Review of World Bank Lending for Science and Technology 1980-99

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September 27, 2001

Acknowledgements:

Jonathan Tin and Marie Gronnegaard Christensen did background research and contributed to the text of an earlier version of this paper.

Introduction

1. **Purpose**. This analysis measures the amount of World Bank lending to support scientific and technological research and S&T capacity building. It devises a taxonomy and methodology for identifying such S&T projects, and differentiates these from other World Bank lending that may be more loosely related to science and technology. The analysis also identifies trends in operational support for S&T, and draws initial lessons on the Bank's effectiveness in helping client countries achieve the maximum contribution of S&T to development.

2. **Support for S&T is One Part of the Bank as a Knowledge Institution**. This analysis and quantification includes only World Bank lending operations that directly supported scientific and technological research and/or explicit attempts to build S&T capacity. Supporting this capacity in client countries is one of the ways in which the World Bank has promoted greater use of knowledge for development. A number of Bank lending operations, programs or initiatives do the same, without having a specific focus on scientific and technological knowledge A recent paper, *Major Knowledge Initiatives of the World Bank Group: Relevance for World Bank Education Sector Lending and Research* (Patrinos, 2001), summarizes these and provides a detailed overview of the context in which this present analysis of S&T lending can be understood.

The Taxonomy for Identifying S&T Projects

3. **S&T Projects Seek to Build Capacity to Produce, Select, Adapt, Diffuse, and/or Use Scientific and Technological Knowledge.** Projects and components were considered S&T operations—and therefore included in the aggregate lending totals—if they provided funding for research or explicitly sought to increase scientific and technological capacity. Under this criterium, an SME (Small- and Medium-sized Enterprise) promotion project, for example, was only included if it supported the development of products and processes through technology upgrading. If, on the other hand, an SME project sought to improve performance through management upgrading or increasing access to credit, it was not included. Similarly, higher education projects were included only if they had a specific focus on supporting research or education in S&T-related areas, such as engineering. Projects focusing on improved access, financing or quality in higher education might have implications for S&T capacity, but they were not considered "explicitly" pertaining to S&T.

Bank lending supports a number of operations that might qualify as "S&T projects" under broader definitions: projects that transfer sophisticated technology, for example, in distance education or telecommunications projects. In general, "high tech" projects or projects with high "technology content" were not included unless the building of local capacity comprised a significant portion of the project. For this analysis, such projects were not deemed to be directly related to research or building S&T capacity and hence were not included. Some of these projects may have had some impact on the clients S&T capacity, but in a way that is very dispersed and/or difficult to measure. While it is worthwhile to examine the effectiveness of the Bank as a vehicle for technology transfer this topic is outside of the scope of the analysis. Indeed, an analysis of World Bank

projects that focus on transferring sophisticated or simple technology may be found in a number of other studies including Weiss 1984. Several other categories of projects loosely relate to S&T were also not included in this analysis because their connection to improved S&T capacity was too indirect or because some logistical problem put them beyond the scope of this inquiry. Among these were projects that supported:

- Management Training and Modernization Projects. The provision of management training and modernization as well as the use of existing knowledge in private sector development can lead to organizational improvements in firms that strengthen technological capability, however, such efforts were not considered in the analysis unless the projects explicitly attempted to accelerate the rate of technological learning through direct interventions.
- Basic and Secondary Education Projects without Specific S&T Goals. Improving science instruction is a stated goals of many primary and secondary education improvement projects. Normally, it is carried out as one part of an integrated package of interventions to improve the overall quality of education. It would be worthwhile to gauge the effectiveness of Bank support for Science Education, but such an inquiry was beyond the scope of this paper. Such an analysis was done a decade ago (Ware 1992) and should be updated. However, basic and secondary education projects that promoted improved S&T were not identified or included here unless they made provisions to improve science education specifically.
- Vocational and Technical Education Projects. Only projects focusing on polytechnical education at the tertiary level were included, while VET projects were not. This is because polytechnical-level skills are normally more advanced than those of secondary-level vocational institutes. Again, one could argue that enhanced vocational and technical skills add to a country's S&T capacity, and these should be analyzed. However, for the logistical reasons, these were deemed outside the scope of the paper.
- Higher Education Projects. Many general university reform projects create conditions for improved S&T capacity; however, if improvement of scientific and technological research and capacity was not specified as a principal goal of the project, it was not included [Refer to the Higher Education Section within the Strategy].
- Agricultural Extension Services Projects. These projects are often a popular vehicle for the diffusion of relevant research outcomes and products, however, because of difficulties in disaggregating their S&T content, they were not included in the list unless supporting research was an explicit project goal.

In light of these parameters, this analysis depicts the Bank's overall support for S&T as narrower than it in fact is. Thus, the numbers presented should be considered conservative estimates of the Bank's overall effort to promote S&T.

Global Characteristics of Bank Lending for S&T

4. **Main Findings.**

Between 1980 and 1999, the World Bank lent $7.8 billion to directly support S&T activities in 590 projects.

- Annually, average lending for S&T totaled $390 million.

Of overall Bank lending, one of every eight projects provides some support to S&T capacity building, but only one in fifty projects is principally concerned with improving S&T.

- Although 590 projects over the past two decades provided some support for S&T, fewer than 100 of the World Bank's 4,794 projects were dedicated primarily to promoting S&T and/or contained a significant S&T capacity building component.

The World Bank sponsored on average 30 S&T projects per year.

- Five projects a year provided major support for S&T (greater than $10 million) and twenty five projects a year provided minor support for S&T (less than $10 million).
- Minor S&T projects averaged $4 million per project while major S&T projects averaged $58 million per project.

The Agriculture (Rural Development) Sector provided more support for S&T than all other sectors combined.

- The agriculture sector accounts for about 42% of all major S&T projects. The remainder consists of the other sectors combined, but predominantly education and industry.
- Agriculture also accounts for the overwhelming majority of projects that provided minor support to S&T [over 400 of the 488 minor projects were in agriculture].
- S&T Support to Agriculture was geographically disperse and covered large and small, low and middle-income countries.

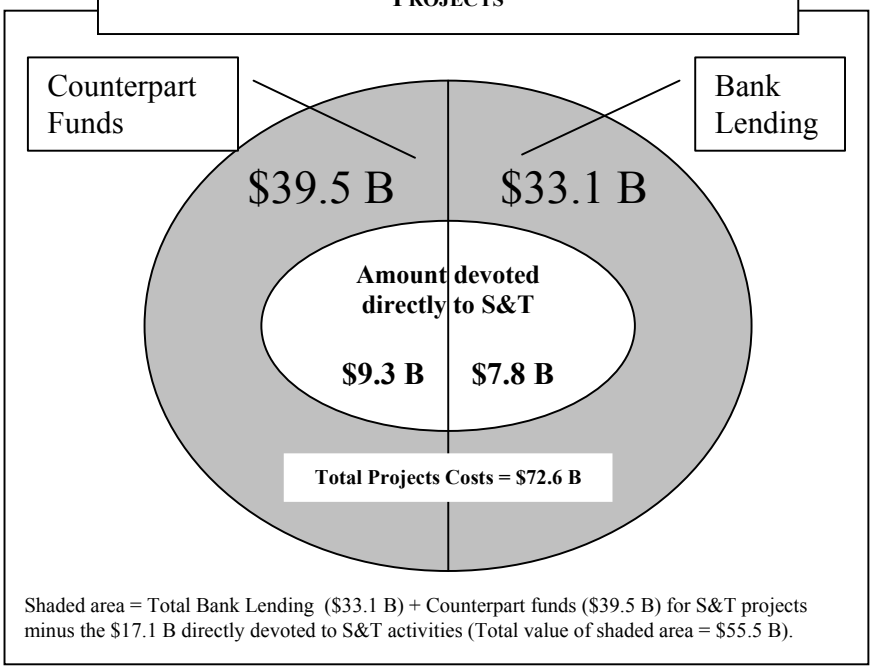
Most major support for S&T (outside of agriculture) went to a handful of large, middle-income countries.

- Over 50% of the major S&T loans (non-agriculture) went to only six countries. About ¾ of the loans were taken by twelve countries.
- In terms of regional distribution, East Asia received half of all major S&T loans during the review period. The next most frequent S&T borrower, Latin America, took out nearly one-fifth of the loans.

5. **S&T Lending as a Percent of Overall Bank Lending** The 590 projects that supported S&T represent 12.3% of all Bank projects [4794] for the period. The $7.8 billion of direct lending support for S&T activities represents only 24% of the total World Bank lending [$33.1 billion] to these projects. The remaining 76% was used for project activities that did not directly support S&T. When counterpart funds are included, the

590 projects totaled $72.6 in total project costs, $17.1 billion of which (also 24%) were dedicated exclusively to activities that support S&T. The $7.8 billion in Bank lending, then, can be considered to have leveraged an additional $9.3 in counterpart country investments in S&T capacity building.

FIGURE I: BANK/COUNTERPART BREAKDOWN FOR S&T PROJECTS



Shaded area = Total Bank Lending ($33.1 B) + Counterpart funds ($39.5 B) for S&T projects minus the $17.1 B directly devoted to S&T activities (Total value of shaded area = $55.5 B).

6. **Support was Divided between Major and Minor S&T projects**. Of the 590 projects, 488 devoted 10$ million or less in direct support for S&T. Counterpart funds provided the remaining amount necessary to cover total project costs for these minor S&T projects. Many of these minor projects were in agriculture in which a smaller portion of the overall project cost went to directly support an S&T component relevant to agriculture. 102 of the 590 projects were considered "major S&T projects" that devoted between $10 million and $500 million directly to research and S&T capacity building.

TABLE 1: BANK LENDING FOR PROJECTS INVOLVING S&T BY INTENSITY AND SUPPORT

Type of Project	Number of Projects	Total Lent	Total Project Costs	Amount Devoted to S&T
Total	**590**	**$33.1**	**$72.6**	**$17.1**
Major S&T Projects	102	$6.9	$14.7	$12.9
Minor S&T Projects	488	$26.2	$57.9	$4.5

Figure 1 depicts the level of support for S&T projects between 1980 and 1999, by funding amount. As the figure shows, approximately 260 projects used less than $3 million for S&T; 100 projects used between $10 million and $50 million; and, approximately 80 projects used funding over $50 million for the building of S&T capacity and/or the strengthening of scientific research.

FIGURE 1: S&T PROJECTS CATEGORIZED BY AMOUNT DEVOTED DIRECTLY TO S&T

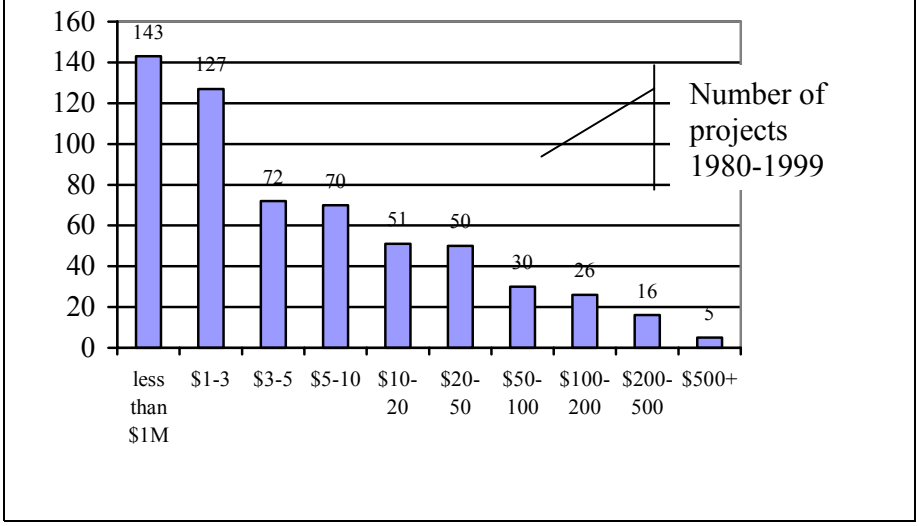


Figure 2 provides annual data for the number of major projects for S&T capacity building and research. On average, 88% of total project costs for these 102 major projects was S&T specific.

FIGURE 2: PROJECTS PROVIDING MAJOR SUPPORT FOR S&T, 1980-1999 ($US MILLIONS)

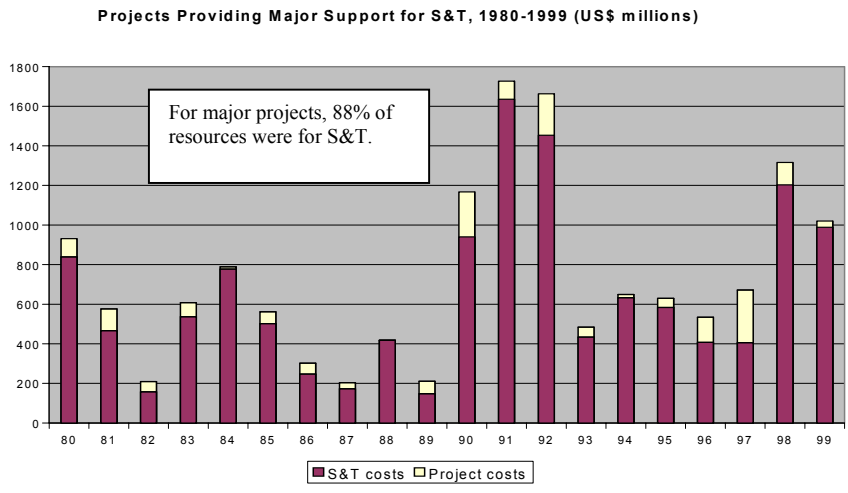
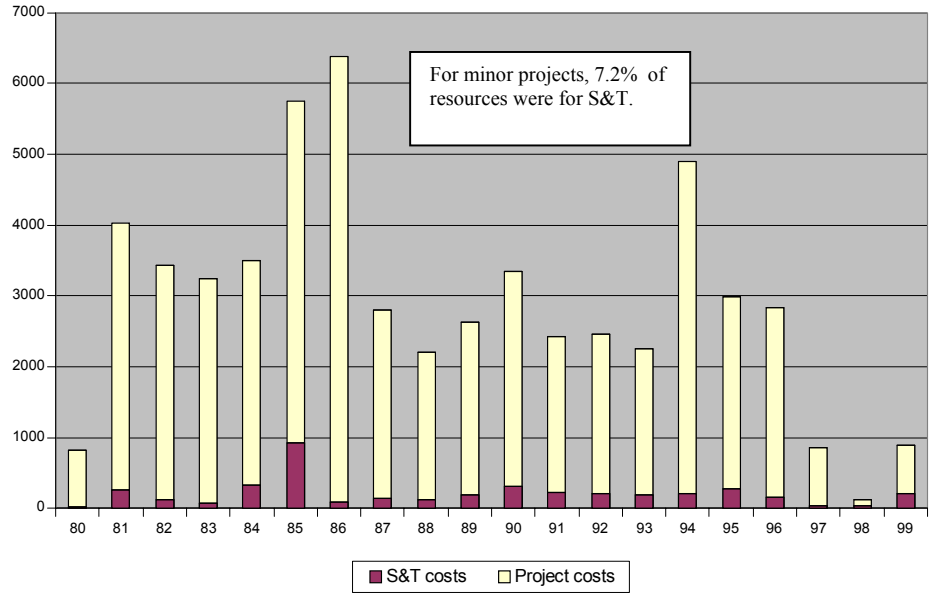


Figure 3 provides annual data for the number of minor projects for S&T capacity building and research. On average, only 7.2% of total project costs for these 488 minor projects was S&T specific.

FIGURE 3: PROJECTS PROVIDING MINOR SUPPORT FOR S&T, 1980-1999 ($US MILLIONS)



7. **Regional Distribution of Non-Agriculture S&T Projects**. Analysis of the regional distribution of S&T projects reveals a heavy bias toward the East Asia region, which had 29 of the 59 major non-agricultural projects. Latin America had the second largest amount with 11 projects. The South Asian region had five projects, Africa had four, and the middle east had three projects during the time period. Nonetheless, while regional distribution is still skewed toward East Asia, it is becoming less so than it was for '73-'91, when close to four fifths of S&T-related higher education lending and two thirds of S&T-related industry lending took place in that region alone.

TABLE 3: DISTRIBUTION OF NON-AGRICULTURAL PROJECTS

Country		# of Non-Ag Loans
TOTAL		**59**
Korea		12
China		6
Indonesia		5
Brazil		4
Mexico		3

India		3
Chile	**45 of the 59 loans were made to only twelve countries**	2
Mauritius		2
Portugal		2
Philippines		2
Thailand		2
Turkey		2
Others	**14 countries had one loan each**	14

8. **Sequential, Simultaneous, and Program Lending in Individual Countries**. Thirty-three of the 59 non-agricultural S&T loans were made to only six countries. Korea was far and away the largest borrower of S&T. Its twelve S&T loans from 1980 to 1999 are double in number the projects in China, (the second most active borrower for non-agricultural S&T projects). Indonesia, Brazil, Mexico and India were also large borrowers for S&T, with five, four, three and three projects each respectively as shown in Table 3.

Much of the Bank's S&T support for Korea has been sequential, with a second loan of similar nature made to the same implementing agency as a logical extension of the previous program. At one point, three S&T loans were made to Korea in consecutive years, and with large overlaps in their implementation periods. Similarly, in Indonesia, a loan in 1983 followed up on a first loan in 1979; a second loan in 1991 addressed S&T more specifically than its 1988 predecessor; and a 1990 professional human resource development loan with a significant S&T component preceded yet another loan in 1995. This continuity also existed in Brazil and India. In the Philippines, preparation of a follow-up operation to the FY92 Science and Engineering project is currently underway. By contrast, China, Mexico and Portugal appear to be supporting a variety of diverse objectives within the S&T sector, maintaining active S&T portfolios with loans for human resources development, research institutes, environmental concerns, and technology and industrial development. The question of the relative impact of the simultaneous versus sequential approaches bears further investigation.

9. **Country Size and Size of the Scientific Community**. The six most active borrowers (Korea, China, Brazil, Indonesia, India and Mexico) for S&T are all large population countries. Together they comprise 46% of the world's population and 55% of the population of the developing world. Korea, however, the most active borrower has by far the smallest population of the six. Its 46 million inhabitants equal less than half of the population of the next smallest country in this group. The volume of lending to these six major borrowers comprised $3.81 billion of the $5.36 billion total lending for the 59 major non-agriculture S&T projects. The average loan size for these countries was $115.4 million.

If the six medium-frequency borrowers (countries with two S&T loans each) are added into the average, loan size remains above US$ 100 million per project. The average loan size for the 14 countries that borrowed only once was $US 50.2 million. These countries

have on average much smaller populations. The figures seem to lend support to the idea that countries with large populations are also concerned with building and maintaining a critical mass of researchers and S&T infrastructure. However the correlation dos not indicate the direction of the causality. That is, we do not know if China, for example, borrowed for S&T because of a perceived need to reach "critical mass" in its S&T systems, or rather because a critical mass had already evolved prior to Bank involvement, and subsequently became the target of project support.

10. **Scientific Capacity in S&T Borrower Countries.** Of the top 12 borrowers for S&T, Korea is both the largest borrower and the most scientifically-advanced country, according to a taxonomy of S&T capacity devised for a recent study.[1] Korea was the only S&T borrower rated as a "Scientifically-Advanced Country" by this study. The remaining countries fall into three other categories. The "Scientifically Proficient Countries" are those defined by a dynamic S&T community, some world class innovative firms, and a critical mass of world class talent in some research disciplines. The "proficient" countries include China, Brazil, India and Portugal. A middle group, referred to as the "Scientifically Developing Countries," contains those countries with some pockets of vibrant research and a few firms involved in the commercialization of knowledge. Among these countries are Indonesia, Mexico, Chile, Mauritius and Turkey. The final category of "Scientifically Lagging Countries," includes those countries in which S&T communities are small and fragile (or, in some cases, non-existent), and firms show almost no capability to use scientific and technological knowledge. Only two of the World Bank's 12 repeat S&T borrowers—the Philippines and Thailand—were rated in the lagging category.

Of the 14 one-time S&T borrowers, nine are categorized as "Scientifically Lagging Countries," according to the RAND study. This correlation suggests that the larger, repeat borrowers have improved their scientific capacity through greater concern for and attention to S&T, which encouraged the commission of World Bank S&T-focused projects. Alternatively, the correlation could suggest that scientifically advanced countries maintain larger research communities and are more likely to seek World Bank assistance in further improving these systems. The reality probably lies somewhere in between

11. **$4.8 Billion in Lending to S&T in Agricultural Research**. A total of 447 S&T projects in the agricultural sector were supported by the World Bank between 1980 and 1999, the majority of which were minor projects. Forty-two percent of all major S&T projects (43 projects total) were also in agriculture, thus, the Bank supports more projects

[1] The taxonomy for these groupings was developed by the RAND Corporation's Science and Technology Policy Institute, as part of a background study on S&T collaboration between the developed and developing worlds. One hundred fifty countries were ranked according to a weighted composite index which considers per capita GNP (as a proxy for infrastructure), number of scientists and engineers per million people (human capital), number of S&T journal articles and patents by citizens (S&T outputs), percentage of GNP spent on R&D (input into S&T); number of universities and research institutions per million people (S&T infrastructure), and number of students studying in U.S. who chose not to return home at conclusion of studies (contact with external knowledge sources).

in this sector than in all others combined, making it the single largest donor for both the agricultural sector and the agricultural research subsector.[2] [For a more in-depth qualitative review of Bank S&T agricultural lending, please refer to Byerlee and Alex (1998) whose study on the issue informed this part of the analysis.]

Science and technology projects in the agricultural sector have a variety of subsector foci, including: research, education and extension, commodities, irrigation, credit and agribusiness, adjustment and reform. With the subsector of agricultural research, projects may be categorized according to the level of research sponsored as part of the effort to build S&T capacity. According to this division, project categories include: large projects dominated by research-building initiatives, large projects with little emphasis on research and small projects with either a large or small research focus. Examples from these categories are provided.

- *Major Agricultural Projects Focusing Principally on Research* One of a number of major agricultural projects that focused principally on research as a means to build S&T capacity, Kenya's 1997 *National Agricultural Research Project* cost $179.9 million, $80.8 million of which was associated with the research component specifically. The purpose of the project was to raise Kenyan agricultural productivity by creating a research institute focused upon adaptive research and technology dissemination.
- *Major Agricultural Projects Including a Smaller Research Component* Of the major agricultural S&T projects that included a smaller research component, the 1980 Côte d'Ivoire *North-East Savannah Rural Development Project* was one. Only $4.2 million of the $21 million in project costs were associated with funding research in this project that aimed to pilot a rainfed irrigation scheme among other rural development objectives.
- *Minor Agricultural Projects* Minor agricultural projects varied greatly, both by the extent to which they prioritized research and by the degree to which they focused upon specific crops or types of technology. Examples of minor agricultural projects include: Guinea's 1988 *National Seeds Project* ($10.6 million in costs, $1.7 million toward research), Barbados' 1987 *Agricultural Development Rehabilitation Project* ($5.8 million in costs, $.2 million toward research), and Turkey's 1980 *Ankara Air Pollution Control Project.*

Lending and policy toward agricultural research have been thoroughly reviewed. Several patterns and trends are worth noting:

- Support for research is increasing as a percentage of total lending to S&T for two reasons: (i) agricultural research has remained a high priority while overall lending for agriculture has declined, (ii) resources are being shifted, in some cases, away from support of extension and toward research;

[2] All data and information in this section are from "The World Bank's Role in Strengthening National Research Systems," chapter four of Strengthening National Agricultural Research Systems: Policy Issues and Good Practice, Derek Byerlee and Gary Alex, World Bank, 1998.

- Regionally, Sub-Saharan Africa receives the largest share of agricultural research lending, with this share growing in recent years (it accounted for 50% from 1993-96). This may mitigate the relative paucity of support for other types of research lending to Africa and should be taken into consideration in formulating any S&T support strategy for the region;
- The Bank's commitment to the National Agricultural Research Systems (NARS) has been steady and long-term; many countries have had sequential NARS support projects over periods of up to 20 years;
- The Bank has made a strong and substantial commitment to support International Agricultural Research Centers (IARCs) through, *inter alia*, its role as a sponsor of and investor in the CGIAR to which it donates roughly US$ 50 million per year;
- The Bank has played an important role in donor coordination. It has helped create programs and facilities such as the Special Program for African Agricultural Research (SPAAR) and the Office for Agricultural Research and Extension (ESDAR), a multi-donor forum;
- Research on natural resources management issues and related environmental concerns are increasingly seen as an integral part of sustainable agricultural policies and strategies.

12. **Outcomes and Impacts of Agricultural S&T Projects.** A 1996 OED report evaluated the Bank's record of lending across the agricultural sector. Although the report cited significant advances made in the sector as a result of Bank work, it also noted "serious deficiencies" in sustaining research institutions and in establishing institutional capacity in research planning, priority setting and evaluation. The review also described the vulnerability of funding to research in the National Agricultural Research Systems and recommended the wider use of economic analysis to inform lending decisions and improve research efficiency (Byerlee and Alex 59).

Despite its shortcomings in the sector, according to Byerlee and Alex (1998), the Bank successfully incorporated lessons from past experience in S&T lending in Agriculture, which have led to changes in lending practices, including a notable shift in priorities after 1993 toward management and policy competence, incentive systems, and accountability. This shift could be described as the adoption of a "quality agenda" that emphasizes: (a) merit and scientific rigor through the use of competitive funding, external reviews, and increased institutional linkages; (b) sustainability of funding through a variety of mechanisms including public-private interaction, cost-recovery, endowed research foundations, and farmer financing; (c) more recognition of and support for human resources training, especially as conducted at universities;[3] (d) continuing efforts to reform National Agricultural Research Institutes (NARIs) and the policies that affect them; and (e) increasing "knowledge-intensive" agriculture through linkages to basic research and the international knowledge base.

[3] P.63 of Byerlee and Alex notes that Bank-supported agriculture R&D projects should pay more attention to general issues of university quality and improvement, as a means to strengthening NARS. This is a potentially fruitful area of cooperation between staff in the agriculture and human developments networks.

Table 2 provides data regarding the changing foci of agricultural projects between 1990 and 1998. The table reveals such trends as increased emphasis on institutional pluralism, greater promotion of private-public interaction in R&D, and a surge in the number of projects promoting the involvement of farmers in research governance.

TABLE 2: TRENDS IN INSTITUTIONAL ISSUES EMPHASIZED IN AGRICULTURAL RESEARCH PROJECTS

Issue	Percent of Projects 1990-1993	Percent of Projects 1993-1999
Emphasis on institutional pluralism	50	86
Promotion of private-public interaction in R&D	12	71
Support of new funding sources	6	87
Support for competitive funding	12	86
Support for downsizing and consolidation	25	57
Involvement of farmers in research governance	38	87
Development of master plans for NARS	50	14
Emphasis on institutional pluralism	50	86

Source: Table 4.4 from Byerlee and Alex, 1998

13. **The majority of non-agricultural S&T projects have multiple components and diverse development objectives.** During fiscal years 1980-99, 59 major non-agricultural projects and *84 (CHECK CALC)* minor projects with specific S&T goals were approved. On average the Bank supported three major non-agricultural S&T projects per year, representing only 1.2% of all World Bank projects. The largest loan given to a non-agricultural S&T project was US$ 307.1 million (India FY91 Second Technician Education project) and the smallest was US$ 3.5 million (Laos FY89 National Polytechnic Institute project).

Those non-agricultural projects reviewed had multiple components and objectives, regardless of whether they provided major or minor support for S&T. Some projects represented broad attempts to intervene throughout an entire sector (e.g., in universities, research institutes and research funding organizations), while others focused on only one S&T relevant part of a specific sector (e.g., secondary science education). The activities undertaken in these projects ranged from metrology to environmental research to basic science education; however, most primarily focused on human resource or technology development. The remained revolved around sectoral concerns, in areas such as energy, health and the environment. For these reasons, the projects do not fall neatly into categories. A brief review the types of interventions within these varied project categories may be useful in identifying and evaluating the nature of Bank involvement in science and technology.

14. **Comprehensive S&T Development Projects**. A number of projects devoted resources to increase the capacity of researchers to produce scientific knowledge and of firms to incorporate it into production. These projects often addressed both the university-based research systems and the technology-using private sector, and included activities such as: providing matching grants to SMEs, fostering university/industry cooperation, and the promotion of intellectual property rights enforcement. Several of these projects were in Latin America--including three Brazil projects: *Science an Technology Reform Support*, *Science Research and Training*, and *Science and Technology*; and two Mexico projects: the *Knowledge and Innovation Project*, and *Science and Technology Infrastructure*. Comprehensive projects in East Asia include China's *Key Studies Development Project*, and Korea's *Program for Science and Technology Education*. In all of these projects, lending was intended to be part of an overall sectoral reform effort in restructuring. The *Mexico: Knowledge and Innovation Project*, for instance, devoted approximately US$ 265 million to research projects vetted under peer review procedures. The consolidation and expansion of peer review and competitive funding is considered a critical means of improving the performance of S&T in client countries.

15. **Human Resources Development**. The majority of non-agricultural S&T projects sought or seek to increase S&T capacity primarily by improving training systems in tertiary and secondary education. It has been common for these projects to finance the provision of S&T infrastructure, and the upgrading of laboratory equipment, in some cases accompanied by either sector-wide or institutional-level reform, such as improved peer-review allocation procedures.

- **Human Resources Projects: University-based Research and Education.** Of the S&T projects focused on human resources development, most occurred within the university system. Virtually all statd their development objective to be some variation of the principle goal of improving the quality and relevance of research, or research/ education programs. However, two distinct approaches seem to have been used for pursuing these objectives.

  One set of these projects supported S&T education or research by establishing or supporting competitive, performance-based funding, with improved peer-review allocation procedures. Such projects include the 1999 *Millennium Science Initiative Project* in Chile and Argentina's 1996 *Higher Education Reform Project*.

  The second set of projects pursued the same general goal of providing S&T education support, but did so without a focus on explicitly performance-based funding procedures. These projects often financed institutional support for research infrastructure albeit without clearly redesigning mechanisms for allocating the support. Such projects ranged from the basic provision of laboratory or other science equipment and libraries and reform of curricula to staff and researcher development through overseas fellowships and more autonomous university management. Collaborations among universities (local and foreign) and research institutes, and linkages with industry were components built into many of these projects, reflecting

the necessity of knowledge-sharing as a basis for knowledge creation. Such projects include: China's 1999 *Higher Education Reform Project* and *Kenya: Universities Investment Project*

- **Human Resources Projects: Polytechnic and Secondary Education Focused.** Two other significant human resources project categories are those of polytechnic education and secondary science education. Polytechnic education projects typically involved providing some combination of specialized equipment or facilities (such as dormitories, classrooms, laboratories, etc.), new programs or schools, teacher training (through workshops, seminars, fellowships), curriculum development, and management planning (e.g., *Mauritius: Higher and Technical Education Project*; *Malaysia: Polytechnic Development Project*; and, *Tunisia: Higher Education Restructuring Project*). Secondary education focused projects sought or seek to improve the quality of secondary level science instruction. In the case of the *Korea: Science Education and Library Computerization Project,* this was done by creating joint science centers to be used by both higher and secondary institutions, and by linking the libraries of over three dozens institutions of higher learning. By contrast, the *Thailand: Secondary Education Quality Improvement Project* focused on improving the capacity of science teachers, and upgrading the laboratories at teacher training institutes.

16. **Technology Development Focused Projects**. Three categories of non-agricultural technology development projects bear description:

- *Projects to Restructure Public R&D Institutes to Make Them More Responsive to Industry Needs*. In China, for example, the *Technology Development Project* assisted in the privatization of research institutes through a program that helped them convert to private, for-profit "Engineering Research Centers" (ERCs). Like the ERCs in the US, these institutes had a "sunset clause:" a pre-determined time period in which they would either have to become commercially viable and self-sustaining or disappear.
- *Projects to Enhance the Level of Technology Development in Industry*. The main focus of the *Indonesia: Technology Development Project,* for example, was to provide technology services to firms, especially SMEs.
- *Projects Focused on MSTQ*. A few of these projects were principally concerned with MSTQ while several others had subcomponents devoted to it such as the FY94 *Mauritius: Technical Assistance to Enhance Competitiveness Project* that supported the creation of a national quality system, while helping to develop an MSTQ accreditation council and upgrade a variety of technical services related to metrology, testing, and dissemination of standards.

17. **Health Projects.** Between 1980 and 1999, eight projects in the health sector used Bank support for S&T capacity building and research, ranging from less than US$ 1 million (a public hospital modernization project in Korea) to US$ 104 million (a US$ 323 million project on rural health and medical education in China). While Bank S&T-focused health projects were relatively uncommon, those that existed were diverse.

One successful project was the *Brazil: Disease Surveillance and Control Project,* which sought to strengthen the national disease surveillance and control system, requiring infrastructure support for a network of laboratories, a data management telecommunications system, and trained management and technical staff. The system was designed to collect and publish information, including incidence of disease and rates of mortality. Studies and research in epidemiological and environmental surveillance were also supported.

18. **Environment-Focused Projects.** Two projects addressed R&D and technology policy concerns within the context of environmental issues. The *China: Environmental Technical Assistance Project*, sought to increase China's ability to understand and manage environmental problems via targeted Bank support to the Chinese Academy of Sciences (CAS) and the National Environmental Protection Agency. The *Korea: Environmental Technology Development Project* provided overseas training, visiting experts, equipment and library materials to several research institutes to provide them with the opportunity to "orient their R&D activities increasingly towards environmental concerns." Also of relevance, an environmental management and cartography project in Venezuela contained about 25% S&T.

19. **Other Sector-Specific S&T Projects.** The Bank conducted few non-agriculture S&T projects outside of the education, health, and environment sectors. Two water projects contained significant S&T components, although these focused mainly on technology (knowledge) transfer. Additionally, a small handful of minor S&T projects (less than 4%) spanned the transportation sector (six projects) and the energy sector (one project).

20. **Outcomes and Impacts of Non-Agricultural S&T Projects** At the time of this analysis, implementation completion reports (ICRs) had been completed for only six of the non-agricultural S&T projects. Three of these were for Korea and the other three evaluated the achievements and impacts of projects in Mexico, the Philippines, and China. The report for the Mexico project gave greatest consideration to the project's contribution to the overall S&T sector, and found it to have been very helpful in limiting the damage to the research community during the 1994 and 1995 financial. Following the completion of the project, Mexican institutions for S&T were stronger and more capable of promoting the long-term growth of scientific research, but the financing of research remained vulnerable. Very positive impacts were attributed to improved transparency and competition through the institutionalization of peer review, provision of infrastructure, and services such as MSTQ. However, the project was faulted for its over-emphasis on supply at the expense of a strategic focus on demand for S&T services. The Philippines project was found to have improved the conditions for scientific training, and the supply of qualified individuals. It also instituted mechanisms for quality assurance in research and training, and greatly improved the flow of scientific information throughout the country's university system. The report recommended, however, a greater degree of involvement for the private sector. The ICR for the *China Regional Cement Industries Project* recognized a reasonably successful privatization and technological upgrading of public enterprises, but was ambiguous regarding the success

of improved R&D capacity. The report acknowledged that both facilities and human capital had been improved but that delays in implementation had made progress unsatisfactory.

The ICRs from the three Korean projects that closed in 1998 all stated that the projects met their objectives, yet at the same time cited the inadequacy of project indicators. All three acknowledged increased scientific capacity due to increased provision of laboratories and equipment as well as improvements in efficiency and utilization of equipment. Comments on sustainability were limited to the condition of the equipment purchased. The Science Education and Computerization project cited an 18.5% increased in employment for university grads, but it did not specify if this increase was attributable to the project. Mention of complementarity between the objectives of the three Korean projects or to a larger S&T development vision was not included in any of the reports.

21. **Millennium Science Initiative**. Through the recently initiated Millennium Science Initiative (MSI), the Bank has begun to seek to stimulate greater operational collaboration with client countries for the improvement of S&T capacity building and research. The MSI is a group of projects, partially funded by World Bank loans, which support high-level scientific and technological research. By creating funding mechanisms that provide competitive grant support to individuals conducting research of the highest possible quality and relevance to their societies, and maximizing training opportunities for aspiring young scientists and researchers, the MSI seeks to contribute long-term to the building of dynamic S&T systems within developing countries. To date, four Bank clients are participating in the MSI (the first of which was the 1999 Chilean project), with discussions underway for a number of others.

22. **Other (Non-project) World Bank S&T Initiatives.** In addition to funding project-specific S&T-strengthening efforts through its lending programs, the World Bank has undertaken support of S&T for development through a variety of ventures across geographical and sectoral areas. One such initiative, the Special Program for African Agricultural Research (SPAAR)—established in 1985 by a group of donors under World Bank leadership—is an open coalition that aims to further the contribution of agricultural research to food security, environmental sustainability and economic development in Africa. The Program promotes reforms of agricultural research institutions aimed at enhancing their sustainability and effectiveness, with a particular focus on building local capacity. SPAAR itself has been instrumental in the development of sub-regional agricultural research organizations throughout Africa.

Also in support of agriculture and rural development, the Bank cosponsors and hosts the secretariat of the Consultative Group on International Agricultural Research (CGIAR), an informal association formed in 1971 that supports sixteen international agricultural research centers. These centers conduct research aimed at increasing productivity, protecting the environment, saving biodiversity, improving policies and strengthening national research. The accomplishments of the CGIAR range from agricultural productivity enhancement of staple crops to improved water management, making the

Group universally recognized as an integral and irreplaceable part of the long-term development agenda.

The Special Program for Research and Training in Tropical Diseases (TDR) is an international technical cooperation program, established in 1975 under the co-sponsorship of the United Nations Development Program, the World Bank and the World Health Organization. Through partnerships with research institutions, ministries of health, disease control programs, industry, academia and other organizations, TDR pursues its goals of (i) developing new methods of prevention, diagnosis, treatment and control of the major tropical diseases; and (ii) strengthening the capability of developing endemic countries to undertake tropical health research on their own. These research and training objectives are essential components of the Bank's S&T-related efforts.

The Bank's S&T portfolio contains several other initiatives in diverse fields and with many partners, also including the InfoDev program—designed to assist the developing world in reaping the benefits of information and communications technologies—and the Global Environmental Facility—charged with facilitating international cooperation and financing efforts to deal with threats to the environment.

23. **Conclusions**. Analysis of S&T projects over the last 20 years reveals no consistent approach or strategy on the part of the Bank toward developing scientific and technological capacity in its client countries. In Agriculture, sustained effort has been put into supporting NARS, much of which has been in the form of minor support undertaken in connection with other rural development activities. Ten to fifteen clients, by contrast, hold loans that focus principally on improving agricultural research capacity. Similarly, for non-Agricultural S&T, efforts have been concentrated on a dozen, larger, more scientifically advanced countries. A few countries in two regions, East Asia and Latin America, have maintained S&T as a constant national priority. These (with the exception of Korea) have tended to be large countries in the low- to middle-income range. Smaller countries have been more likely to ask for assistance in tertiary technical studies, or with technical standards related to trade liberalization. In general, however, the Bank's approach has been *ad hoc*, experimenting with different mechanisms for different circumstances as they occurred. Human resource development and technology development appear to have been persistent priorities, and account for the most resources. The rationale for interventions in this area has often been based in a desire to improve the efficiency and effectiveness of science funding systems, as well as the accompanying allocation mechanisms. In more recent projects, concern to improve transparency and to develop better indicators has been stressed, probably in reaction to several ICRs that faulted projects for not having the correct indicators of impact. Many projects are input focused, and cite as a principle achievement the provision of infrastructure to scientists and researchers. Larger projects have also helped countries minimize the damage to their S&T systems during periods of fiscal and financial crises. Tracer studies of employment of graduates have been rare, as have serious attempts to devise monitoring indicators that respect the time lag inherent in research. Cooperation among sectors appears minimal, but international training has been a part of a number of projects. With the exception of the environment, research seems not to be directed toward specific societal ends. There

is clearly room for the projects to sponsor greater cooperation among client countries, and a first step toward this should be more interaction among the Bank staff who work on science and technology issues.

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