AGRICULTURAL SCIENCE AND TECHNOLOGY INDICATORS

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MALI

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This brief reviews the major investment and institutional trends in public agricultural research in Mali since 1976, including a new set of survey data for the 1990s collected through the Agricultural Science and Technology Indicators (ASTI) initiative (IFPRI–ISNAR–CORAF/WECARD 2002–03).[1]

INSTITUTIONAL DEVELOPMENTS

With a gross domestic product (GDP) per capita of US$234 in 2001, Mali is one of the world's poorest countries (World Bank 2003). The most deprived layers of the population live in the rural regions where drought is a frequently occurring phenomenon. Farmers, mainly practicing subsistence agriculture, account for roughly 80 percent of the country's labor force (FAO 2004). Consequently, agriculture in general and agricultural research and development (R&D) in particular form important priorities for the Malian government. In 2001, five agencies were involved in agricultural research in Mali, which combined employed 300 full-time equivalent (fte) researchers and spent over 6 billion 1999 CFA francs—equivalent to 28 million 1993 international dollars (Table 1).[2, 3]

Mali's principal agricultural research agency is the Rural Economy Institute (IER),[4] accounting for roughly 85 percent of total agricultural research staff and expenditures in 2001. IER was established in 1960 and is placed under the Ministry of Agriculture (See *A Short History of Government-Based Agricultural Research* on page 2). The institute's mandate is to design, manage, and carry out agricultural research programs; to plan and evaluate agricultural development projects; to supervise and coordinate organizations and authorities that conduct research in Mali; and to create, conserve, and protect national scientific assets. IER's headquarters are situated in the city center of Bamako and the institute oversees six additional regional centers dispersed over the country's various agroclimatological zones (Kayes, Sotuba, Sikasso, Niono, Mopti, and Gao), three central laboratories, and one genetic resources unit. Each center operates within a network of eight research stations and twelve

Table 1—Composition of agricultural research expenditures and total researchers, 2001

Type of agency	Spending: 1999 CFA francs	Spending: 1993 international dollars	Total Researchers	Share: Spending	Share: Researchers	Agencies in sample[a]
	(*millions*)		(*fte's*)	(*percent*)		(*number*)
IER	5,479.3	23.8	248.0	86.3	82.6	1
Other government[b]	221.5	1.0	21.5	3.5	7.2	2
Higher education[c, d]	650.5	2.8	30.8	10.2	10.2	2
Total	**6,351.3**	**27.5**	**300.3**	**100**	**100**	**5**

Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–CORAF/WECARD 2002–03).
[a] See note 2 for a list of the 5 agencies in our sample.
[b] The 39 staff at the 2 other government agencies spent 50 and 70 percent of their time on research, resulting in 21.5 fte researchers.
[c] The expenditures for the higher-education agencies are estimates based on the government agencies' average expenditures per researcher.
[d] The 112 staff at the 2 higher-education agencies spent 15 and 30 percent of their time on research, resulting in 30.8 fte researchers.

KEY TRENDS

- Total agricultural researcher numbers declined gradually during 1991–2001, while agricultural R&D expenditures remained more or less stable.
- Mali distinguishes itself from many African countries in terms of agricultural research centralization in having one main agricultural R&D agency—the Rural Economy Institute (IER)—that accounted for roughly 85 percent of the country's agricultural researchers and expenditures in 2001.
- In addition to government contributions, IER was largely dependent on funding from the National Agricultural Research Project (PNRA) and the Agricultural Services and Producer Organizations Program (PASAOP), drawn predominantly from World Bank loans, and financing from the Netherlands through the IER Support Project (PAPIER).
- PNRA had an important training component that significantly improved the education levels of IER's researchers throughout the 1990s.

ABOUT ASTI

The Agricultural Science and Technology Indicators (ASTI) initiative comprises a network of national, regional, and international agricultural R&D agencies and is managed by the International Service for National Agricultural Research (ISNAR) division of the International Food Policy Research Institute (IFPRI). The ASTI initiative compiles, processes, and makes available internationally comparable data on institutional developments and investments in public and private agricultural R&D worldwide, and analyses and reports on these trends in the form of occasional policy digests for research policy formulation and priority setting purposes.

Primary funding for the ASTI initiative was provided by the CGIAR Finance Committee/World Bank with additional support from the Australian Centre for International Agricultural Research (ACIAR), the European Union, and the U.S. Agency for International Development (USAID).

substations (IER 2000a). IER is governed by a Board of Directors whose members include representatives from the Ministry of Agriculture, producer organizations and IER's research, technical support, and finance departments. The directors of the regional centers are appointed by IER's Director General and are responsible for managing and supervising activities at their research stations and substations. In 2003, IER's scientific portfolio comprised 16 research programs, distributed over five themes: crops, livestock, forestry and fisheries, production systems and natural resource management, and economics of agricultural networks. During the 1990s, important institutional reforms were initiated through the National Agricultural Research Project (PNRA), which was funded by a World Bank loan. This project has contributed tremendously to the improvement of the cohesion, quality, and relevance of IER's research (World Bank 2002).

In 2001, two other government agencies were involved in agricultural R&D, accounting for only 7 percent of fte researchers and 4 percent of total spending. The Central Veterinary Laboratory (LCV), under the Ministry of Livestock and Fisheries (MEP), employed 15 fte researchers in 2001. The objective of its Diagnostic and Research Division is to contribute to the prevention and eradication of animal diseases, the protection of public health by the detection of diseases transmissible to humans, and microbiological analysis of food and drink products. The Division disposes of one diagnostic unit with about ten specialized laboratories and three research programs: one on infectious diseases, one on parasite diseases, and one on metabolic diseases. Like LCV, the Malian Livestock and Meat Agency (OMBEVI) is equally placed under MEP and it employed seven fte researchers in 2001. Besides conducting research on the socioeconomic aspects of livestock production, OMBEVI establishes overall development strategies for the livestock sector, and it enforces quality standards for meat production (Mazzucato 1994).

We identified two higher-education agencies involved in agricultural R&D. In 2001, these two agencies accounted for 10 percent of the country's total agricultural research staff and expenditures. The Rural Polytechnic Institute for Training and Applied Research (IPR/IFRA) under the University of Bamako (known as the University of Mali until June 2002), is the country's main agricultural training institute, employing 28 fte researchers in 2001. Based in Katibougou, at about 60 kilometers from Bamako, IPR/IFRA forms an important link in Mali's agricultural research structure, having trained the majority of IER's researchers. Besides training, the institute dedicates an increasing part of its activities to agricultural R&D, including crops biotechnology, crop pest and disease control, and soil fertility improvement (Samaké 2002). The Higher Institute of Training and Applied Research (ISFRA) is also placed under the University of Bamako. Although its principal focus is on training, ISFRA conducts limited research on biological sciences and human and social sciences.

We have not identified any private for profit companies conducting agricultural research in Mali. However, IER works closely with various producer organizations and private companies, in particular with the Malian Cotton Company (CMDT). IER conducts applied cotton research on a contractual basis on behalf of the latter and the two agencies work together on technology transfer to cotton producers (IER 2000b). Besides national partners such as IPR/IFRA, ISFRA, LCV, and the National Scientific and Technological Research Center (CNRST), IER also collaborates with regional and international agencies such as the Sahel Institute (INSAH), Winrock International, the International Institute of Tropical Agriculture (IITA), the World Agroforestry Center (ICRAF), the West Africa Rice Development Association (WARDA), the International Livestock Research Institute (ILRI), the Royal Tropical Institute (KIT) of the Netherlands, the Center of International Agricultural Research Cooperation for Development (CIRAD), and the Institute of Research for Development (IRD), the latter two from France. In addition, IER is a member of various regional networks such as the West and Central African Sorghum Research Network (ROCARS) and the West and Central African Millet Research Network (ROCAFREMI) (IER 2000b; Lozano 2002). Twelve of IER's 16 research programs are now executed in collaboration with regional and international partners, which has seriously enhanced research quality (World Bank 2002). The nature of these exchanges ranges from on-demand research contracts to exchanges of research results (Kouriba and Soumaré 2002).

A Short History of Government-Based Agricultural Research

Prior to Mali's independence in 1960, most agricultural research in the country was conducted or supervised by the Bambey (Senegal) Federal Center for Agronomic Research and the Niger Office. Mali was one of the few French African colonies that immediately upon independence created a national agricultural research structure that sought to take control of and coordinate agricultural research activities in the country. In 1960, the Rural Economy Institute (IER) was established as an agency within the Ministry of Agriculture. It was charged with coordinating the different research organizations as well as all the agencies implementing development projects and conducting evaluation studies of these projects. In 1968, IER's mandate was broadened by ministerial decree to include the execution as well as the coordination of research.

An agreement with France enabled the existing French research institutions to collaborate with IER after the country gained political independence. Various French institutes began (or continued) conducting research in Mali. In 1969, the Malian Livestock and Meat Agency (OMBEVI) was created to conduct research on livestock. The Central Veterinary Laboratory (LCV) was established ten years later and its research focus included (and still includes) animal diseases. Apart from the mergers between the National Institute of Zootechnic, Forestry and Hydrobiological Research (INRZFH) and IER in 1990 and the Agricultural Mechanization Division (DMA) and IER in 2001, not much change has taken place in the composition of the Malian agricultural research system during the 1980s and 1990s.

Source: Mazzucato (1994).

The scientific partners of LCV and OMBEVI include the International Atomic Energy Agency (IAEA), ILRI, the International Center for Research and Development of Livestock in the Subhumid Zone (CIRDES), and the Virginia Polytechnic Institute. IPR/IFRA works closely with national partners such as IER, CNRST, and CMDT, as well as with international agencies such as IAEA, ICRAF, and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). ISFRA maintains a very close relationship with IER, with which it signed a formal agreement that takes charge of the funding of a training project on crop protection (Lozano 2002). Other scientific partners of ISFRA include IRD, ICRISAT, and various French universities.

HUMAN AND FINANCIAL RESOURCES IN AGRICULTURAL R&D

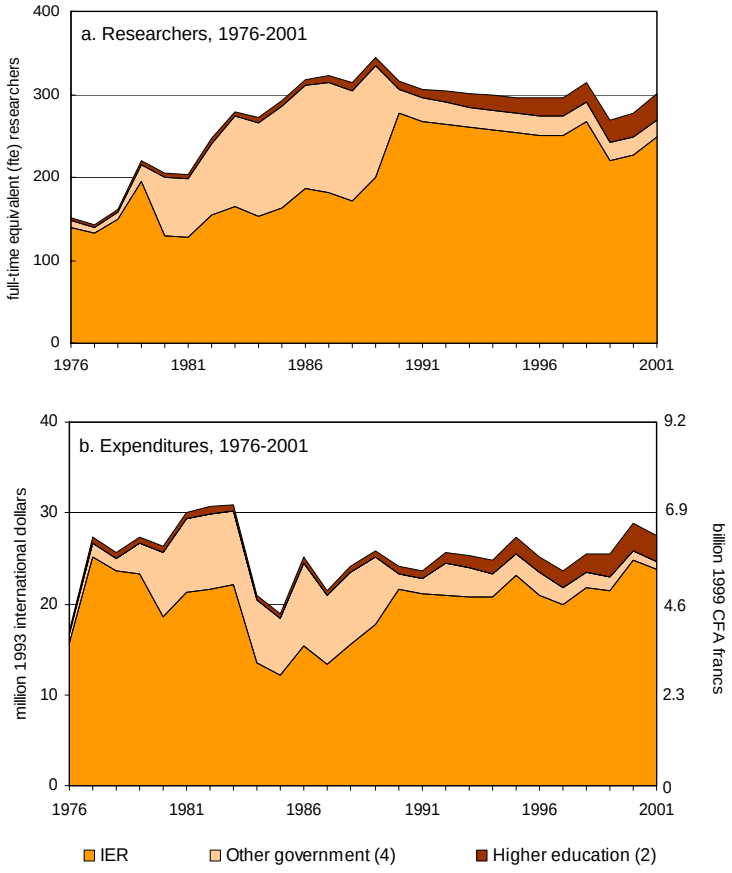
Overall Trends

Mali's total number of agricultural researchers increased by 2.3 percent per year on average during 1976–2001, but shows a slow decline during the last decade (Figure 1a).[5] Between 1976 and 1989, researcher totals increased steadily by 7 percent annually, reaching a peak of 345 fte researchers in 1989. In 1990, the National Institute of Zootechnic, Forestry and Hydrobiological Research (INRZFH) merged with IER, explaining the surge in IER researcher totals during that year. Between 1990 and 2001, fte researcher numbers showed an erratic trend but fell gradually by 0.7 percent per year and totaled 300 in 2001. The sudden drop in the number of IER researchers in 1999 was the result of the departure of various researchers following a refusal to adhere to IER's new staff policies, but this decrease was only temporary. Agricultural researcher totals in the higher-education sector rose steadily during 1991–2001 as a result of increased research activities at IPR/IFRA. The number of researchers in the other government agencies, on the other hand, fell gradually throughout the same period, the combined result of declining researcher totals at OMBEVI and the merger of the Agricultural Mechanization Divison (DMA) with IER in 2001.

The share of expatriate researchers in the total number of researchers was relatively high in Mali during the 1970s and 1980s but has rapidly declined since then. In 1976, 31 of IER's 140 fte researchers were expatriates (22 percent), compared with 8 of 248 (3 percent) in 2001. The majority of expatriate researchers at IER in the 1990s were French working on joint CIRAD–IER cotton projects, the Irrigated Rice Project (PRI), and the Sudano-Sahelian Production Project (PSS), Dutch working on the IER Support Project (PAPIER), or American working on the Agricultural Research Support Project (PARA). We observed a similar decline in expatriate totals in the other government and higher-education agencies.

The level of agricultural R&D spending shows an erratic trend during 1976–2001, but has remained more or less stable in real terms (Figure 1b). Spending increased by 6.4 percent annually throughout 1976–1983, mainly as a result of the initiation of research activities by LCV in 1979 and a large increase in donor-funded projects at IER between 1981 and 1984. The largest of such projects included the renovation of the rice research station at Kogoni with support from the United States Agency for International Development (USAID) and Ciba-Geigy. Both projects involved substantial capital investments, leading to an increase in IER's overall expenditures during those years (Mazzucato 1994). The completion of these projects in 1984 caused an enormous decline in Mali's agricultural R&D spending. After 1985, spending gradually picked up again, rising by 4.2 percent per year between 1985 and 1990. During the 1990s—in which Mali's agricultural research agencies showed a heavy reliance on funding from foreign donors, particularly the World Bank, the Netherlands and USAID—total spending stabilized at around $26 million annually.

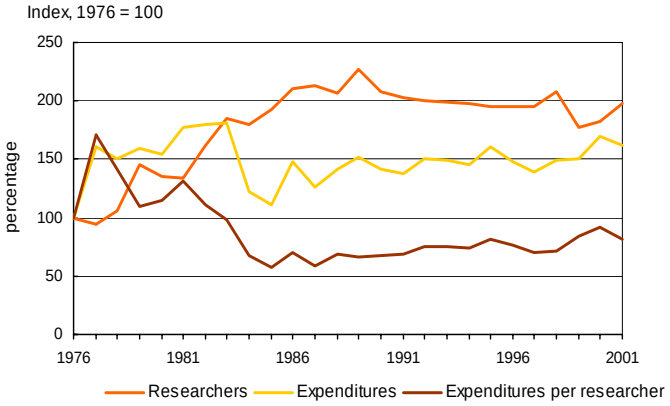
Figure 1—Public agricultural R&D trends, 1976-2001



Sources: Compiled by authors from ASTI survey data (IFPRI–ISNAR–CORAF/WECARD 2002–03) and Mazzucato (1994).
Notes: Figures in parentheses indicate the number of agencies in each category. "Other government" includes INRZFH and DMA, which were transferred to IER in 1990 and 2001, respectively. Expenditures for the higher-education agencies are estimates based on combined average expenditures per researcher for the government agencies. Underlying data are available at the ASTI website (http://www.asti.cgiar.org).

The decline in the total number of researchers and the relative stability in agricultural R&D spending have led to an increase in expenditures per researcher during the 1990s from $77,000 in 1991 to $92,000 in 2001 (Figure 2). Average expenditures per researcher in Mali are higher than in most West African countries.

Figure 2—Trends in public expenditures, researchers, and expenditures per researcher, 1976-2001

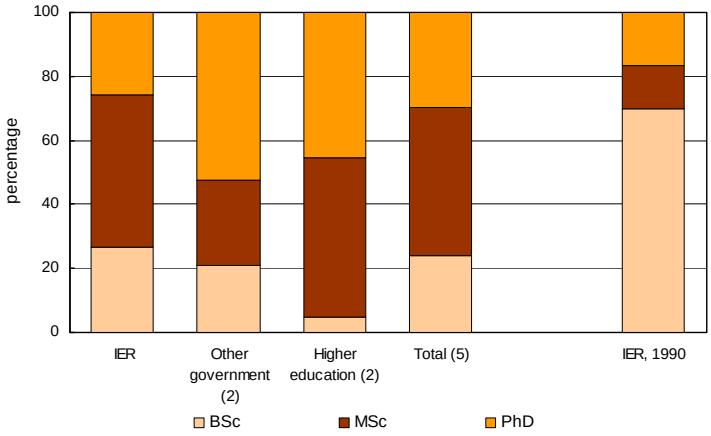


Source: Figure 1.

Human Resources

In 2001, 76 percent of Mali's 292 fte researchers had postgraduate training, with 30 percent holding a doctorate degree (Figure 3). A higher proportion of higher-education agency staff (95 percent) held postdoctorate degrees compared with staff at IER (73 percent) and the other government agencies (79 percent), which is in line with findings in other African countries. PNRA's training component has greatly assisted in the upgrade of the education levels of research staff. During the 1990s, 17 IER researchers were trained up to the PhD level, and 34 IER researchers were trained up to the MSc or comparable levels as part of PNRA.[6] PNRA-financed training took place at the University of Bamako as well as abroad (World Bank 2002). As a result, the share of researchers with MSc and PhD degrees increased considerably from 13 and 17 percent in 1990 to 48 and 26 percent, respectively, in 2001.

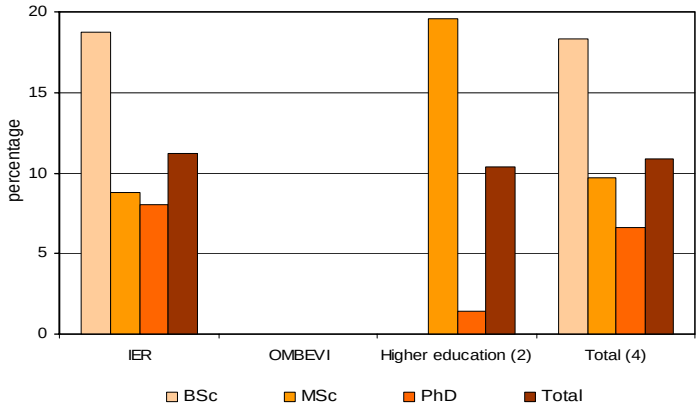
Figure 3—Educational attainment of researchers, 1991 and 2001



Sources: Compiled by authors from ASTI survey data (IFPRI–ISNAR–CORAF/WECARD 2002–03) and Mazzucato (1994).
Notes: Figures in parentheses indicate the number of agencies in each category. Data exclude expatriate staff.

In 2001, based on a sample comprising IER, OMBEVI, and the two higher-education agencies, 11 percent of Mali's researchers were female (Figure 4), a similar share compared with 2001 figures for many other West African countries and an improvement over Mali's 1990 figure, which was below 5 percent (Mazzucato 1994). In terms of education levels, 8 percent of IER's PhD researchers and 1 percent of the higher-education agencies' PhD researchers were female in 2001. IER was the only agency in our sample that employed female researchers with BSc degrees; in 2001 they accounted for 19 percent of total IER researchers trained to this level.

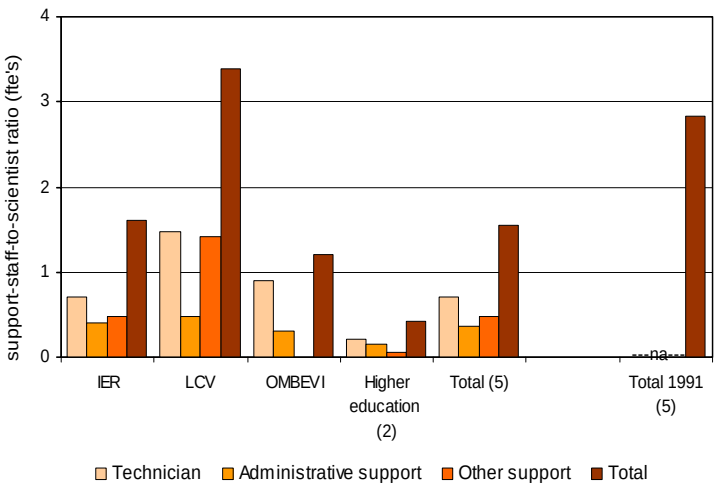
Figure 4—Share of female researchers, 2001



Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–CORAF/WECARD 2002–03).
Notes: Figures in parentheses indicate the number of agencies in each category. Data exclude expatriate staff.

In 2001, the average number of support staff per scientist in a five-agency sample was 1.6, comprising 0.7 technicians, 0.4 administrative personnel, and 0.5 other support staff such as laborers, guards, drivers, and so on (Figure 5). LCV had the highest ratio of support staff per scientist (3.4), followed by IER (1.6) and OMBEVI (1.2). Ten years earlier, the country's support-staff-to-scientist ratio was 2.8. This decline can be explained by the nonreplacement of retiring support staff following Mali's current policy of reducing civil servant numbers.

Figure 5—Support-staff-to-researcher ratios, 1991 and 2001

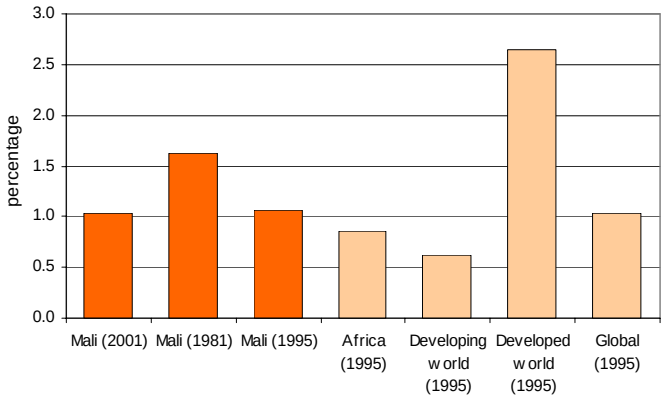


Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–CORAF/WECARD 2002–03) and Mazzucato (1994).
Notes: Figures in parentheses indicate the number of agencies in each category. Data exclude expatriate staff. 1991 data include DMA but exclude IPR/IFRA. 1991 data per support staff category were not available.

Spending

Total public spending as a percentage of agricultural output (AgGDP) is a common research investment indicator that helps to place a country's agricultural R&D spending in an internationally comparable context. In 2001, Mali invested $1.03 for every $100 of agricultural output, a share well above that of many neighboring countries (Figure 6). However, the country's research intensity ratio for 2001 was lower than those recorded in 1981 (1.62) and 1995 (1.07). The corresponding 1995 ratios for Africa (0.85) and the developing world (0.62) were well below those for Mali during that same year.

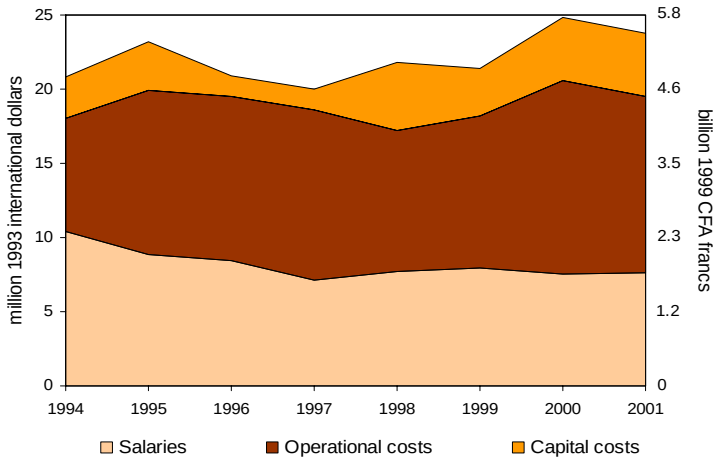
Figure 6—Mali's public agricultural research intensity compared regionally and globally



Sources: Mali compiled from Figure 1b; AgGDP from World Bank (2003); other intensity ratios from Pardey and Beintema (2001).

Between 1994 and 2001, operating costs accounted for 49 percent of IER's total expenditures, whereas salaries and capital costs accounted for 37 and 14 percent, respectively (Figure 7). The share of salaries declined in absolute and relative terms throughout this period, because of a reduction in national and expatriate researcher totals and a rise in operating and capital expenditures. The continuously high operating and capital investments during 1994–2001 were the results of important funding through PNRA and PAPIER. Notwithstanding sizeable investments in civil works, vehicles and equipment, maintenance, and operating costs, only 30 percent of the funds initially budgeted for the rehabilitation of research infrastructure and 28 percent of the budgeted amount for equipment acquisitions were received at the closure of PNRA. This was the result of a lower than expected contribution to PNRA by foreign donors (World Bank 2002). Despite this somewhat disappointing donor commitment, spending levels at IER were very stable compared with counterpart institutes in many other West African countries.

Figure 7—Cost-category shares in ITRA's expenditures, 1998–2001



Source: Compiled by authors from ASTI survey (IFPRI–ISNAR–CORAF/WECARD 2002–03).
Note: Data include estimated salaries for expatriate staff (see *Methodology* on page 9).

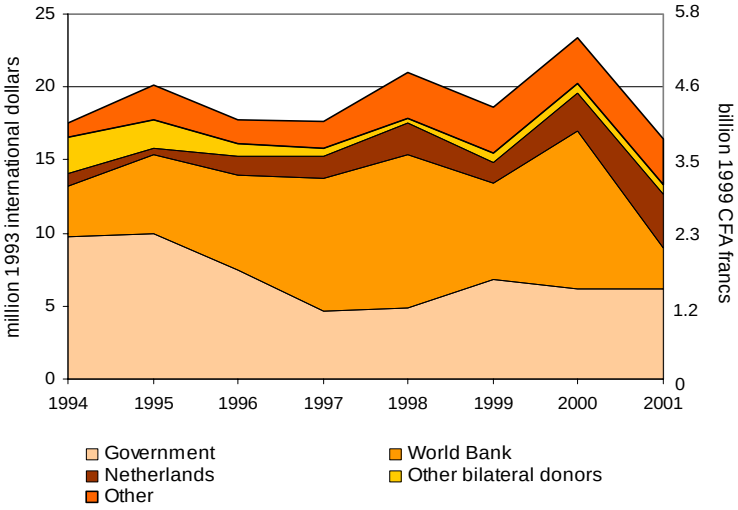
FINANCING PUBLIC AGRICULTURAL R&D

Agricultural research in Mali is largely financed by the national government, loans from the World Bank, aid from (foreign) donors, and producer organizations. Besides funding from the government, LCV depended largely on financing from the Food and Agriculture Organization of the United Nations (FAO), USAID, IAEA, the Swiss government, and the European Union during 1991–2001. OMBEVI and the higher-education agencies were almost fully dependent on government funding. The University of Bamako sets 2 percent of its annual total budget aside for research (including nonagricultural research). Additional research funding is acquired through CNRST and foreign funds. As a whole, the University of Bamako disposes of very limited financial resources to accomplish its research mission (Lozano 2002).

Rural Economy Institute

Between 1994 and 2001, IER showed a heavy reliance on foreign donor funding. An average of one-third of the institute's total budget came from the national government and another third through PNRA (Figure 8). The remainder of IER funding was provided by the Netherlands and other donors including USAID, the Swiss government, CMDT, and the Novartis Foundation. Internally generated funds accounted for only 1 percent of IER's total budget. Corresponding with an increase in donor funding, government contributions to IER have declined in real terms, from $10 million in 1994 to $6 million in 2001.

Figure 8—IER's funding sources, 1994–2001



Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–CORAF/WECARD 2002–03).
Notes: "Other" includes internally generated income, contributions from private enterprises, and nonidentified sources of funding. IER's funding levels are lower than expenditure levels because estimated salaries for expatriates are not included.

The World Bank has assisted the Malian government in the development of the country's agricultural sector since 1971. During the period 1991–2003, two consecutive World Bank projects have targeted Mali's agricultural research sector: PNRA and the Agricultural Services and Producer Organizations Program (PASAOP). PNRA ran from 1994 to 2001 and its principal aim was the enhancement of the performance of IER and the National Agricultural Research Council (CNRA),[7] by improving coherence, quality, relevance, and accountability of research results through institutional reforms. Farmer-participatory research also played an important role in this project. The anticipated total budget for PNRA amounted to US$111.7 million and—in addition to a World Bank loan (US$20 million)—consisted of contributions from the Malian government (US$17.9 million), USAID (US$23.3 million), the Netherlands (US$13.8 million), France (US$3.4 million), IER itself (US$0.8 million), the United Nations Development Programme (UNDP) (US$0.3 million), and the Swiss government (US$0.2 million). The remaining US$25.5 million represented contributions from other donors that had not yet committed to the financing of the project at its beginning (World Bank 1993). At the closure date of PNRA in 2001, however, only US$19.2 million of the US$68.2 million were received from donors other than the World Bank and the national government. As a result, the infrastructure rehabilitation program and the funding of research activities had to be cut by US$34.4 million and US$21.0 million, respectively. The impact of these budget cuts on the institutional reform component of PNRA was limited. Unlike many other West African governments who cofinanced similar World Bank projects in their respective countries, the Malian government delivered 99 percent of its share of counterpart funding, albeit after numerous delays.[8] The commitment shown by the national government has seriously contributed to the relative success of the project. PNRA has strengthened IER at an institutional level and has improved the quality of its research programs. The institute's statute was changed from an ill-suited administrative one to that of a public research and technology establishment. Serious delays in project implementation, however, had negative impacts on the strengthening of human resource and financial management components of the project. The involvement of farmers in the financing and execution of research projects remained insufficient at the closure of PNRA (World Bank 2002).

A second World Bank project—PASAOP (2002–13)—immediately followed up PNRA. PASAOP has a budget of US$123.5 million, largely cofinanced by the Government of Mali; USAID; the French, Swiss, and Dutch governments; and the European Union. PASAOP consists of three phases. The first phase of the project (2002–05), with a budget of US$53.4 million, comprises four main components: the reform of MAEP, agricultural research support, agricultural extension support, and support to producer organizations. The "agricultural research support" component of PASAOP's first phase (US$8.7 million of which US$6.3 million is financed by a World Bank loan) focuses on the strengthening of the scientific capacity, the improvement of IER's and LCV's research facilities, the funding of strategic and applied research projects, the

establishment of a competitive and decentralized financing mechanism for short-term agricultural research projects in Mali's principal agroecological zones, and the improvement of linkages between the national and international agricultural research systems (World Bank 2001). Despite the important agricultural research component of PASAOP, the first disbursement made to IER was only 60 percent of the budgeted amount and did not occur until September 2003. This late disbursement was due to a delay in the national government's counterpart funding and it has seriously affected the functioning of the project, which makes the success of the project's first phase difficult to assess at this stage. However, despite the initial problems at the start-up of the project, PASAOP's principal objectives are expected to be reached.[9]

Another project that was responsible for a sizeable share of IER's funding in recent years is PAPIER. This project is financed by the Dutch government and carried out by KIT. Its main objectives are to better connect IER's activities to its client's needs and to make IER more efficient and cost-effective. In order to achieve these goals, KIT has organized various planning workshops at all levels of the organization, resulting in a detailed budget and work plan. The project started in December 1999 and has a five-year duration (KIT 2000). Between 1999 and February 2004, IER had received 4.9 billion current CFA francs through PAPIER. The project has been very successful so far on the macroeconomic as well as on the applied research level. Important research quality control mechanisms have been established, linkages with other actors in the rural development field have been set up, and information and communication management has been improved.

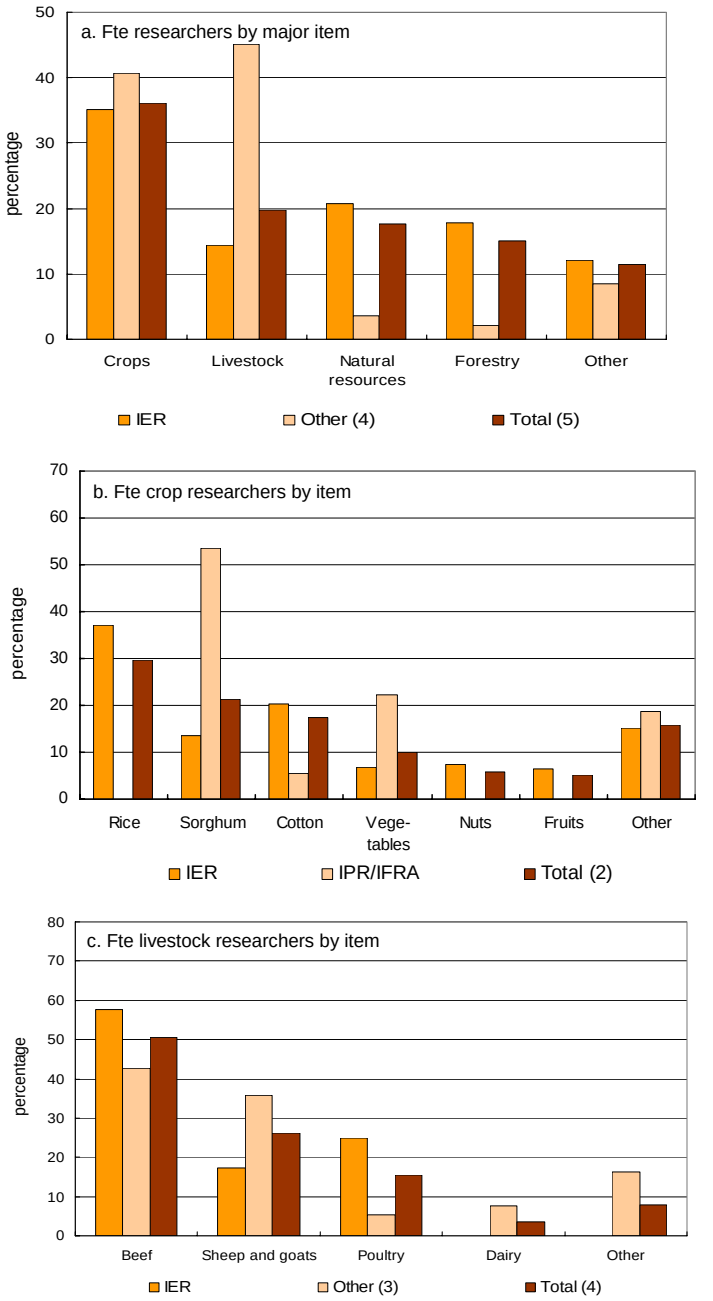
RESEARCH ORIENTATION

Commodity Focus

The allocation of resources among various lines of research is a significant policy decision; hence detailed information was collected on the number of fte researchers working in specific commodity and thematic areas.

In 2001, more than one-third of the total 300 fte researchers conducted crop research (Figure 9a). Livestock accounted for 20 percent, natural resources for 18 percent, and forestry for 15 percent. As far as crops are concerned, IER focused its research activities mainly on rice (37 percent) (Figure 9b). The country's second most researched crop is sorghum, accounting for 13 percent of total crops research at IER, and more than half of total fte crops researchers at IPR/IFRA. Other important crops include cotton (17 percent), vegetables (10 percent), nuts (6 percent), and fruits (5 percent). Livestock researchers at IER and the other agencies focused primarily on beef (51 percent), followed by sheep and goats (26 percent), and poultry (16 percent) (Figure 9c).

Figure 9—Commodity Focus, 2001



Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–CORAF/WECARD 2002–03).
Notes: Figures in parentheses indicate the number of agencies in each category. Figure 9b includes IER and IPR/IFRA, the only two agencies involved in crop research. Figure 9c excludes ISFRA, the only agency not involved in livestock research.

Thematic Focus

In 2001, 18 percent of IER researchers worked on crop genetic improvement, 14 percent on crop pest and disease control, and 7 percent on livestock genetic improvement (Table 2). The remainder of IER researchers focused primarily on other crop and livestock themes. Livestock pest and disease control (22 percent) followed by crop genetic improvement (14 percent) formed the most important themes at the other four agencies in our sample.

Table 2—Thematic focus, 2001

	Numbers of researchers		Shares	
	IER	Other (4)	IER	Other (4)
	(*in fte's*)		(*percent*)	
Crop genetic improvement	44.6	7.2	18.0	13.8
Crop pest and disease control	34.7	4.2	14.0	8.0
Other crop	69.4	5.7	28.0	10.9
Livestock genetic improvement	17.4	—	7.0	—
Livestock pest and disease control	9.9	11.6	4.0	22.2
Other livestock	34.7	5.1	14.0	9.7
Soil	—	4.5	—	8.6
Water	—	1.3	—	2.5
Other natural resources	7.4	0.3	3.0	0.6
Postharvest	9.9	0.7	4.0	1.3
Other	19.8	11.7	8.0	22.5
Total	**248.0**	**52.3**	**100**	**100**

Source: Compiled by authors from ASTI survey data (IFPRI-ISNAR-CORAF/WECARD 2002-03).
Notes: Figures in parentheses indicate the number of agencies in each category.

CONCLUSION

Since the beginning of the 1990s, agricultural researcher numbers have gradually fallen in Mali, but agricultural spending has remained stable, mainly as a result of the continuously adequate levels of donor funding. During 1991–2001, IER was strongly dependent on two donor projects: PNRA—funded by World Bank loans, counterpart funding from the Government of Mali and IER itself, as well as various foreign donors—and PAPIER—funded by the Dutch government. These projects have brought important institutional changes to IER and have considerably improved the quality of its research programs. PNRA was immediately followed by another World Bank project: PASAOP. This project is currently in its first phase (of three), and despite its unsound start, the project's principal objectives are expected to be reached, and the second and third phases of the project are likely to be implemented, securing stable funding for IER and LCV in the years to come.

During 1991–2001, Malian agricultural research was characterized by a significant improvement of the education levels of researchers and efficient operation in regional and international partnerships. Mali outperformed its neighbors in many key indicator areas. The country also distinguishes itself from many African countries in having an extremely centralized agricultural research system. One single agency (IER) is responsible for 85 percent of the country's total agricultural researchers and expenditures.

NOTES

1. The authors are grateful to numerous colleagues in Mali for their time and assistance with the data collection, and thank Nienke Beintema, Modido Damba, Ibrahima N'Daye and Bino Teme for their useful comments on drafts of this brief.
2. The five-agency sample consisted of:
   - Three government agencies/units: *Institut d'Économie Rurale* (IER), *Laboratoire Central Vétérinaire* (LCV), and *Office Malien du Bétail et de la Viande* (OMBEVI); and
   - Two higher-education agencies: *Institut Polytechnique Rural de l'Institut de Formation et de Recherche Appliquée* (IPR/IFRA) and *Institut Supérieur en Formation et en Recherche Appliquée* (ISFRA), both under the *Université de Bamako*.
3. Unless otherwise stated, all data on research expenditures are reported in 1993 international dollars or in 1999 CFA francs.
4. English translations of agency names have been used throughout the brief except in note 2, where the original French is provided.
5. Data are calculated as least square growth rates.
6. Numerous researchers were trained up to DEA (*Diplôme d'Études Approfondies*) levels.
7. CNRA was established in 1995 as a central national coordinating and funding institution for agricultural research within the Ministry of Rural Development. CNRA evaluates and funds research project proposals that are subsequently implemented mostly by IER.
8. Funding provided by Mali's government amounted to US$17.7 million versus US$17.9 million estimated. Government contributions expressed in local currency were, however, significantly higher as a result of the CFA franc devaluation of 1994 (World Bank 2002).
9. During the four years of PASAOP's Phase II, the institutional reforms of Phase I will be consolidated and a new decentralized, demand-driven agricultural service delivery system will be implemented. The integration of the national agricultural knowledge system will be completed during Phase III (four-year period) (World Bank 2001).

METHODOLOGY

- Most of the data in this brief are taken from unpublished surveys (IFPRI, ISNAR, and CORAF/WECARD 2002-03).
- The data were compiled using internationally accepted statistical procedures and definitions developed by the OECD and UNESCO for compiling R&D statistics (OECD 1994; UNESCO 1984). We grouped estimates using three major institutional categories—government agencies, higher-education agencies, and business enterprises, the latter comprising the subcategories private enterprises and nonprofit institutions. We defined public agricultural research to include government agencies, higher-education agencies, and nonprofit institutions, thereby excluding private enterprises. Private research includes research performed by private-for-profit enterprises developing pre, on, and postfarm technologies related to agriculture.
- Agricultural research includes crops, livestock, forestry, and fisheries research plus agriculturally related natural resources research, all measured on a performer basis.
- Financial data were converted to 1993 international dollars by deflating current local currency units with a Malian GDP deflator of base year 1993 and then converting to U.S. dollars with a 1993 purchasing power parity (PPP) index, both taken from World Bank (2003). PPP's are synthetic exchange rates used to reflect the purchasing power of currencies, typically comparing prices among a broader range of goods and services than conventional exchange rates.
- The salaries and living expenses of many expatriate researchers working on donor-supported projects are paid directly by the donor agency and are often excluded in the financial reports of the agricultural R&D agencies. These *implicit* costs have been estimated using the average cost per researcher in 1985 to be $160,000 1993 international dollars and backcasting this figure using the rate of change in real personnel costs per fte researcher in the US state agricultural experiment station system. This extrapolation procedure has the assumption that the personnel-cost trend for US researchers is a reasonable proxy of the trend in real costs of internationally recruited staff in the agricultural R&D agencies.

See the ASTI website (http://www.ASTI.cgiar.org) for more details on methodology.

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