution and assessment of PADCT III. The first system is SIAFI – Financial Administration Integrated System, which had been developed by SERPRO and was used to process all disbursements under the Program. This enabled CAPES to meet the demands of the contracted projects on a timely basis.

The second system is the SISPC, a complementary system developed by CAPES technical staff that permitted analysis, preparation of fact-finding tasks, control over internal handling of financial and technical opinions, as well as approval of the statements of account furnished by the arrangements and assistance agreements signed by CAPES with managers of PADCT III projects.

Another system was developed by the team at CESAR-PE, a company associated with the Federal University of Pernambuco – UFPE. It worked in concert with the executing agencies and was monitored by the S&T Ministry, which had assumed responsibility for all program monitoring and was consolidating the data from the three agencies.

Assessment of World Bank Performance

Despite the difficulties the Brazilian Government encountered in maintaining Loan Agreement No. 4266-BR with a view to continuing more than one phase of PADCT, it should be taken into consideration that World Bank participation as an encouraging force in various extremely needy areas in this country is widely recognized. Most of our educational, scientific and technological indicators have improved significantly because of financial support from the World Bank.

One of our project coordinators criticized the failure to pay for the stable isotopes analyses that were supposed to have been performed directly by the World Bank outside Brazil. The fact that this did not happen impaired the project in technical terms, as reported, besides putting the Bank in somewhat of a bad light.

Assessment of Performance by the Executing Agencies

The research project initially was intended to run from September 8, 1999 to September 8, 2001 (and later extended to December 31, 2001). According to the Announcement, contracting was scheduled to begin in October 1998. However, contracts were not signed until a year later. Despite the uncertainty caused by the one-year delay in the formal startup of the project, which had obviously negative impacts on its execution, it was possible to accomplish a good part of the work programmed for 1998 and 1999, thanks to cooperation agreements maintained with research institutions in both Brazil and abroad. The financial resources for the Brazilian part of the project were transferred in October 1999 and January 2000. This made it possible to purchase computer hardware and software (bought in Brazil) and to carry out scheduled field trips for meetings (initial and subsequent) as well as for complementary data collection and sampling.

The funds allocated for use abroad (equipment imports) did not, however, begin to be released until October 2000, and import processing extended until early 2001, when more than half of the project execution time had elapsed. Funds from outside Brazil to pay for analyses were never released. These circumstances primarily impaired the execution of Subprogram 2.

On March 15, 2000, the project team received an evaluation visit from the FINEP/PADCT technical team, composed of Dr. Ronaldo Azambuja and Professor Lydia Lobato. The problems mentioned above and others were pointed out in an oral and written report on that occasion. On February 28, 2001, we sent

FINEP technical and financial reports covering the project period up to December 31, 2000, and the problems were also mentioned in those reports.

Lessons Learned from Program Execution

First, it can be said that the scientific and technological reform proposed by the PADCT did in fact take place. The financial support and scientific competitiveness installed in this country, especially at the universities and research centers, are of fundamental importance. The mobilization of a critical mass of researchers and technical personnel was important to the projects. Also worth special mention is the managerial format adopted by the program. It concentrated on a decentralized activities model, using a financial agent—FINEP/RJ in this case—that made it possible to provide researchers with timely funding, especially for procurement via imports.

Other achievements took the form of publications that resulted directly from the project (see complete list in the Final Report), specifically:

(1) Ten books, chapters of books, theses and dissertations were completed;

(2) Nine complete articles were published in journals that are highly regarded internationally;

(3) More than 30 complete papers and expanded abstracts were published in the Proceedings of international congresses and symposia.

(d) Brazilian National Foundation for Technology Development – FINEP

Conduct of activities related to PADCT III under FINEP was guided by the rules established initially, as well as by a data system designed specifically to record the anticipated stages in the progress of the projects.

The program provided training to both the administrative and technical teams involved and also enabled them to identify new areas in which the agency could take action. This resulted in support for correlated initiatives through other funding sources.

The length of the program implementation period meant that different teams would pass through the project, whether from the point of view of management—more than one board of directives was in charge of the FINEP while PADCT activities were under way, with consequent changes in coordinator—or from the technical standpoint, entailing replacement of the consultants and technical personnel who were responsible for each project.

FINEP's activities were also heavily influenced by the pace at which counterpart funds were allocated by the Brazilian Government which, in turn, had repercussions for the allocation of World Bank funds. This resulted in discontinuities in project execution and consequently. in the releases of funds for research and therefore on FINEP's monitoring of the projects.

The computerized system created specifically for the PADCT posed several problems for FINEP throughout that period. The agency decided to accept delivery of some opinions from consultants on paper, because it was not thought suitable to continue indefinitely to insist that these people include their opinions in that system. This meant that alternative procedures had to be created to ensure implementation of certain activities and only later, when possible, would the necessary changes in the system be made. For example,

the technical personnel responsible for the projects were not necessarily those whose names appeared in the system, since on a number of occasions it was impossible to update the names when people were replaced.

In conclusion, we can say that the experience with PADCT enabled FINEP to further develop its capabilities and to create, internally, all the conditions needed to participate in similar operations that may be undertaken in the future by the Brazilian Government in the fields of science, technology, and innovation.

Evaluation of the World Bank

Based on financial data, we can say that all the requests for action and other requests made to the World Bank by the Financing Agent/FINEP/DCOF were responded to with fully satisfactory solutions and within appropriate time frames.

One of the criticisms made by our project coordinators related to studying and adhering to the complex *Normas de Licitação Internacional e Processos de Importação do Banco Mundial* [World Bank guidelines for international competitive bidding and import procedures]. However despite the difficulties and the limitations they encountered, they were able to satisfy all the requirements of those rules and the process of purchasing equipment and materials from foreign sources was a success.

Lessons Learned from Program Execution

Although Brazilian society has evolved rapidly in its recognition of the importance of projects in technological innovation, when we began the PADCT project in July 1998, this was still a rather recent project methodology.

Therefore, the broad outlines of the PADCT project and its strategic components, such as technological innovation allied with a scientific level of excellence, the training of personnel at various levels of expertise, the interaction between the project and high-tech companies in Brazil and abroad, the socioeconomic contribution, etc. certainly were the major contributions to the evolution of the technological innovation scenario in this country.

Furthermore, we would point out that there is significant demand in the scientific community for support for projects (especially in earth sciences). If financing is available, they will bear fruit. The development of basic and applied research, and especially the training of skilled human resources, is a necessity for any country that desires to achieve or maintain progress, not only in the sciences but also in its socioeconomic conditions. Under this scenario, I believe that the work of academia is important and that academics, in turn, need induced actions such as those related to the PADCT.

Following is a list of the PADCT projects, supplied by the CNPq, CAPES, and FINEP:

Controle estrutural e geocronologia das mineralizações de Au e W nas Faixas Seridó e Cachoeirinha, NE do Brasil [Structural control and geochronology of gold and tungsten mineral deposits in the Seridó and Cachoeirinha seams in Brazil's Northeast]. The project was carried out in a multidisciplinary, harmonious fashion among its various levels of approach. Usually, three fronts of approach to the topics on which the project focused were always present: (i) bibliographic research, both geographic area-specific and topic-specific; (ii) the kind of field work that is essential to this type of project; and (iii) laboratory work.

Besides maintaining several researchers who pursued the selected line of research, the project made possible an always desired interaction between students at various levels and those about to obtain their degree, through tasks planned at the novice, master's and doctoral levels. Two holders of doctoral degrees, two holders of master's degrees, and three candidates for graduation were assisted by the project. About 30 scientific papers were published in specialized literature.

The project also led to interaction with international institutions in countries such as France and Australia. Researchers were able to use laboratories and researchers and students exchanged experiences.

Gerenciamento Integrado dos Aqüíferos da RMR – UFPE [Integrated management of the aquifers in the Recife Metropolitan Region – UFPE]. The proposal was to establish a data system to assist decision-making for the integrated management of the aquifers in the Recife Metropolitan Region (RMR).

Estudo Isotópico e Geoquímico dos Aqüíferos do DF – UnB [Isotopic and geochemical study of the aquifers in the Federal District – University of Brasília]. This study deals with the demand for water resources in the Federal District.

Distritos Mineiros de Calcário do Paraná - UFPR [Limestone Mining Districts of Paraná – Federal University of Paraná]. This project was designed to increase the geological and prospecting knowledge of the layers of Proterozoic limestone found in the First Plateau of the State of Paraná. This project is a shining example of partnership between the public and private sectors.

Determinação da erosão/deposição de solo pela medida da redistribuição do conteúdo (UEL) [Determination of the erosion/deposition of soil by measuring the redistribution of content (State University of Londrina)]. The group worked with the Federal University of Rio Grande do Sul in gathering samples from erosion experimental parcels; furnishing of erosion data using conventional methodologies.

Desenvolvimento de Sondas de Visualização e Medida de Vazão para Aplicações em Escoamentos Bifásicos - USP [Development of visualization and flow measurement probes for applications to two-phase drainage – University of São Paulo (USP)].

Transformações Catalíticas Estereosseletivas – UFRGS [Stereo-selective catalytic conversions – Federal University of Rio Grande do Sul]. The project made it possible to develop a multidisciplinary approach to molecular and macromolecular chemistry, starting from synthesis and description of the catalysts, proceeding to their application in conversions of industrial interest and then to descriptions of the materials thus obtained.

Modernização da Infra-estrutura de Informática e Atualização do Acervo da Biblioteca Principal de Química e Engenharia Química – USP – [Modernization of the information technology infrastructure and updating of the collection of the main chemistry and chemical engineering library at the University of São Paulo]. The objective here is purchase of equipment to expand the main chemistry and chemical engineering library, since the project has already updated the library and supplemented the collection with reference works; restructured and expanded the cooperative network of computers; enabled creation of a room, 40 m2 for training the users; and created a website for the library.

Medições, análise e simulações da variedade sazonal, anual e interanual dos ciclos de energia, água, carbono e nitrogênio na Região Amazônica - UFV [Measurement, analysis and simulations of seasonal, annual, and interannual variety of the energy, water, carbon and nitrogen cycles in the Amazon Region –

Federal University of Viçosa - UFV]. This project calls for continuous measurements of the flows of energy, CO2, and water vapor in mangrove, forest and agriculture (*caupi*) ecosystems in Bragança, Pará.

Detecção de Hepatoxinas de Cianobactérias – Caruaru – UnB [Detection of hepatoxins in cyanobacteria – Caruaru – University of Brasília]. This project proposes to make new contributions to an issue that is important to environmental and human health, i.e., the presence of cyanobacterial toxins in the water supply owing to increasing use of fertilizers in farming and the discharge of household and industrial effluents into bodies of water. These have enriched the nutrient content of those waters and in various cases, the eutrophication of water sources.

Desenvolvimento de Materiais para Supressores (ZnO) de Surtos de Voltagem [Development of materials (zinc oxide) for voltage surge suppressors]. The objective of this project is to develop methods for classifying protection devices used to reduce disconnections caused by disturbances in electrical systems, while gaining the ability to produce and characterize the class of ceramic materials of which they are made.

Utilização de Rejeitos da Serragem de Granitos para Uso como Matéria Prima Cerâmica - [Utilization of granite-cutting waste in the manufacture of ceramic raw material]. This project deals with the use of waste from cutting of ornamental granites to make alternative ceramic raw material in ceramic masses for red ceramics (brick, roofing tiles, rustic brick, and hollow elements) and white ceramics (sanitary fixtures).

Características Molecular de Estoques Pesqueiros - UFRJ [Molecular characteristics of fisheries stocks – Federal University of Rio de Janeiro - UFRJ]. The results achieved from this project could be used in developing fish management polices, since it has enabled researchers to become familiar with the population structure of various marine groups of commercial interest (fish, oysters, and shrimp).

Mecanismo de Formação e manutenção de lesões em Leishmaniose: Envolvimento de moléculas de adesão no recrutamento e interações celulares – UFMG [Mechanism of formation and maintenance of lesions in leishmaniasis: Evolution of adhesion molecules in the cellular recruitment and interactions – Federal University of Minas Gerais – UFMG]. The results achieved by the project helped explain aspects related to the role of adhesion molecules in the development and maintenance of lesions caused by leishmaniasis, in an effort to gain a better understanding of the mechanisms and elements involved in the formation and maintenance of the lesions resulting from an *leishmania* infection.

Depósitos de Zinco e Chumbo das Bacias Proterozóicas do Craton do São Francisco: Estudos Integrados Isotópicos e de Inclusões Fluidas, Correlações e Modelos Metalogenéticos [Zinc and lead deposits in the Proterozoic basins of the São Francisco Craton: Integrated isotopic studies and studies of liquid inclusions, metalogenetic correlations and models]. The main objective of the project was to increase the knowledge, for mineral exploitation purposes, of a geological environment that has proven metalogenetic potential.

Desenvolvimento Tecnológico do Setor Sericícola [Technological development of the silk-making industry]. PADCT funding made it possible to implement a project designed to assist the silk-making industry in the state of Paraná, with significant emphasis on technical cooperation between the productive sectors and academia.

Desenvolvimento de Preforma de Sílica Vítrea para Fibra Óptica pelo Método VPD. [Development of a vitreous silica preform for optical fiber using the VPD method]. In accordance with the lines of PADCT III program activities, execution of this project concentrated on the following basic objectives: (1)

technological innovation. (2) training personnel in advanced technology. (3) development of special optical fibers to replace the imported product, and (4) patent protection of the technology developed.

Mastery of the technology of nanostructured silica preforms using the vapor phase axial deposition method (VAD) made it possible to cut the production cost of silica per kilometer of fiber from US$10.00 (MCVD method now used in Brazil) to US$1.00. The contribution that had the greatest impact was the possibility of using the knowledge generated under the project to develop amplifying optical fibers and other kinds of special fibers that have a high value-added.