

THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF MOROCCO¹

1. HISTORICAL BACKGROUND

The first formal agricultural research (AR) related activities in Morocco were conducted by the *Jardin d'Essais* (Botanical Garden) of Rabat established in 1919 by the French colonial authorities. This unit served throughout the years (until today) as headquarters for the *Service de l'Expérimentation Agricole* (1924), the *Centre de Recherche Agronomique* (1934), and the *Service de la Recherche Agronomique et de l'Expérimentation Agricole* (SRAE, 1946). All these institutions enlarged their AR activities through an increasing number of scientific departments and experimental stations spread throughout the country. Among the other colonial initiatives related with agricultural sciences, there were:

- the *Service de l'Expérimentation Forestière* (1934), which is the first antecedent of the current National Center for Forestry Research (CNRF: *Centre National de la Recherche Forestière*);
- the Agricultural School of Meknès (1940), created mainly to train sons of French farmers at the BS level;
- the Scientific Institute for Marine Fisheries (1947), renamed later (1969) "*Institut Scientifique des Pêches Maritimes*," then (1996), "National Halieutic Research Institute" (INRH: *Institut National de Recherche Halieutique*); and
- the *Centre des Expérimentations* (1952), created for supporting the design and operation of the large irrigation schemes launched afterwards in the country, which became later the Service for Experimentation, Testing and Normalization (SEEN: *Service d'Expérimentation, d'Essais et de Normalisation*).

After independence (1956), SRAE absorbed (in 1957) some existing national services affiliated to the new Ministry of Agriculture (mainly the Service for Plant Protection and the laboratories responsible for plant/food analysis). From 1959 to 1961, SRAE and the agricultural higher and technical schools were affiliated to a unique service responsible for agricultural research and education. In 1962, the National Agricultural Research Institute (INRA: *Institut National de la Recherche Agronomique*) was established as an autonomous institution under the Ministry of Agriculture and Agrarian Reform (MARA), and its director remained for some years Director of Agricultural Education. In 1966, INRA became the *Direction de la Recherche Agronomique* (DRA) within the largely reorganized MARA.

That same year, the Agronomic Institute was established at Rabat as a new agricultural higher education (AHE) institution; in 1971 it became the Hassan II Institute of Agronomy and Veterinary Medicine (IAV: *Institut Agronomique et Vétérinaire Hassan II*). This Institute has taken advantage of the stability of its management (two directors in 30 years) and scientific staff for growing and enlarging its mandate (horticulture section opened at Agadir; halieutic sciences; food technology; etc.) with strong external support (132 expatriates in 1978), mainly from France and the USA. The National Forestry School, Salé (ENFI: *Ecole Nationale Forestière d'Ingénieurs*) was created in 1968.

In 1980, DRA again became INRA, a MARA autonomous institution. After this new start, INRA undertook progressive and large renovation with strong external support (mainly a huge 10-year USAID grant and then a World Bank loan); it concentrated on AR activities, transferred its plant protection and technical control services to a new MARA directorate and its seed production to a public enterprise, created regional centers, reduced the excessively large number of stations, developed postgraduate training for its staff, and recruited numerous new scientists.

In 1993, MARA established the Directorate for Agricultural Training, Research and Development (DERD: *Direction de l'Enseignement Agricole, de la Recherche et du Développement*) for overseeing and coordinating the MARA units involved in these three fields.

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2. THE CURRENT NARS

2.1 Overview (see Table 1)

The Moroccan NARS currently consists of three main sets of public institutions:

- Four AR institutions: the National Agricultural Research Institute (INRA); the National Center for Forestry Research (CNRF); the Service for Experimentation, Testing and Normalization (SEEN); and the National Halieutic Research Institute (INRH); together they account for 64% of the total potential research years (pRYs: equivalent full-time researchers) and 63% of the financial resources of the NARS. These institutions are presented in Section 2.2.
- Three agricultural higher education (AHE) institutions: the Hassan II Institute of Agronomy and Veterinary Medicine of Rabat and Agadir; the National Agricultural School (ENA), Meknès; and the National Forestry School (ENFI), Salé, which account for 18% of the pRYs and 12% of the total financial resources of the NARS (see Section 2.3).
- A few other scientific and technical institutions which allocate significant resources to AR (around 18% of the pRYs and 25% of the total financial resources of the NARS) (see Section 2.4).

The AR and AHE institutions and most of the other NARS institutions are affiliated to the new Ministry of Agriculture, Rural Development, and Marine Fisheries (MADRPM: *Ministère de l'Agriculture, du Développement Rural et des Pêches Maritimes*). DERD is officially responsible for overseeing and coordinating the MADRPM units involved in training, research and development, especially at the regional level, and for accelerating technology transfer through stronger linkages between scientific institutions and the public and private development/extension organizations; but it has few resources and limited authority on the national AR policy. The National Center for Coordination and Planning of Scientific and Technical Research (CNCPRST), affiliated with the Ministry of Higher Education and Scientific Research (MESRS), is mandated with defining, implementing, and evaluating the overall national research policy, with little direct involvement in the AR sector.

Private AR activities are limited. They are implemented mainly by the *Domaines Agricoles* (previously called the *Domaines Royaux* or King Estates)¹ and by some foreign agro-industrial companies², which operate alone or in collaboration with the public NARS institutions.

2.2 The Agricultural Research Institutes

The National Agricultural Research Institute (INRA)

Mandate and Organization - INRA is the major NARS institution (45% of the pRYs and of the total financial resources of the NARS). It is a public autonomous institution headed by a Director who reports to the Minister of Agriculture and to a Board chaired by the Minister of Agriculture, which includes representatives of the Ministries of Finance, Education, Health, and the Interior, and of the farming sector.

Its main mission is AR, which mobilizes around 90% of the time of its senior staff and covers all fields (crops, livestock, food technology, etc.), except forestry, irrigation technology and fisheries. Research is mainly applied and adaptive (80%). Other activities cover transfer of technologies (through its *Service de Recherche et Développement*), and education (support to graduate students' theses, lectures at several universities, etc.).

INRA headquarters are in Rabat. Its seven departments (natural resources, plant breeding, plant protection, agronomy, livestock, food technology, and socioeconomics) and eight regional centers (see below) contribute to the implementation of 16 programs on commodities (cereals, food legumes, forage, etc.), farming systems (arido-culture, Saharan agronomy, etc.), and disciplines (socioeconomics, farm machinery, food technology, etc.).

¹ These *Domaines Agricoles* have highly advanced research laboratories in biotechnology and tissue culture (Selouane Laboratory, Meknès; Agronomic Laboratory of El Boura, Agadir; etc.), which collaborate closely with INRA, IAV Hassan II and ENA, and with advanced laboratories in Europe and the USA. They play a leadership role in agricultural development and technology adoption.

² Such as Pioneer and Tezier, which conduct applied research on various crops (cereals, vegetables) to test their performance and pest resistance before release to farmers.

Human, Physical and Financial Resources - Currently (1997), INRA has 1,800 employees, of whom 300 are professional graduate staff members, including 282 nationals (50 PhD, 196 MS and 36 BS holders)¹ and 18 expatriates, who represent a total of 270 pRYs². National research staff members are generally young. Until 1996, national graduate staff joined INRA according to one of two categories: (i) the new scientific status, chosen by about 20% of the members, which is equivalent to university scientists, with advancement in their careers subject to the assessment of their scientific results; or (ii) the technical status, equivalent to ministry organizations with slightly lower salaries.

The regionalization policy implemented by INRA during the last 20 years has reduced the concentration of graduate staff at Rabat (34% now, compared to 40% previously) and reinforced some regional centers, mainly Settat (19%), Meknès (15%) and Marrakech (11%). However, the other centers remain much understaffed.

INRA has 354 technicians, many of whom are assigned to administrative positions, which makes the current average number (1.1) of technicians per graduate staff member very insufficient and should be better distributed among the regional centers. Moreover, INRA has maintained a large body of support staff (1,150 clerks, secretaries and laborers), which fits with the usual norm.

The eight regional research centers and 24 experiment stations (total: 4,800 ha) are spread across the country. The regional centers host more than 90% of the 109 laboratories. Experiment stations are devoted mainly to research (some seed and crop production). Some recently established or renovated centers (Settat, Marrakech, Tangiers, Meknès) enjoy good physical resources, but laboratory equipment and farm machinery suffer insufficient maintenance and repair. Considerable investments have been made in the last years to strengthen the division of information and documentation and the central library of Rabat³ (recruitment of qualified librarians, new equipment, linkages with the other national documentation centers and international databases, etc.).

The 1996 INRA total financial resources amounted to Dh 166 million (Dh: dirham) (US\$ 18.9 million), of which Dh 134 million came from national sources (mainly from the government budget, and about 10 million from self-earned funds: research contracts, royalties, sales of seeds, analysis, etc.), Dh 26 million from a World Bank loan, and Dh 6 million⁴ from grants offered by donors (Germany, France, USA, etc.) through the 18 expatriates and collaborative research programs. National salaries absorbed Dh 94 million, and operation and capital costs (OCC) some Dh 69 million—almost fully allocated to research activities—amounting to around Dh 260,000 (US\$ 29,000) per pRY. Until 1994, the year of completion of the 10-year USAID project, OCC per pRY has been much higher due to the large USAID financial assistance, partly replaced by the World Bank loan (in 1994, the operation/capital budget directly allocated to researchers was two times higher than in 1996). Procedures for financial transactions related to the national budget and the World Bank loan are lengthy and payments are delayed.

Research Activities and Linkages - With ISNAR support, INRA has developed in the last 10 years a "programming by objectives" (PBO) system based on consultations between INRA and researchers, farmers, and extension agents, and assessment of market demand. Evaluation of research programs is made through different bodies, mainly a scientific committee (composed of INRA leaders and high-level scientists from IAV Hassan II and ENA) and sectorial committees (which include representatives of the agro-food associations). All these mechanisms have reinforced the multidisciplinary approach, allowed better use of human and financial resources, and improved linkages with development organizations and other NARS institutions.

However, the PBO system has not been totally finalized because human and financial resources have not been available according to the system's needs. Some high-priority research areas, such as cereals, food legumes, IPM, plant nutrition and management, soil/water management and conservation, forage/pasture and sheep, are rather well covered, but many cross-sectorial research areas are understaffed, mainly horticultural crops, industrial crops, rangelands, farming systems, socioeconomics, biotechnology and food processing.

INRA's results are published in "*Al Awamia*," a quarterly scientific journal, and technical bulletins. Based on these results, about 65 of INRA's cultivars of various cereals, forages and food legumes are marketed by the National Seeds Marketing Society (SONACOS).

¹ Due to its successive reorganization and changes in mandate, INRA lost a large number of national professional staff from 1980 (259) to 1989 (171). Then, the number and academic level of this staff steadily increased, with a high turnover of senior research staff due to salaries lower than at the academic institutions.

² 300 professional graduate staff members × 90% (the percentage of their time allocated to AR).

³ This library contains about 30,000 books, 21,000 reports and 1,400 periodicals.

⁴ This amount includes the cost of the 18 foreign researchers estimated at the "national cost" (average cost of national researcher with same qualifications/experience).

For improving its research programming and dissemination of research results, INRA has strengthened its linkages with development organizations through numerous channels:

- PBO (presented above), which has adapted research priorities according to farmers' needs;
- specific research contracts with regional integrated projects;
- preparation of information packages for extension services and farmers; this is the main task of the Research and Development (R&D) Units created in each regional center;
- demonstration experiments in farmers' fields set up and evaluated jointly with extension agents and farmers on a large scale throughout the country (500 to 2,000 farmers participate annually);
- several sectorial committees set up both at the national and regional levels (National Cereals Development Committee, National and Regional Citrus Committees, National Soya Committee, National Colza Committee) which bring together representatives of the research profession, and training and development institutions; and
- field days in experimental stations, commodity- or discipline-oriented workshops, training courses, on-the-job training, etc.

INRA has good linkages with ENA, Meknès (its regional center of Meknès is on ENA campus), IAV, and some universities (Marrakech, Meknès, Settat). Many academic staff members participate in its research programs in order to provide some methodological and scientific support, and train young researchers. Relations with the other NARS institutions are rather limited.

Scientific relations with AR international centers (CIMMYT, CIP, ICARDA, ISNAR), regional organizations (ACSAD, CIHEAM), and with scientific institutions from developed countries (European Union, France, Germany, Italy, USA) are also well developed. INRA is also a member of AARINENA.

The National Center for Forestry Research (CNRF)

CNRF's mission is mainly research (90% of its graduates' time) on forestry, wildlife, and land erosion.

Resources - CNRF employs 37 researchers, including 36 nationals (1 PhD and 35 MS holders), who follow the same salary scale and career scheme as public servants, and 25 technicians (0.7 per scientist). It has its main laboratories at Rabat in addition to eight experiment stations. The total 1996 financial resources amounted to Dh 17 million (US\$ 1.9 million) provided by the Government, of which only Dh 1.4 million was devoted to OCC (about US\$ 4,200 per pRY).

Research Activities and Linkages - Priority research areas are natural and plantation forests (14 researchers), wood processing and utilization (4 res.), and wildlife (5 res.). These research areas are supported by researchers in land/water management, agrometeorology, integrated pest management, biotechnology, rangelands, socioeconomics, and biometrics. Sixty-five percent of the resources are devoted to applied/adaptive research, 25% to basic research, and 15% to on-farm research.

There is no evaluation of research or researchers. Research outreach is very weak, since the allocated human and financial resources are insufficient. CNRF publishes a scientific journal, "*Annales de la Recherche Forestière*." It disseminates research results through field days, seminars and technical bulletins.

With the reorganization of the forestry services, CNRF will have to work more closely with the forestry extension agencies (CDFs: Centers for Development of Forestry) that are spread across Morocco. CNRF has little interaction with the international scientific community (joint research programs and scientific exchanges with four international institutions, including membership of the International Union of Forestry Research organization, IUFRO).

The Service for Experimentation, Testing and Normalization (SEEN)

SEEN is under the MADRPM Directorate of Rural Engineering (AGR). Its main mandate (80% of the time of its graduate staff) is on applied and adaptive research on land and water and agricultural engineering (hydraulics).

Resources - SEEN has 17 graduate staff members (4 PhD, 12 MS and 1 BS holders), who follow the same salary scale and career scheme as public servants, and 50 technicians. Laboratories are located mainly in Rabat; SEEN uses nine regional experimental stations belonging to irrigation bureaus. In 1996, financial resources, almost fully provided by the Government, amounted to Dh 7 million (US\$ 0.8 million). Dh 1.2 million is allocated to OCC (about Dh 86,000 or \$ 9,700 per pRY).

Research Activities and Linkages - Research domains cover mainly soil and water management and conservation in irrigated areas, agricultural engineering, agrometeorology, and laboratory testing of irrigation technologies. Even though it does not have a specific scientific journal, SEEN disseminates its results through technical bulletins,

seminars, technical meetings, and a pilot farm for training extension agents in irrigation techniques in order to upgrade the human resource capabilities of the nine irrigation "offices" (that cover 1 million ha of irrigated land). It has few international linkages.

SEEN is managed and viewed as a regular public-service-oriented institution, with a classical administrative structure and management, and not as a research institution.

The National Halieutic Research Institute (INRH)

Mandate and Organization - INRH, an autonomous institute affiliated to MADRPM, is governed by a Board of Directors and led by a Director General and a Secretary General. It has five departments: Halieutic, Marine Environment (Quality and Salubrity), Oceanography, Economy and Fishing Technology, and Finance and Administration; however, this organization is under deep restructuring to achieve decentralization that is more appropriate for covering scientific marine research along an extended coastline (about 3500 km). INRH is the major fisheries research body in Morocco; its graduate staff allocate around 70% of their time to research and 30% to other activities (public analysis/surveys, extension support to the profession, etc.).

Human, Physical and Financial Resources - INRH currently has 99 scientific and technical graduate staff members (10 PhD, 42 MS and 47 BS, including 15 applying for MS: 14 in Morocco and 1 in Canada), supported by 81 technicians, 26 unskilled staff (drivers and others), and a crew (2 captains with an MS-equivalent degree and 20 seamen). High-level staff members for management are insufficient. A proposal for a specific statute for researchers will be soon submitted to the Government for approval.

Physical resources are rather good and have been improving over the last years. The central laboratories of INRH are located in Casablanca. It also has a network, that is well distributed along the coastline, of 5 regional research centers¹, 6 stations for monitoring the salubrity of the littoral, and 6 sampling stations (for carrying out sampling on a regular basis of commercial landings and for collecting bio-statistical data). INRH owns a large research vessel acquired in 1986 within the framework of Moroccan–Japanese cooperation, equipped with modern facilities for carrying out oceanographic and sedimentologic studies.

Within the last decade, the budget allocated to research has undergone substantial growth, especially with the decentralization of research through the establishment of regional centers. In 1998, national financial resources, almost fully provided by the Government, amounted to Dh 48 million (US\$ 5.4 million), of which Dh 17 million were for salaries and Dh 31 million for OCC (about US 35,000 per graduate staff member), which appears to be a sufficient amount for covering INRH research and service mandates. The 1999 budget amounts to Dh 60 million. External resources are limited.

Research Activities and Linkages - INRH has four principal missions: (i) stock assessment and fisheries management (biology and ecology of the main species of high commercial value, stock population dynamics, fisheries management plans through bio-economic models and simulation of scenarios, etc.); (ii) quality/salubrity dynamics of the marine environment (assessment and permanent monitoring in the fields of bacteriology, chemistry and toxicology; salubrity of sea products; etc.); (iii) research and experimentation in marine technologies (new fishing gear, traditional fishing vessels, fish preservation, etc.); and (iv) economics and valorization of sea products (socioeconomic studies of the various fishing and aquaculture products and the transformed ones).

Research results are published in INRH publications: *Travaux et Documents* and *Note d'Information*. Documentation is now under reorganization for improving the efficiency of the process.

Scientific cooperation is fruitful, mainly with France, Japan, Spain, and Portugal.

2.3 The Agricultural Higher Education Institutions

The Hassan II Institute of Agronomy and Veterinary Medicine (IAV)

Mandate and Organization - IAV is the most important national academic institution. Thirty percent of its academic staff's time is allocated to training, 30% to research, 20% to services (consultancies, studies, etc.²), and 20% to study leaves and administration. It offers MS and PhD education covering all fields, including veterinary sciences, seafood

¹ Two (Nador, Tangier) along the Mediterranean seacoast and three (Dakhla, Laayoune, Agadir) along the coast of the Atlantic Ocean; the Centers of Nador and Agadir are about to start their activities.

² Soil and water analysis for farmers and the private sector (annual capacity: 3,000 soil samples and 4,000 water samples); plant and animal disease diagnosis and recommendations for control, etc.

sciences, rural agricultural engineering (irrigation¹, mechanization), and food technology. Around 1,200 students are enrolled (including about 10% from French-speaking sub-Saharan countries), which means a fair ratio of 4 students per academic staff member, one of the best in the WANA region.

Human, Physical and Financial Resources - IAV employs 1100 staff members, including 132 technicians, 625 other support staff (clerks, laborers), and 317 academic staff members (315 nationals: 194 PhD, 113 MS and 8 BS holders; 2 expatriates), of whom 91 are in the agronomy section, 65 in the veterinary medicine section, and 35 to 37 in each of the food technology, rural development, horticulture and basic sciences sections.

IAV has large, modern facilities (lecture rooms, labs, a central library, etc.) on two campuses (Rabat and Agadir) and three experimental farms/stations (total: 655 ha) serving for both research and teaching purposes. Equipment is reasonably satisfactory, but limited funds are available for maintenance and replacement.

The 1996 total financial resources are estimated at Dh 164 million (US\$ 18.6 million), of which:

- Dh 156 million came from national sources, mainly from the Government (80% for salaries; 20% for OCC, of which 20% are allocated to AR activities), and from research contracts with public and private organizations (MADRPM Departments of Plant Production and Animal Production, commodity associations, food industries, etc.); and
- Dh 8 million from external grants, mainly obtained through research contracts with bilateral and international organizations (FAO, WHO, UNDP, EU, IFS, etc.), including some contracts related to research/studies conducted in other African countries (Guinea, Mauritania, Mali and Chad).

Total funds allocated to AR at IAV are roughly estimated at Dh 38 million (US\$ 4.3 million), coming from national (Dh 35 million) and external sources (Dh 3 million), of which Dh 26 million are devoted to staff salaries and Dh 12 million to OCC². This OCC deserves two comments: (i) OCC per scientist per year is Dh 38,000 or US\$ 4,300, and may allow the academic staff to dedicate only, as an average, around 15 to 20% of its time to AR activities; and (ii) the Dh 12 million OCC is funded mainly through research contracts and research grants (Dh 8.3 million, of which 3 are from external sources), and 3.7 million from the government allocation.

Research Activities and Linkages - IAV has no research policy; most of its research programs are initiated upon request and through funding from the national public and private sectors or from international institutions. They aim to solve short-/medium-term problems related to agricultural development, without sufficient continuity. However, IAV's research activities have resulted in the introduction of many improved agricultural practices leading to increased yields (through breeding, agronomy, IPM, etc.) for citrus, potato, vegetables, sugar beet, etc. Tropical crops, such as banana, pineapple and mango, were introduced and adapted to the ecological conditions of the country.

The IAV publishing center, *Actes Editions*, is very active; it publishes books, a Newsletter, a magazine, and two scientific journals (*Les Actes de l'Institut Agronomique et Vétérinaire Hassan II* and *Hommes, Terre et Eaux*). Papers are also published in other national or international journals. Moreover, all completed projects necessarily end with a written report, and every year, IAV produces about 350 MS theses and 10 to 20 PhDs.

Relations with national development organizations are established through research/study contracts, services (soil and water analysis, etc.), soil mapping, direct technical assistance, and many professional associations set up by the Institute³. IAV is involved in numerous regional and international networks (camels, legumes, goats, range management, date palm) and collaborative research programs with scientific institutions from developed countries (USA: University of Minnesota, Utah State University, and others; France; Belgium; etc.) and with regional and international organizations (ICARDA, CIHEAM).

¹ The International Irrigation Center (IIC), established by IAV in 1985, offers both national and international training (MS-level training) and short courses in diverse fields (management of large-scale irrigation projects, on-farm water management, etc.).

² Data for the year 1993/94.

³ Such as the National Associations for land consolidation, irrigation and drainage (ANAFID); plant production, protection and plant breeding (ANAPPAV); animal production (ANPA); soil sciences (AMSSOL); nutrition (SMN); etc.

The National Agricultural School of Meknès (ENA-Meknès)

ENA's mission covers education, research (15% of its academic staff's time) and development/services¹. It offers MS education (6 years beyond high school education or *baccalaureat*), with specialization in plant production, plant protection, animal production, agricultural economics, agricultural extension and agricultural education.

Resources - The total number of staff is 269, including 93 academic staff members (88 nationals: 39 PhD, 44 MS and 5 BS holders; 5 expatriates) and 46 technicians. ENA enjoys good physical facilities; its buildings are located on a farm of 600 ha (staffed by 5 graduates and 3 technicians), which serves research, training and production objectives. Its total financial resources amount to Dh 37 million (US\$ 4.2 million), of which Dh 35 and 2 million come from national and external sources, respectively.

Research Activities and Linkages - Research funding and programs have the same characteristics as those of IAV. AR funds may amount to around Dh 3 million, and OCC is mainly provided by research contracts (private sector, public and international cooperating agencies: GTZ, UNDP, USAID, France, FAO, etc.), and remain far below the needs. Programs are initiated by academic members according to the national and external funds available and aim to solve short-/medium-term problems related to agricultural development (especially of the Middle Atlas region), without sufficient continuity.

Dissemination of research output is through publications, such as scientific papers, pamphlets, books, and the ENA research bulletin; organization of and participation in seminars and workshops; training of extension agents; field days and outreach programs; and audiovisual programs.

Transfer of technologies is achieved through on-farm trials, field days, demonstrations, and workshops. Relations are maintained with professional organizations. ENA enjoys good relations with INRA (the INRA regional center of Meknès is located on the campus of the school) and IAV (which contributes to some teaching programs at ENA). ENA academic staff members are active in national associations for research and development (ANAPPAV, ANPA and AMSSOL); they participate in research networks in the framework of international projects supported by UNDP, ICARDA, CIHEAM, EU, INRA-France, etc.

The National Forestry School of Salé (ENFI-Salé)²

ENFI has been offering MS education since 1992 (BS from 1970 to 1989), covering ecology, forest management, range and watershed management, forest economics, and technology and forest equipment. More than 40% of its students come from other African countries, particularly Tunisia, Algeria and Mauritania.

It has 27 national academic staff members (15 with PhD degrees) and 3 expatriates. Its total budget amounts to Dh 11 million (US\$ 1.3 million), of which 10 come from the Government budget and 1 from external sources.

Its research activities cover all the Maghreb forest areas and the associated economic sectors; however, research budget is insignificant.

Research Activities of the Agricultural Higher Education Institutions

The availability of numerous highly qualified and experienced academic staff (430 nationals, including 248 PhD and 168 MS holders; and 10 expatriates) and numerous postgraduate students represents large comparative advantages for the three AHE institutions for implementing AR activities.

However, AR is constrained by the lack of technicians, who are scarce at IAV and ENA and mobilized mainly for education activities, and by the very limited funds for AR operation and capital expenses. For IAV and ENA, these funds come only from their government budgets and amount to around one-third of their AR OCC. ENFI does not allocate any public fund for AR. Thus, as main results:

- AR projects rely mainly on short-/medium-term funds (OCC) provided by research contracts and grants, which lack continuity, and are not based on a clear and well-defined research policy. This situation reveals (or has as a consequence) the absence of AR policy in the AHE institutions, and may explain the absence of recognition of

¹ ENA has four service units: the National Center for Studies and Research in Extension (CNERV), which produces audiovisual material and implements research in extension; the Center of Experimentation and Application of Agricultural Machinery (CEAMA), developed in cooperation with GTZ; *Ferticonseil*, for diagnosis and recommendations on soil fertilization for the private sector; and a phytopathology unit for pest and disease diagnosis and recommendations for the private sector.

² ENFI will move soon to Ifrane in the central mountainous zone of the country.

the three AHE institutions as an integral part of the NARS and their difficult position with respect to collaborative research because of the disparity in available resources compared with INRA.

- The total OCC available is not sufficient for meeting the research needs; scientific and other equipment (vehicles, farm machinery, etc.) cannot be repaired, replaced or modernized; and infrastructure (buildings, labs) lacks maintenance. Therefore, the AHE institutions' scientific potential is far from being well mobilized. As noted earlier, IAV academic staff may be actually devoting 20% of its time to AR activities; this rate is probably less than 10% for ENA staff, and almost nil for ENFI staff; accordingly, the three AHE institutions may account for about 70 actual research years.

2.4 The Other NARS Institutions

Other various public and professional scientific and technical institutions carry out AR activities, which generally cover a more or less small part of their mandate.

The Other NARS Scientific Institutions

Some universities have units and/or highly qualified staff specialized in agriculture-related sciences such as plant/animal biology (including breeding, pathology, entomology, microbiology), food technology, rural socioeconomics, rural geography, nutrition, etc. This is the case of the University of El-Jadida (Department of Biology of the Faculty of sciences of El-Jadida and Department of Applied and Food Biology of the Faculty of Sciences of Settat), the University of Marrakech (Departments of Biology of the Faculty of Sciences of Marrakech and of the Faculty of Sciences and Technology of Beni Mellal), the Faculties of Economics in almost all the universities, etc. Some of these units (in Marrakech, Meknès, Settat) currently have collaborative research activities with INRA and ENA.

As a recent, complete inventory of these units is not available, it is difficult to have a precise estimate of the total number of academic staff members concerned. Nevertheless, through a quick survey of some universities (Marrakech, Meknès, Settat, El-Jadida, and Beni Mellal), this number may reach around 100 scientists or 25 potential RYs. However, most of these scientists are overloaded by their education commitments, and their physical and financial resources are generally poor.

The Other Technical NARS Institutions

The Directorate for Agricultural Training, Research and Development (DERD) - For fulfilling its mandate, DERD has recently (since 1995) created Centers for Training, Research and Development (CFRDs: *Centres de Formation, de Recherche et de Développement*), which aim to strengthen collaboration between the NARS institutions and the linkages with development organizations in each large agroecological region of the country. These CFRDs mobilize the resources of the concerned institutions and add specific human and financial resources needed for the activities and projects they intend to develop. Currently, there are two categories of CFRDs:

- Four CFRDs have been set up in regions where permanent presence of the NARS institutions is very limited or nil; they are located at Errachidia, Ifrane, Missouri and Tétouan, specialized in the Saharan zone, Atlas mountain/forestry, pastoralism/rangeland zone (east-central part of the country), and Rif (northern) mountains, respectively. These CFRDs have benefited from rather large efforts, including recruitment of around 20 permanent graduate staff members and new infrastructure (offices, lecture rooms, labs, housing, etc.) for permanent staff and visiting scientists (and students) from the NARS institutions.
- Four CFRDs are based on existing units of some NARS institutions: Agadir for horticulture (within IAV), Meknès for rainfed agriculture and animal production (within ENA), Rabat for rural agricultural engineering, food technology, veterinary medicine (within IAV), and Settat for dry areas (within the largest INRA regional center). These CFRDs will essentially take advantage of the existing infrastructures and will try to associate scientists and students from other NARS institutions interested in the four mentioned agro-systems.

Currently, the additional AR resources directly mobilized by the CFRDs (apart from the resources of the NARS institutions allocated in their activities, taken into consideration in the previous sections) are limited: around 8 pRYs (20 permanent graduate staff of the four first CFRDs who allocate around 40% of their time to AR) and Dh 30 million (US\$ 3.4 million) provided by DERD and through contracts with national development organizations. In the near future, these resources may greatly increase through the planned recruitment of 50 new graduate staff members and scheduled external financial support.

The Other MADRPM Directorates Involved in AR - Within their mandate, some MADRPM directorates implement AR activities. The Directorate for Plant Protection, Chemical Control and Fraud Prevention is involved in applied research in crop protection (epidemiology, integrated pest management), food technology, etc. The Animal

Production Directorate is involved in research on animal genetics, nutrition, health (mainly research in epidemiology conducted by the laboratory for vaccine production), food technology (meat/milk quality), and economics. These directorates dedicate some 40 pRYs and Dh 25 million (rough estimate) directly to AR activities, without counting the resources mobilized by scientific institutions (mainly IAV) through research contracts funded by the directorates.

The Other Organizations - For supporting their development mandates, some public agricultural enterprises and professional organizations carry out applied AR activities (crop, irrigation and/or livestock experiments, farming systems and socioeconomic studies) alone or more often in close collaboration with the public sector (IAV, ENA, INRA, etc.) as part of their research activities or through research contracts. These are:

- The Regional Authorities for Agricultural Development (ORMVAs), which supervise public intervention in some irrigated and rainfed areas¹; the National Society for Land Management (SOGETA), which directly manages state properties (inherited from the nationalization of former French farms); the National Society for Agricultural Development (SNDA); the National Society for Livestock Development (SNDE); and the Society for Agricultural Development (SODEA).
- The professional organizations or associations set up by some of the more active farmers specialized in commodities such as citrus, vegetables, cut flowers, and bananas; some of them (such as the *Société Agricole de Services au Maroc*, SASMA, for citrus, which is endowed with some researchers and an experimental farm of 50 ha) have their own laboratories, scientists and extensionists, and are funded by a levy on exported produce.

The resources directly devoted to these AR activities have not been precisely inventoried. They may mobilize some 40 pRYs and Dh 25 million (rough estimates).

3. AR RESOURCES

3.1 Human Resources

In 1997, the Moroccan NARS involved 1073 scientific and technical graduate staff (29 of whom were expatriates), who represent around 606 potential RYs.

The agricultural scientific institutions employ 864 national scientists (313 PhD, 453 MS and 98 BS) who represent over 80% of the total graduate staff. The academic level of these scientists is much higher at the AHE institutions (58% with PhD degree, 39% with MS) than at the AR institutes (15% with PhD degree, 66% with MS). At INRA, the training policy and recent enhancement of the status and salaries of researchers have led to obvious improvement; however, there seem to be no favorable prospects for CNRF and SEEN whose scientists follow the same salary scale and career scheme as public servants.

NARS graduate staff is highly concentrated in Rabat (496: 46%), largely because of the weight of IAV. Recent efforts have been made to change this situation with the creation of the regional CFRDs; however, many regions are far from having a sufficient number of permanent scientists able to efficiently meet their AR needs.

The number of technicians per scientist is highly variable from institution to another (INRA: 1.1; CNRF: 0.7; SEEN: 3.1; INRH: 0.8; IAV: 0.4; ENA: 0.5). Because many technicians are assigned to administrative positions (clerks, etc.), their numbers are very insufficient (compared with the common norm of 2 technicians per researcher in AR institutes) and constitute a strong limiting factor constraining scientists' research efficiency.

In general, other support staff (laborers, clerks) are sometimes too numerous and not very productive, but rather inexpensive².

3.2 Physical Resources

The physical resources are impressive. The Moroccan NARS possesses about 65 physical units (headquarters, regional centers, farms) of a total area of about 7,000 ha. A large majority of these units, which are rather well spread

¹ The major ORMVAs of the irrigated schemes of Doukkala, Errachidia, Gharb, Haouz, Moulouya, Ouarzazate, Souss Massa, have 13 experimental stations, totaling more than 200 ha.

² The monthly salary of this low-qualified staff is about Dh 1,500–2,000 (US\$ 170–230) compared to the following salaries for qualified staff (average estimated from different scientific institutions): senior scientist with PhD, Dh 11,000 or US\$ 1,300/month; researcher with MS, Dh 8,000 or \$ 910; research assistant, Dh 5,000 or \$ 570; technician, US\$ 350.

across the country, is run by INRA. In general, land is sufficient and library/documentation services are considered satisfactory, but the other physical resources (offices, laboratories, scientific equipment, computers, transport/communication facilities) are unevenly distributed among the institutions and among the units of the same institution, with only few units (Rabat, Settat for INRA; IAV; ENA) currently being well endowed, thanks to recent investments mostly funded by external sources (grants and loans).

3.3 Financial Resources

In 1996–98, the total (national and external) annual NARS financial resources amounted to an average of about Dh 355 million (US\$ 40 million), of which Dh 320 million (US\$ 36 million) came from national sources (mainly the government budget, in addition to some self-earned institutions' resources and research contracts funded by national organizations), Dh 26 million as a loan (from the World Bank to INRA), and Dh 9 million from external grants provided by bilateral or multilateral donors.

The NARS national and total resources amounted to around 0.68 and 0.76%, respectively, of the Agricultural Gross Domestic Product (AGDP estimated at US\$ 5.3 billion in 1996). Such ratios are lower than the 1% recommended by some international organizations.

INRA and INRH enjoy good operating and capital budgets (US\$ 29,000 per pRY and US\$ 35,00 per graduate staff member, respectively), which may be sufficient for providing almost satisfactory resources for their research staff¹. On the other hand, CNRF, SEEN and the AHE institutions suffer low research operating and capital budgets (CNRF and SEEN: US\$ 4,200 and 9,700 per pRY, respectively; IAV: US\$: 4,800 per academic staff member), which prevent (together with other factors, especially the insufficient number of technicians) a fair mobilization of their scientific potential. Therefore, the NARS should account for **around 540 actual RYs** (about 400 of which would be for the four AR institutes, 70 for the AHE institutions, and 70 for the other NARS institutions) as opposed to the 606 potential RYs estimated above.

4. RESEARCH ACTIVITIES

4.1 Research Orientation and Priorities

Each institution has developed research programs and activities in its fields of competence and mandates. As seen above, research programs differ largely among the NARS institutions. Through the PBO system, INRA has tried, and partly succeeded in, conducting long-term programs based on a rational appraisal of the priority needs of the agricultural sector, with rather sustained funding sources; while the AHE institutions have developed short-/medium-term programs, mainly initiated according to changing research contracts.

These complementary approaches should be of mutual benefit to the scientific institutions and enhance their whole research activities within the framework of strong collaboration which does not exist. Despite formal past efforts, linkages between the scientific institutions, mainly between the two largest ones: INRA and IAV, are rather weak, sporadic, and based on personal contacts²; each institution follows its way without taking advantage of the results and experiences of the others. This results in a non-integrated aggregate research program, with unbalanced coverage of AR needs; some fields seem to be insufficiently taken into consideration (rainfed regions with favorable conditions, pasture/rangelands, animal production, food technology, rural economics, etc.), while there is duplication of efforts in some areas. A comprehensive critical balance of the overall current AR programs has never been made.

4.2 Linkages with Development

¹ Most of the national AR long-term plans elaborated by developing countries during the 1990s consider an average annual operation and capital budget of US\$ 25,000–30,000 per researcher for covering all AR expenses (research and administrative costs, except the salaries of the permanent staff); such norm is valid for a full set of research domains and varies slightly according to the field (higher costs for perennial crops, animal production, food technology, etc. than for annual crops, rural economy, etc.).

² In spite of the recent agreement signed in 1995 between INRA and IAV, which describes the various linkages to be formalized between the two institutions and calls for the establishment of joint scientific committees to expand collaborative AR programs (funded by national or international organizations) and activities (exchange of scientific events, sharing of information, etc.).

Most of the scientific NARS institutions have a rather rich experience in establishing various linkages with their development partners: government agencies, professional organizations or the private sector. Some of these linkages are specific to one institution (such as the PBO and the research and development units in each regional center of INRA). But most channels are similar and sometimes leave room for strong competition between the institutions, such as the INRA national and regional sectorial committees, the professional associations set up by IAV, research contracts with national and external organizations, demonstration experiments in farmers' fields, field-days in experimental stations, services (soil and water analysis, etc.), workshops, training courses, etc.

Such competition is good to a certain extent, but it may imply a waste of energy and resources. It could also lead to a weakening of the scientific institutions in terms of their relations with their national and external partners. The recent creation of the Inter-Professional Groups for Agronomic Research (GIRA: *Groupement Interprofessionnel pour la Recherche Agronomique*), established for involving the private sector in research orientation and funding, and of the National Committee for Transfer of Technology (CNTT) and Regional Committee for Transfer of Technology (CRTT) should be fully profitable to the scientific institutions only if they are able to develop better relations among themselves.

4.3 International Cooperation

In general, the scientific institutions of the NARS have large and diversified international partnerships with scientific institutions from developed countries (European Union, France, Germany, USA, etc.) and from the WANA region (directly but mainly through ICARDA), and with international/regional centers or organizations (CIMMYT, ICARDA, CIHEAM, FAO, AARINENA, ACSAD, etc.). However, effective relations implying collaborative research programs and external funding remain relatively limited with regard to the size of the NARS.

5. CONCLUSION

The Moroccan NARS remains moderately fragmented, with three major institutions (INRA, INRH and IAV) mobilizing about 70% of the total pRYs and financial resources. Its human and financial resources are rather limited with regard to the size of the country and the difficult long-term food prospects resulting from the growing population and limited natural resources.

The major AR institutes (INRA and INRH) and the AHE institutions have complementary characteristics. Closer collaboration among these institutions would greatly benefit the NARS; however, little has been done to promote such collaboration, either by the institutions concerned or by MADRPM; this has resulted in sub-optimal use of the available human, physical and financial resources. Effective collaboration between the scientific institutions of the NARS could be considerably enhanced, as indicated by Besri and El Idrissi (FAO, 1996), by:

- Joint preparation of the national agricultural policy and identification of research priorities, with a view to strengthening coordination of the research activities of the various institutions involved.
- Joint discussion of budgets and program priorities.
- Pooling human resources (scientists and technicians) in similar areas of specialization, especially of highly trained staff, for implementing joint research tasks, and establishing joint laboratories.

This should be possible under a renovated body responsible for the national AR policy, which is able to boost concrete actions and mobilize larger funds.

Main Acronyms

MADRPM: Ministère de l'Agriculture, du Développement Rural et des Pêches Maritimes.

CFRDs: Centres de Formation, de Recherche et de Développement. **CNRF:** Centre National de la Recherche Forestière. **DERD:** Direction de l'Enseignement, de la Recherche et du Développement. **ENA:** Ecole Nationale d'Agriculture de Meknès. **ENFI:** Ecole Nationale Forestière d'Ingénieurs de Salé. **IAV:** Institut Agronomique et Vétérinaire Hassan II. **INRA:** Institut National de la Recherche Agronomique. **INRH:** Institut National de Recherche Halieutique. **SEEN:** Service de l'Expérimentation, des Essais et de la Normalisation.

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Table 1 - The National Agricultural Research System (average 1996–1998)

Italics: Approximate data. ...: Data not available. 0.-: Minimal (almost zero). *: See footnotes.

NARS Institutions				AR Scientific & Technical Graduate Staff (Units)			Potential Res. Years (pRY)		Total Budget (million Dh)		AR Expenditures/Resources (E) (million Dh)				
No.	Name - Acronym Head Office - Year Established		Mandates AR Fields	Govern. Ministry	Nationals Total - (PhD , MS)		Exp.	Nat.	Exp.	Nat.	Ext.	Nat. E NE	Loan LE	For. E FE*	Total E TE
a	b		c	d	e	f	g	h	i	j	k	l	m	n	o
1.1	Institut National de la Recherche Agronomique Rabat	INRA 1919-81	AR (90%) - AD All (except 2.1, 2.2)	MADRPM	282	50 , 196	18	254	16	134	32	127	26	6	159
2.1	Centre National de la Recherche Forestière Rabat	CNRF 1934-...	AR (90%) - AD Forestry		36	1 , 35	1	32	1	17	0.-	16		0.-	16
2.2	Service d'Expér., d'Essais et de Normalisation Rabat	SEEN 1952-...	AR (80%) - AD Water resour. manag.		17	4 , 12		14		7	0.-	6		0.-	6
2.3	Institut Nat. de Recherche Halieutique Casablanca	INRH 1952-96	AR (70%) - AD Marine resources		99	10 , 42		70		48	0.-	41		0.-	41
1-2	Total Agricultural Research Institutes				434	65 , 285	19	370	17	206	32	190	26	6	222
3.1	Institut Agronomique et Vétérinaire Hassan II Rabat, Agadir	IAV 1967	AHE - AR (30%) - AD All	MADRPM	315	194 , 113	2	78	1	156	8	35		3	38
3.2	Ecole Nationale d'Agriculture Meknès	ENA-M 1945	AHE - AR (15%) - AD All		88	39 , 44	5	22	2	35	2	5		0.-	5
3.3	Ecole Nationale Forestiers d'Ingénieurs Rabat/Salé (→ Ifrane)	ENFI 1968	AHE - AR (15%) - AD Forestry		27	15 , 11	3	7	1	10	1	0.-		0.-	0.-
3	Total Agricultural Sciences Graduate Schools				430	248 , 168	10	107	4	192	11	40		3	43
4.1	Univ. Marrakech, Meknès, El-Jadida, ...		HE - AHE - (AR) Diverse	MES	80	... , ...	0	20	0	...	...	10		...	10
4	Total Other Scientific Institutions				80	... , ...	0	20	0	...	...	10		...	10
5.1	Centres de Formation, de Rech. et de Développement Errachidia, Ifrane, Missour, Tétouan, ...*	CFRD 1993-...	AHME-AR (40%)-AD All	MADRPM	20*	... , ...		8*		...	...	30*		...	30*
5.2	MADRPM Central Directorates*		AD - (AR)		40*	... , ...		40*		...	...	25*		...	25
5.3	Public/professional Agr. Development Bodies*		AD - (AR)		40*	... , ...		40*		...	...	25*		...	25
5	Total Admin./Dev./Service Institutions Involved in AR				100	... , ...	0	88	0	...	...	80		...	80
6	Total NARS				1044	... , ...	29	585	21	...	...	320	26	9	355
	Exchange Rate: US\$ 1 = 8.8 dirhams (Dh) (1996 average official rate)				Approximate Actual Res. Years (aRYs)			520	20	AR Expenditures (million US\$)		36.3	3	1	40.3

MADRPM: Ministry of Agriculture, Rural Development, and Marine Fisheries; **MES:** Ministry of Higher Education. **c: Mandates:** AR (. %): Approximate average % of human resources devoted to ag. research (AR); **R:** Research; **AHE:** Ag. higher education; **AHME:** Ag. high and medium education; **HE:** Higher education; **AD:** Ag. development/services (for AR and AHE institutes: seed production, soil and water analysis, extension, studies, etc.). **h,i:** Potential research-year (pRY) = equivalent full-time researcher; for the FASs, the pRYs were estimated by multiplying the number of academic staff by 0.25. **l:** For the AR institutes, AR financial resources were roughly estimated through the following formula: Total budget × [ω + 0.5(100 - ω)], ω being the % of time devoted to AR by the graduate staff. **n:** FE: the expatriates' costs are estimated at "national costs" (= national senior staff's average unit cost).

* **Notes: 5.1, 5.2, 5.3:** Only the professional staff (in RYs) and financial resources allocated to AR activities. **5.2:** Central Directorates of Crop Protection, Animal Production. **5.3:** Regional Offices: SOGETA, SNDE, SASMA, ... National AR expenditures (NE) = **0.68%** of the Agricultural Gross Domestic Product (AGDP: US\$ 5.3 billion in 1995). Total AR expenditures (TE) = **0.76%** of the AGDP.