

MOROCCO

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This country brief reviews the major investment and institutional trends in public agricultural research in Morocco since 1981, including a new set of survey data for 1996–2002 collected under the Agricultural Science and Technology Indicators (ASTI) initiative (IFPRI–ISNAR–INRA 2003–04).¹

INSTITUTIONAL DEVELOPMENTS

Although Morocco was self-sufficient in terms of food production in the 1970s and 1980s, high population and urbanization growth, accompanied by periodic droughts, necessitated increased imports of cereals, oleaginous (oil-related) products, and sugar to meet domestic demand in more recent years. Since agriculture employs almost 50 percent of Morocco's workforce, droughts undeniably have a severe knock-on effect to the national economy. Given this ongoing—and deteriorating—situation, growth of food production is an important priority for Morocco, and agricultural research and development (R&D) will be integral to its achievement. Nineteen agencies were involved in public agricultural research in Morocco in 2002.² These agencies employed a combined total of 655 full-time equivalent (fte) researchers and spent close to 600 million 2000 Moroccan dirhams, or 168 million constant 2000 international dollars (Table 1).^{3,4} Morocco's principal agricultural research agency is the National Agronomic Research Institute (INRA), which in 2002 accounted for roughly 40 percent of all agricultural research staff and expenditures.⁵ INRA is an autonomous public agency administered by the Ministry of Agriculture, Rural Development, and Maritime Fisheries (MADRPM) and governed by a Board of Directors representing several ministries and producer organizations. (see *A Short History of Government-Based Agricultural Research* on page 2). During the 1990s,

Table 1—Composition of agricultural research expenditures and total researchers, 2002

Type of agency	Spending		Researchers ^a	Share		Agencies in sample ^b
	2000 Moroccan dirhams	2000 international dollars		Spending	Researchers	
	(millions)		(fte's)	(percent)		(number)
INRA	241.0	68.0	240.0	40.4	36.7	1
Other government ^c	138.2	39.0	176.2	23.2	26.9	7
IAV Hassan II ^d	165.3	46.7	181.5	27.7	27.7	1
Other higher education ^d	52.0	14.7	57.1	8.7	8.7	10
Total	596.5	168.4	654.8	100	100	19

Sources: Compiled by authors from (IFPRI–ISNAR–INRA 2003–04) and Besri et al. (1999).

^a Includes national and expatriate staff.

^b See note 2 for details of all agencies. The private sector is excluded from the analysis because data were unobtainable.

^c Researcher totals for CNRF and SEHA have been extrapolated using 1997 data from Besri et al. (1999). Expenditure totals for all seven other government agencies are estimates based on 1997 data from Besri et al. (1999) and INRA's average expenditures per researcher. Staff at the seven other government agencies spent between 15 and 100 percent of their time on research, resulting in 176.2 fte researchers.

^d Expenditures for the higher-education agencies are estimates based on average expenditures per researcher in the government sector. Staff at IAV Hassan II spent 50 percent of their time on research, resulting in 181.5 fte researchers; staff at the other 10 higher-education agencies spent between 25 and 40 percent of their time on research, resulting in 57.1 fte researchers.

KEY TRENDS

- Total agricultural researcher numbers in Morocco increased gradually throughout the 1980s and 1990s, while total agricultural R&D expenditures fluctuated somewhat erratically.
- The National Agronomic Research Institute (INRA) and the Agronomic and Veterinary Institute Hassan II (IAV Hassan II) are Morocco's largest R&D agencies; in 2002, they accounted for roughly 40 and 25 percent of Morocco's fte agricultural researchers and expenditures, respectively.
- INRA depended on national government funding, along with sizeable contributions from foreign donors, public and private enterprises, and internally generated sources.
- Financing of Moroccan agricultural R&D has undergone significant reform in recent years with the introduction of competitive funding mechanisms; such mechanisms have also encouraged cooperation among the country's R&D agencies.
- The educational qualifications of Moroccan researchers have increased significantly since the early 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's survey round in North Africa and the Middle East region was provided by the CGIAR Finance Committee/World Bank.

the World Bank–led Agricultural Research and Extension Project (PRV) considerably strengthened INRA’s management capacity and supported the decentralization of its research activities (World Bank 1997). In addition to its headquarters in Rabat, INRA comprises several regional research centers located across the country’s nine agro-ecological zones (Agadir, Errachidia, Kénitra, Marrakech, Meknès, Oujda, Settat, Tadla, and Tangiers), as well as 21 experiment stations also spread across the country. INRA organizes its research around 22 programs on crops, livestock, food technologies, natural resources, and conservation (INRA 2004a), and its mandate incorporates technology transfer through its Research and Development Service, and education through activities such as support of graduate thesis work and lectures at various Moroccan universities (Besri et al. 1999).

In 2002, seven other government agencies were involved in agricultural R&D, together constituting about 25 percent of total fte researchers and spending. The largest of these, in terms of human resources and expenditures, are the National Fisheries Research Institute (INRH) and the National Center for Forestry Research (CNRF), also within MADRPM. INRH is located in Casablanca and is Morocco’s principal fisheries research agency. Its mandate includes fisheries stock assessment, conservation of the marine environment, marine technology research, and development of fisheries products (Besri et al. 1999). In 2002, INRH employed 83 fte researchers. CNRF is Morocco’s primary forestry research agency. It is headquartered in Rabat and has programs in silviculture (development and care of forests), genetics and improvement of tree species, forest technology, and ecology (Kissi and Reguragui 1997). The center manages six laboratories and a network of 150 experiment fields, 30 arboretums, 360 climatological stations, three seedbeds, and two poplar centers. In 2002, CNRF employed an estimated 38 fte researchers.

The remaining five government agencies conducting

agricultural research in Morocco are the Agricultural Hydraulics Experiment Service (SEHA), the Chemical Research Laboratory of Casablanca (LOARC), the Service for Experimentation, Testing, and Normalization (SEEN), the Center for Sugarcane Technology (CTCAS) within the Regional Agricultural Development Office of Gharb, and the Regional Tree Center of Tadla (CRAT) under the Regional Agricultural Development Office of Tadla. In 2002, each of these agencies employed between 3 and 18 fte researchers.

The 11 higher-education agencies play an important role in Moroccan agricultural research, accounting for 36 percent of research staff and expenditures in 2002. The Agronomy and Veterinary Institute Hassan II (IAV Hassan II) is Morocco’s second largest agricultural R&D agency in terms of human and financial resources. In 2002 it accounted for over a quarter of Morocco’s agricultural R&D capacity. Again within MADRPM, IAV Hassan II has 35 education and research departments operating at its primary campus in Rabat and its satellite campus in Agadir, which specializes in horticulture and plant breeding. In addition, three application farms at Gharb, Tadla, and Aït Melloul support applied research activities on crops, livestock, and natural resources (IAV Hassan II 2004).

The National School of Agriculture (ENA), in Meknès, conducts research largely focusing on crops, livestock, and socioeconomic issues, and in 2002 employed 30 fte researchers. The National Forestry Engineer School (ENFI) in Salé conducts research on forestry, natural resources, and mountain economies (Kissi and Reguragui 1997), and in 2002 employed 8 fte researchers. The faculties of science at the universities of Agadir, Beni-Mellal, Fès, Kénitra, Marrakech, Meknès, Oujda, and Settat—all of which are administered by the Ministry of Higher-Education and Scientific Research (MESRS)—conduct limited agricultural research. These eight faculties combined employed an estimated total of 20 fte researchers in 2002.

A Short History of Government-Based Agricultural Research

The first agricultural research activities in Morocco were carried out by the Agricultural Experimentation Service, established in 1919 by the French colonial government. In 1924, the Genetics and Seed Tests Station expanded this service, later adding the Agricultural Chemistry Laboratory (in 1934). Agricultural R&D had gained prominence by that time, and as a result became the Agricultural Research Center, with the mandate of promoting, coordinating, and controlling agricultural research activities in Morocco.

In 1962, six years after independence, the country’s first public autonomous agricultural research agency was established: the National Agronomic Research Institute (INRA). This was short-lived, however, and the institute was dissolved only a few years later (January 1966). INRA’s activities were subsequently brought under the Ministry of Agriculture, within the Agronomic Research Directorate (DRA). National agricultural research reverted to the oversight of the Ministry for Agriculture, ultimately resulting in a deceleration of essential research activities and the erosion of quantitative and qualitative research, along with the diffusion of research results. This situation continued until 1980, when the Moroccan government reinstated INRA, including its autonomous status. INRA underwent significant renovations, largely financed by USAID and a World Bank loan, and eventually grew to hold its current position as the country’s primary agricultural research agency.

The National Center for Forestry Research (CNRF) originated in 1934, when the French established the Forestry Experimentation Service. In 1947, the Fisheries Institute of Morocco was established as part of the French Scientific and Technical Institute of Maritime Fisheries. The institute was located within the newly established National Fisheries Office in 1969 and renamed the Scientific Maritime Fisheries Institute, then in 1996 was replaced by the National Fisheries Research Institute (INRH).

In 1998, the Moroccan government created a new Secretariat of State for Scientific Research, reflecting its renewed commitment to scientific research generally, and the agricultural sector in particular.

Sources: Kissi and Reguragui (1997); Besri et al. (1999), and FAO (2000).

It is estimated that private companies, primarily the Moroccan Agricultural Services Company (SASMA) and the Technical Center of Oleaginous Products (CETIO), conduct a limited amount of agricultural R&D in Morocco, representing a very small share of agricultural R&D expenditures and research staff. These agencies, however, are excluded from the analysis in this report because data on their activities were not available. In addition, the Othame Flour Mills and the recently privatized Tobacco Company, along with numerous seed and fertilizer companies, reportedly undertake joint research projects with public-sector agencies periodically. Certain producer organizations also conduct limited agricultural research activities, and a small number of progressive farmers carry out adaptive research for the benefit of their own operations. At times these activities are jointly undertaken with INRA, IAV Hassan II, or ENA (Kissi and Reguragui 1997; INRA 2004b).⁶

A considerable number of academic staff from IAV Hassan II, ENA, and the university faculties participate in INRA's research programs, and collaboration has intensified in recent years with the establishment of competitive funding mechanisms (discussed in detail in the section on financing). At an international level, significant collaboration occurs between INRA and agencies such as the International Center of Agricultural Research for the Dry Areas (ICARDA), the International Maize and Wheat Improvement Center (CIMMYT), the International Potato Center (CIP), the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), and the International Center of Advanced Agronomic Mediterranean Studies (CIHEAM), as well as various scientific institutions from the other four Maghreb countries (Algeria, Libya, Mauritania, and Tunisia) and developed countries including France, Germany, Italy, and the United States (Besri et al. 1999). INRH maintains close relations with other fisheries research institutes in the Mediterranean region and with Japan. IAV Hassan II is involved in a number of regional and international networks and collaborative research programs with scientific establishments in Belgium, France, and the United States, as well as with regional and international agencies such as CIHEAM and ICARDA (Besri et al. 1999). Important regional and international cooperation also occurs between Moroccan universities and their counterparts in the other Maghreb countries, as well as with universities in France, Southern Europe, and the United States.

HUMAN AND FINANCIAL RESOURCES IN PUBLIC AGRICULTURAL R&D

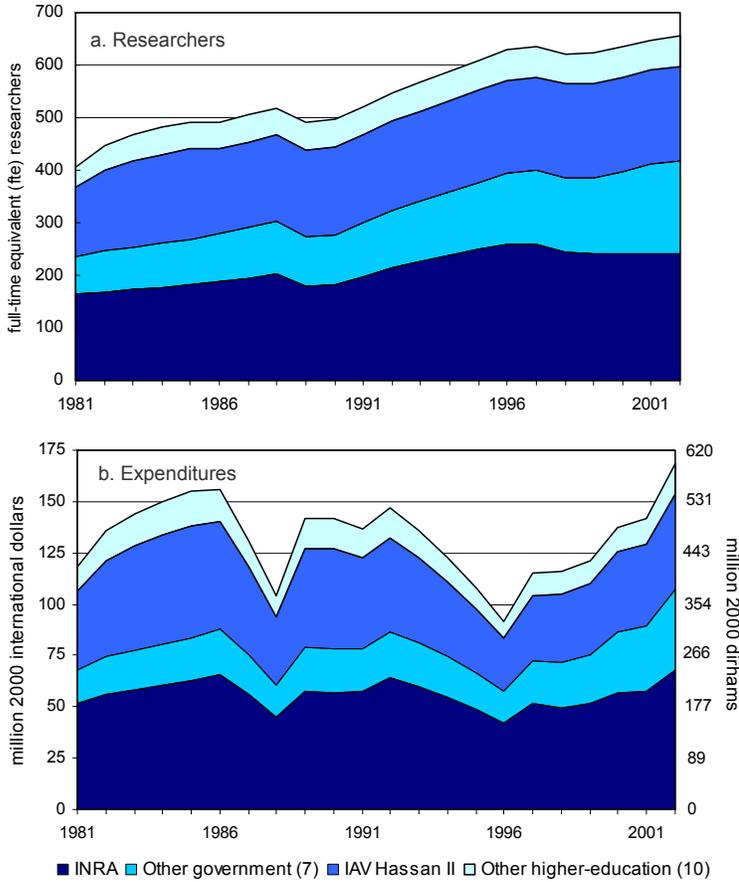
Overall Trends

During 1981–2002, the number of agricultural research staff in Morocco increased by 2.1 percent per year on average, from 407 fte's in 1981 to 655 fte's in 2002 (Figure 1a). This growth occurred very steadily but was more pronounced at the government agencies (2.9 percent per year) than at the higher-education agencies (0.9 percent per year). Morocco's higher-education sector was severely underdeveloped in the early 1970s, though this situation changed rapidly beginning in the second half of that decade, when France and the United States

provided substantial financial support to Morocco's higher-education sector, and to IAV Hassan II in particular (Besri et al. 1999). National researcher numbers at IAV Hassan II, for example, increased from only 3 fte's in 1971 to 81 in 1981 and 138 in 1986 (Eriksen et al. 1987; IFPRI–ISNAR–INRA 2003–04). In 2002, IAV Hassan II employed 182 fte researchers, all of whom had Moroccan nationality.

The majority of Morocco's French-led colonial agricultural R&D activities continued after the achievement of independence in 1956, which explains the comparatively high proportion of expatriate researchers still working in Morocco in the 1970s. In 1971, close to two-thirds of INRA's research staff (82 of 130 fte researchers) were foreign nationals. This share fell rapidly, however, in the 1980s and 1990s when increasing numbers of Moroccan researchers were recruited. By 1992 only 32 of INRA's 215 fte researchers were expatriates, and by 2001 all expatriate researchers had departed. The trend at the other Moroccan agricultural R&D agencies was similar, with the share of expatriate researchers at IAV Hassan II dropping from 89 percent in 1971 to 14 percent in 1986, and to zero as of 2002. This included a joint project whereby a number of U.S. professors from the University of Minnesota taught at IAV Hassan II for periods over two years between 1980 and 1993. During 1981–2002, total agricultural R&D spending followed a positive, albeit erratic, trend (Figure 1b). Annual growth was stronger during 1981–86, at 5.4 percent, mainly the result of the aforementioned expansion of research activities led by the higher education sector. Spending dropped temporarily in 1988 due to adjustment policies advocated by the World Bank and the International Monetary Fund (IMF) to reduce national government spending. This dip was short-lived, however; expenditure levels promptly rebounded with the implementation of the PRV initiative in the early 1990s (discussed in detail in the financing section). Despite the completion of PRV in 1996 and accompanying declining support from other (bilateral) donors, total expenditures continued to rise as a result of increased government support, internally generated resources, and contract-based research for the private sector. Agricultural R&D spending peaked in 2002 when it reached \$168 million in real terms, the highest level for the period 1981–2002. This reflects the Moroccan government's decision to support its agricultural research system in achieving sustainable economic—and especially food production—growth.

Figure 1—Long-term composition of public agricultural researchers 1981–2002

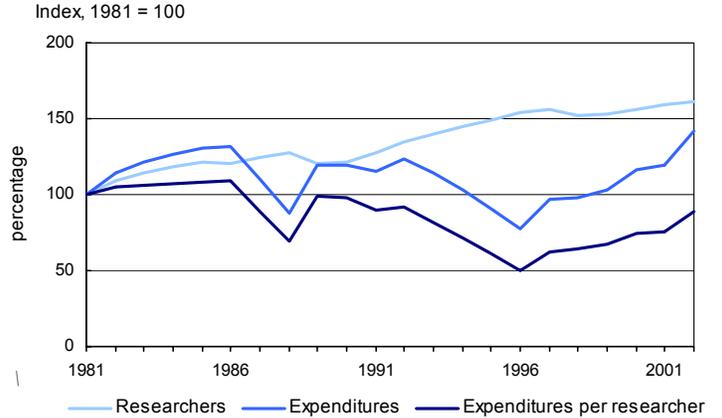


Sources: Compiled by authors from ASTI survey data (IFPRI–ISNAR–INRA 2003–04) and Besri et al. (1999).

Notes: Figures in parentheses indicate the number of agencies in each category. Researchers and expenditure totals for the other government agencies are extrapolated from 1997 estimates using the trend for INRA. Expenditures for the higher-education agencies are estimates based on average expenditures per researcher at the government agencies. Underlying data are available on the ASTI website (<http://www.asti.cgiar.org>).

Because total agricultural researcher numbers grew more rapidly than agricultural R&D expenditures, spending-per-researcher levels fell by half during 1981–96, from \$291,000 to \$146,000, though levels quickly rebounded with overall increased funding and therefore expenditure levels (Figure 2). In 2002, spending per researcher was \$257,000, considerably higher than the levels in other in Maghreb countries such as Tunisia (\$117,000) and Mauritania (\$86,000) (Stads et al. 2005; Stads et al. 2004).⁷

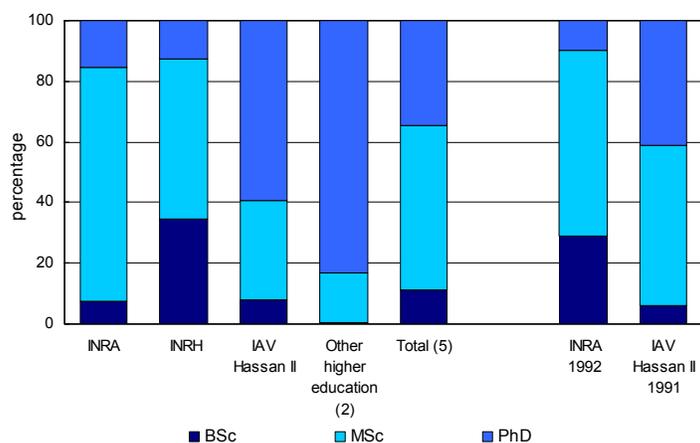
Figure 2—Trends in public expenditures, researchers, and expenditures per researcher, 1981–2002



Source: Figure 1.

Human Resources

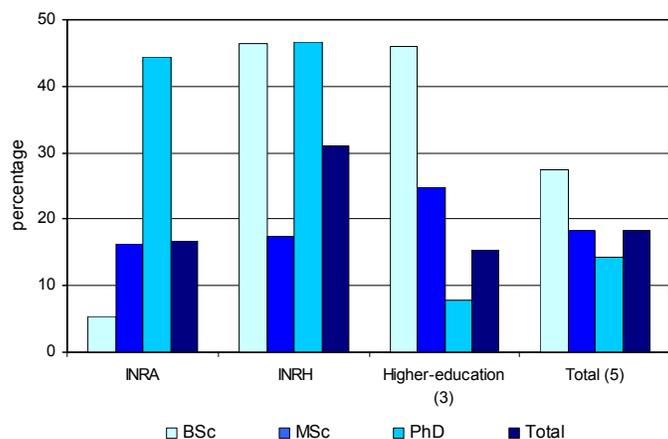
In 2002, 89 percent of the 542 fte researchers in a sample comprising INRA, INRH, IAV Hassan II, ENFI, and ENA were trained to the postgraduate level, and 34 percent held doctorate degrees (Figure 3). The shares of researchers with PhD degrees at IAV Hassan II (60 percent) and the other two higher-education agencies in our sample (83 percent combined) were much higher than corresponding shares at INRA (15 percent) and INRH (13 percent), which is consistent with general trends elsewhere in the region and worldwide. The qualification levels of INRA's researchers were raised significantly during 1992–2002, from 71 to 93 percent, in large part because of the U.S.–government funded Mid-America International Agricultural Consortium (MIAC), whereby 30 or so researchers received PhD and MSc training at U.S. universities. Researcher training was also included in the PRV initiative, but only 6.5 of the 17 fte researchers scheduled for a two-year training program, and 8.2 of the 34 fte researchers scheduled for a one-year training program actually received training by the end the project in 1996. The training that did occur was provided by the French government, both inside and outside Morocco (World Bank 1997). Qualification levels of researchers at IAV Hassan II further increased in the 1990s; 41 percent of the institute's researchers held PhD degrees in 1991 compared with 60 percent in 2002. Another factor in the improvement of qualification levels was increased cooperation between U.S. and European universities and IAV Hassan II, allowing IAV Hassan II researchers to spend considerable time studying abroad (IAV Hassan II 2004).

Figure 3—Educational attainment of researchers, 1991-92 and 2002

Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–INRA 2003–04)

Notes: Figures in parentheses indicate the number of agencies in each category. Data exclude expatriate researchers.

Based on a five-agency sample for 2002 (excluding IAV Hassan II), 18 percent of Morocco's researchers were female, which is very low compared with Tunisia, for example (30 percent, Stads *et al.* 2005), but similar to 2000/01 averages recorded for Sub-Saharan Africa (18 percent) and 1996 averages for Latin America (20 percent) (Figure 4) (Beintema and Stads 2005). The female researcher share at the three higher-education agencies in our sample, at 15 percent, was lower than the share at INRH (31 percent) but similar to the share at INRA (17 percent). In terms of education levels, 28 percent of BSc researchers, 18 percent of MSc researchers, and 14 percent of PhD researchers were female.

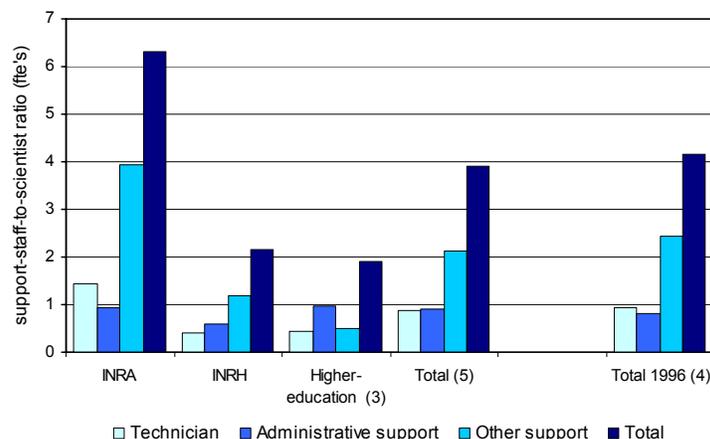
Figure 4—Share of female researchers, 2001

Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–INRA 2003–04).

Notes: Figures in parentheses indicate the number of agencies in each category. Data for IAV Hassan II were unavailable. Data exclude expatriate researchers.

In 2002, the average number of support staff per scientist in a five-agency sample (excluding IAV Hassan II) was 3.9, comprising 0.9 technicians, 0.9 administrative personnel, and 2.1 other support staff such as laborers, guards, and drivers (Figure 5). Despite a significant drop in support-staff levels during 1991–2002, INRA still had the highest ratio in 2002 (6.3), whereas INRH and the three higher-education agencies

combined had support-staff-to-scientist ratios of only 2.2 and 1.9, respectively. Overall, Morocco's 2002 support-staff-to-scientist ratio was slightly lower than the corresponding 1996 ratio, at 4.2, which mainly resulted from the retirement and nonreplacement of other support staff.

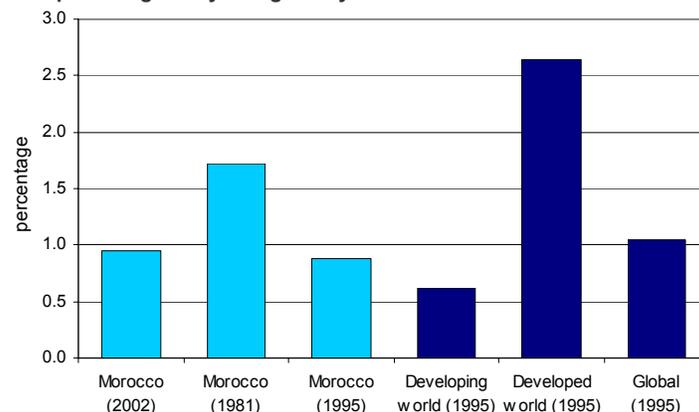
Figure 5—Support-staff-to-researcher ratios, 1996 and 2002

Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–INRA 2003–04).

Notes: Figures in parentheses indicate the number of agencies in each category. Data for IAV Hassan II were unavailable. Data exclude expatriate researchers; 1996 totals exclude ENA.

Spending

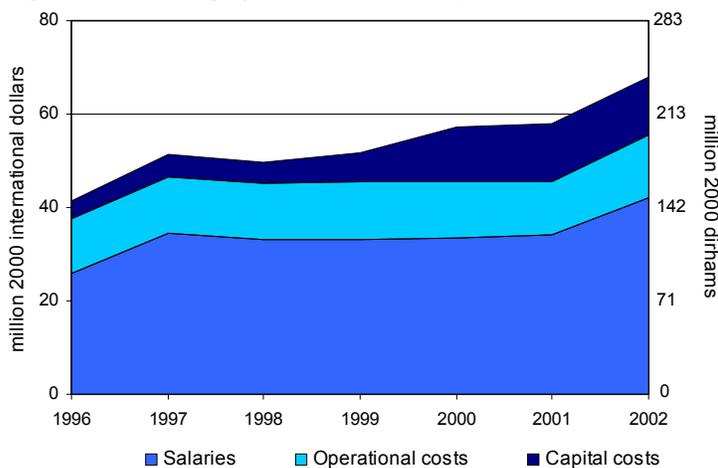
Total spending as a percentage of agricultural output (AgGDP) is a common research investment indicator that helps to place a country's agricultural R&D spending in an internationally comparable context. Morocco's 2002 research intensity ratio of \$0.95 for every \$100 of agricultural output was considerably lower than the 1981 ratio of 1.72, reflecting faster AgGDP growth relative to agricultural R&D expenditures (Figure 6). Nevertheless, it was higher than the country's 1995 ratio of 0.88. In terms of regional comparisons, Morocco's 2002 rate was similar to the 2001 ratio of 0.92 for Mauritania (Stads *et al.* 2004) and higher than the 2002 ratio of 0.84 for Tunisia (Stads *et al.* 2005), and well above the 1995 average ratio of 0.62 for the developing world (Pardey and Beintema 2001).

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

Sources: Morocco data are compiled from Figure 1b; AgGDP are from World Bank 2004; other intensity ratios are from Pardey and Beintema 2001.

During 1996–2002, salaries accounted for an average of 63 percent of INRA's total agricultural research expenditures, whereas operating and capital costs accounted for 23 and 15 percent, respectively (Figure 7). Annual operating costs remained relatively stable, averaging \$12 million per year in real terms, whereas salary and capital costs showed some growth. In the early 1990s, PRV financed sizable construction projects, laboratory equipment, computers, and vehicles for INRA's regional centers (World Bank 1997). Significant proportions of INRA's operating costs were financed through bilateral support from the United States (through the MIAC-sponsored project previously mentioned), from Germany (for projects on forages, vegetables, red meat, and pest control), and for France (for projects on olives, wheat, oleaginous products, and nematology).

Figure 7—Cost category shares in INRA's expenditures, 1996–2002



Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–INRA 2003–04).

Note: Data include estimated salaries for expatriate staff.

FINANCING PUBLIC AGRICULTURAL R&D

Finances for agricultural research in Morocco in the 1990s and early 2000s were derived from the national government, the World Bank (through a loan), foreign donors, public and private enterprises, and internally generated sources. In 1996, the government introduced a special research fund supporting Morocco's universities, primarily to finance laboratory equipment (for both nonagricultural as well as agricultural research). The fund amounted to 20 million current dirhams per year from 1996 to 1998, and 45 million current dirhams per year from 1998 to 2000 (Kleiche 2002). IAV Hassan II, ENA, and ENFI have successfully generated funding by entering into research contracts with public and private enterprises both within and outside Morocco. These contracts include the conduct of studies, consultations, water and soil analyses, diagnoses of animal and plant diseases, veterinary care, and technical advice and training to extension and development staff (Kissi and Reguragui 1997).

National Agronomic Research Institute

INRA's principal source of financial support is the Moroccan government, though substantial sums were derived through bilateral and multilateral donor projects that greatly contributed to the development of the institute's research infrastructure and equipment in the 1980s and 1990s. These donors have also played an important role in upgrading researcher qualifications and establishing a number of high quality research programs. INRA's primary bilateral donors during 1991–2002 included France, Germany, Italy, and the United States, but data on actual contribution levels were not available. Toward the end of the 1990s, bilateral donor support contracted somewhat as large, broad-scoped donor projects were replaced with significantly smaller, well-targeted projects that were often organized through national or regional networks. A number of these projects were also coordinated by international centers, particularly ICARDA (Kissi and Reguragui 1997).

PRV significantly bolstered Moroccan agricultural research and extension. The project ran from 1990 until 1996 with a budget of US\$60.9, comprising loans from the World Bank (US\$28.0 million) and Germany's Credit Institute for Reconstruction (US\$8.5 million), contributions from the Government of Morocco (US\$8.3 million), and bilateral aid from the French and German governments (US\$7.1 million combined) (World Bank 1989). PRV included both a research and an extension component; the research component, budgeted at US\$30.6 million, aimed to decentralize INRA's research management, rehabilitate 13 research farms, establish 8 research/development units, and improve INRA's personnel and financial management. Five priority themes were identified under the project, including bread wheat, forage crops, livestock, oil crops, and olives. At the project's completion in 1996, total research-related disbursements were US\$28.8 million, or 94 percent of the budgeted amount. The project was highly successful in strengthening INRA, and virtually all of the material objectives were deemed to have been achieved. The only area that fell short of planned goals was staff recruitment, given that only about two-thirds of the intended number of engineers and a quarter of the intended number of technicians were actually employed (World Bank 1989 and 1997).

As mentioned previously, INRA's funding from foreign donors contracted toward the end of the 1990s, encouraging the institute to pursue new funding sources. In 2002, INRA generated close to \$5 million internally through the sale of products, the receipt of royalty payments on proprietary seed and crop varieties, and the provision of services such as crop and product testing and adaptation, conservation, and transformation techniques via contract agreements with individual farmers, farmer groups, government development agencies, and crop production or commercialization companies. Some of these agreements also involve training of extension personnel. Significant growth potential still exists at INRA for generating an even greater proportion of research funding internally.

Increased contractual research at the regional level is expected to attract important complementary funding to INRA in the coming years. Such funding will facilitate specific research activities to address the agricultural development needs of certain rural regions. As far as future bilateral funding is concerned, France committed to nine new research projects in 2003, and support may also be forthcoming from Belgium, Japan, and Spain. INRA's research contracts with the Othmane Flour Mills, the Tobacco Company, and various seed companies are also expected to raise significant funds in the coming years (INRA 2004b).

Competitive Funding Mechanisms

In 1997, MESRS launched a new competitive funding mechanism, the Scientific Research Support Program (PARS), with the goal of increasing collaboration among agricultural R&D agencies in Morocco and improving the overall quality and relevance of Moroccan research. Research teams constituted from a variety of R&D agencies submitted proposals for review by a commission of experts on the basis on the proposals' feasibility and scientific merit. Between 1997 and 1999 PARS approved and funded 227 of 731 submissions received, at a total cost of 37.8 million current dirhams. As the first fund of its kind, research themes submitted under PARS were not restricted, and ultimately represented a broad cross-section of interests (Kleiche 2002).

Based on the success of PARS, three follow-up programs were launched—the Thematic Scientific Research Support Program (PROTARS) I (1999/2000), PROTARS II (2000/01), and PROTARS III (2002). For each of these programs proposals were limited to six themes, two of which related to agriculture: (1) Agriculture and challenging conditions, and (2) Knowledge, preservation, and valuation of natural resources (roughly half the projects of the second theme focused on renewable resources). The total (agricultural and nonagricultural) budgets for PROTARS I, II, and III were 25, 30, and 25 million current dirhams, respectively. We were only able to obtain data on the proportion of funding allocated to agricultural projects for PROTARS I, which was 45 percent, or about 11 million current dirhams (Collion and Ward 2003; Kleiche 2002). Although to date these competitive funding programs only account for a small proportion of Morocco's agricultural research financing, such programs are driving important progress by promoting collaboration, enhancing resource efficiency, and ensuring that research programs address priority issues. By contractualizing research and separating the functions of research funding and research execution, all agencies compete for funding equally, research is highly focused, and parties involved are held accountable for program outcomes (Collion and Ward 2003).

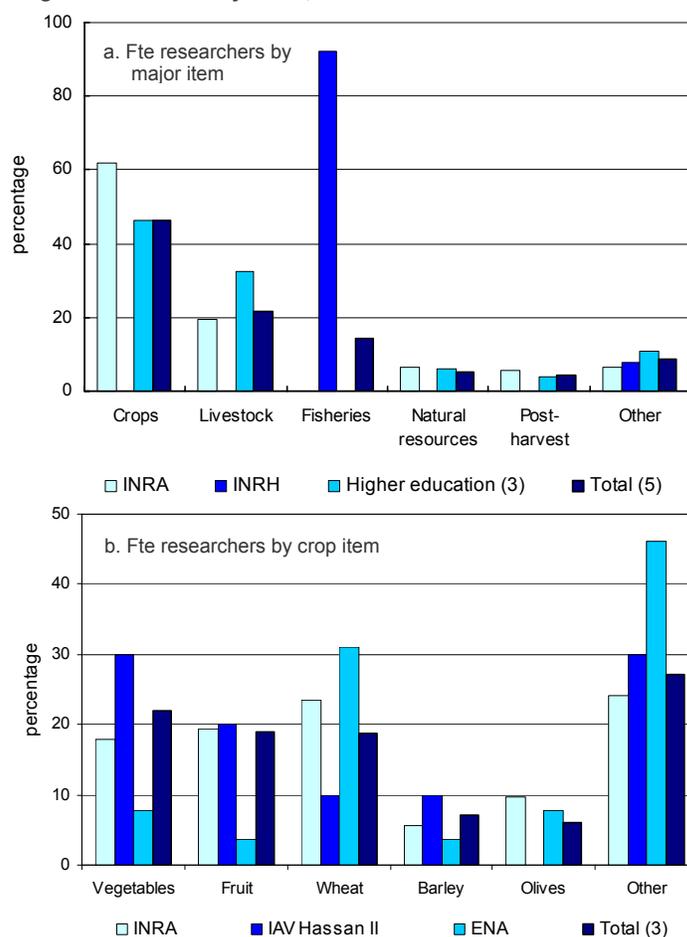
RESEARCH ORIENTATION

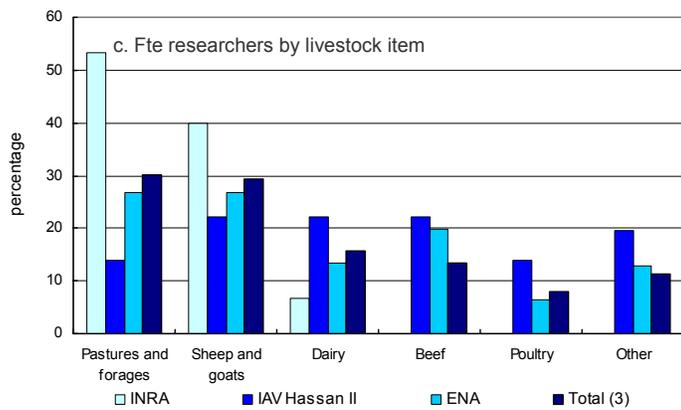
Commodity Focus

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.

Close to half the 542 fte researchers in a five-agency sample for 2002 conducted crop research (Figure 8a). Livestock research accounted for a 22 percent share, fisheries research for 14 percent, and natural-resources research for 5 percent. More researchers at the higher-education agencies focused on livestock research, but roughly the same number worked on crop research compared with their counterparts at INRA. INRA's most researched crops were wheat (23 percent of 149 fte crop researchers), fruits (citrus and noncitrus) (19 percent), and vegetables (18 percent) while olives, sugar beets, and date palms accounted between 8 and 10 percent each (Figure 8b). Crop researchers at the two higher-education agencies in our sample worked on similar commodities, the most common being vegetables, fruits, and wheat, which together constituted close to 60 percent of all crop research. Researchers conducting livestock research spent 30 percent of their time on pastures and forages, followed by sheep and goats (29 percent), dairy (16 percent), beef (13 percent), and poultry (8 percent) (Figure 8c).

Figure 8 – Commodity focus, 2002





Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–INRA 2003–04).

Notes: Figures in parentheses indicate the number of agencies in each category. INRH and ENFI are not involved in crop or livestock research

Thematic Focus

In 2002, 20 percent of INRA's researchers concentrated their research efforts on crop genetic improvement, 17 percent worked on crop pest and disease control, and 18 percent worked on other crop-related themes (Table 2). The remainder of INRA's researchers focused largely on livestock, soils, water, and postharvest activities. Research on natural resources was dominant at the four other agencies in our sample. Other research themes at these agencies included water, livestock, pest and disease control, and crops.

Table 2—Thematic focus, 2002

	Numbers of researchers		Shares	
	INRA	Other (4)	INRA	Other (4)
	<i>(in fte's)</i>		<i>(percent)</i>	
Crop genetic improvement	47.5	16.9	19.8	5.6
Crop pest and disease control	40.1	17.7	16.7	5.9
Other crop	42.5	28.6	17.7	9.5
Livestock genetic improvement	1.0	6.2	0.4	2.1
Livestock pest and disease control	—	25.8	—	8.5
Other livestock	21.8	26.0	9.1	8.6
Soil	19.9	16.2	8.3	5.4
Water	19.2	27.7	8.0	9.2
Other natural resources	6.7	92.1	2.8	30.5
Postharvest	18.0	7.0	7.5	2.3
Other	23.3	37.5	9.7	12.4
Total	240.0	301.8	100	100

Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–INRA 2003–04).

Note: Figures in parentheses indicate the number of agencies in each category. "Other" includes socioeconomics, farming systems, food safety, agricultural machinery, and on-farm storage and processing.

CONCLUSION

Since the beginning of the 1980s, agricultural researcher numbers in Morocco have steadily risen. Agricultural R&D spending followed a more erratic trend in response to fluctuations in national government funding and (foreign) donor support, though spending has trended steadily upward in recent years, given the Moroccan government's renewed commitment to developing the agricultural sector. Morocco's principal agricultural R&D agency, INRA, was highly dependent on government funding throughout 1991–2002, particularly because donor funding contracted over that time. However, the World Bank–led PRV initiative successfully strengthened the institute's management in the 1990s, in part by decentralizing many of its research activities.

INRA and the higher-education agencies also began to generate considerable shares of their funding through the sale of products and services, entering into numerous national and international research contracts. This is a very positive development, and one with substantial prospects for future growth. The introduction of competitive funding mechanisms is another positive development since the late 1990s, and one that has already promoted collaboration among the various agencies within Morocco's national agricultural research system. Competitive funding programs have also successfully promoted effective and synergistic research practices, leveling the playing field among Morocco's agricultural R&D agencies and compelling them to make efficient use of their scarce resources. Accompanying these changes has been significant improvement in researcher qualifications within the system in terms of the proportion of researchers holding PhDs.

NOTES

1. The authors are grateful to numerous colleagues in Morocco for their time and assistance with data collection, and thank Nienke Beintema, Hamid Narjisse, El Madani Zouattane, and various staff at IAV Hassan II and ENFI for useful comments on drafts of this brief.
2. The 19-agency sample consisted of:
 - Eight government agencies: *Institut National de la Recherche Agronomique* (INRA), *Institut National de Recherche Halieutique* (INRH), *Centre National de la Recherche Forestière* (CNRF), *Service des Expérimentations d'Hydraulique Agricole* (SEHA), *Centre Technique des Cultures Sucrières* (CTCAS) of the *Office Régional de Mise en Valeur Agricole* (ORMVA) of Gharb, *Centre Régional Arboricole du Tadla* (CRAT) of the ORMVA of Tadla, *Laboratoire Officiel d'Analyses et de Recherches Chimiques* (LOARC), and *Service des Expérimentations, Essais et de la Normalisation* (SEEN); and
 - Eleven higher-education agencies: *Institut Agronomique et Vétérinaire* (IAV) Hassan II, *École Nationale Forestière d'Ingénieurs* (ENFI), *École Nationale d'Agriculture* (ENA), and the Faculties of Science of the Universities of Agadir, Beni-Mellal, Fès, Kénitra, Marrakech, Meknès, Oujda, and Settat.

This sample excludes private-sector agencies involved in agricultural research in Morocco because data for these agencies were unobtainable.
3. Unless otherwise stated, all data on research expenditures are reported in 2000 international dollars or in 2000 Moroccan dirhams.
4. With the inclusion of the private-sector agencies for which data were unobtainable, these totals would be slightly—though not substantially—higher, given the omitted agencies are reported to conduct minimal agricultural research.
5. English translations have been used throughout this brief except in not 2, where the original French is provided.
6. A 1999/2000 finance law allows private enterprises to claim a tax exemption on R&D expenditure to the value of 20 percent of their total revenues (Kleiche 2002).
7. The Mauritanian expenditures per researcher are for 2001.

METHODOLOGY

- Most of the data in this brief are taken from unpublished surveys (IFPRI, ISNAR, and INRA 2003-04).
- 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 2000 international dollars by deflating current local currency units with a Moroccan GDP deflator of base year 2000 and then converting to U.S. dollars with a 2000 purchasing power parity (PPP) index, both taken from World Bank (2004). 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.
- Annual growth rates are calculated using the least-squares regression method, which takes into account all observations in a period. This results in growth rates that reflect general trends that are not disproportionately influenced by exceptional values, especially at the end of the period.

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

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