

THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF SUDAN¹

1. HISTORICAL BACKGROUND

Agricultural research (AR) in Sudan dates back to the turn of the century. Formal AR began in the northern province in 1902 and near Khartoum in 1903 to explore the possibilities of growing cotton under irrigation. This was followed shortly by similar work at Rumbek and Wau, in the south, for rain-grown cotton. The Wellcome Tropical Research Laboratories were established in Khartoum in 1903, with emphasis on medical research, but they also conducted chemical and entomological research related to agriculture. Botanical and agricultural research started in 1904 at Shambat Research Station. Pilot schemes and experiments by the Sudan Plantation Syndicate showed that cotton could be grown successfully on a commercial scale in the Gezira area. This promoted the establishment of Gezira Research Station in 1918. In 1931, the Agricultural Research Service was formed as an independent body, and in 1935, it was absorbed into the Department of Agriculture and Forests. In 1944, the new Agricultural Research Division (ARD) was established.

Research on animal health started in 1913 following the creation of the Central Veterinary Research Administration (CVRA) in Khartoum. Research on fisheries and on animal production was initiated with the establishment of the Fisheries and Marine Biology Center at El Shagar in 1953 and of the Animal Production Administration (APRA) in 1955, respectively.

After independence in 1956, ARD expanded rapidly (new research stations created at Hudeiba, Sennar, Maatug, Kenana, Guneid, etc.) to encompass activities in different crops and ecological zones in the country. To ensure the technical and productive efficiency of research activities, ARD was made semi-autonomous in 1967 and became the Agricultural Research Corporation (ARC), affiliated to the Minister of Agriculture and Forests. In 1975, ARC considerably broadened its mandate, merging the Forest Research Center Institute (created at Soba in 1962), the Fisheries and Marine Biology Center, the Food Research Center (established in Shambat in 1965 with FAO support), the Pasture and Range Research Section (of the Range and Pasture Management Administration), and the Game and Wildlife Research Station (of the Department of Wildlife and Game).

In 1970, a formerly created Veterinary Research Division became the Veterinary Research Laboratories Administration (VRLA) within the Central Veterinary Research Administration (CVRA), established at Soba (with FAO support), and five regional laboratories (Sennar, Nyala, El Obied, Kassala, Juba).

Also in 1970, the National Council for Research was established to formulate and supervise the national research policy², and to fill in gaps in research not tackled by existing research institutes. In 1991, the Ministry of Higher Education and Scientific Research (MHESR) was set up. Accordingly, in 1992, the National Council for Research was converted into the National Center for Research (NCR), affiliated to MHESR, to carry out research work only. It still heads six research institutes, among which three are AR related: the Environment and Natural Resources Research Institute (ENRRI), the Aromatic and Medicinal Plant Research Institute, and the Remote Sensing Institute (previously an ENRRI department).

In 1996, APRA and CVRA (two directorates of the Secretariat for Animal Resources) were merged to form the Animal Resources Research Corporation (ARRC) as a semi-autonomous public institute under the Ministry of Animal Resources (MAR), responsible for research on livestock and also on fisheries and wildlife (previously under ARC).

Agricultural higher education (AHE) began with the establishment in 1938 of the School of Agriculture of Shambat and the Veterinary School of Khartoum. In 1951, these schools were incorporated into the University College of Khartoum, also established in 1951, which then became the University of Khartoum (UK) in 1956, and were renamed as the Faculty of Agriculture and the Faculty of Veterinary Sciences, respectively.

During the period 1954–84, nine new AHE and AR-related HE units³ were established: (1) four within UK (the Faculties of Forestry and Animal Production, created from the two existing faculties—Agriculture and Veterinary Sciences; the Department of Agricultural Engineering within the Faculty of Engineering; and the Institute of Environmental Study), (2)

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² NCR had five sub-councils, one of which was the Agricultural Research Council, which did not have its own facilities, but provided funding to institutions, teams or individual scientists to conduct AR activities.

³ The Department of Agricultural Engineering within the Faculty of Engineering of UK and the Institute of Environmental Study, also within UK, are only partly related to AR.

two within the Sudan University of Science and Technology (SUST) in Khartoum (the College of Agricultural Studies, CAS, which took over in 1975 a technicians' training institute established in 1954, and the Faculty of Animal Production created in 1984 from a former branch of CAS), (3) two within the University of Gezira (the Faculty of Agricultural Sciences, and Abu Haraz Faculty of Agriculture and Natural Resources, both at Wad Medani), and (4) one within the University of Juba (the Faculty of Natural Resources and Environmental Studies).

During the last six years, the national AHE system (NHAES) has witnessed dramatic changes, accentuated by the new federal organization of the country (creation of 26 states in 1995): 11 additional agriculture, veterinary, and animal production faculties and colleges have been established in new universities; other faculties are projected (each state would like to have its own faculty of agricultural sciences). The older faculties are giving more attention to higher-degree education and are supporting the new faculties. The Government has just set up an ad hoc committee mandated to assess the situation and to elaborate proposals for mastering the expensive and rather anarchic expansion of the NHAES.

2. THE CURRENT NARS

2.1 Overview (see Table 1)

The NARS currently includes two main sets of scientific institutions:

- The scientific institutes or units mainly involved in AR: the Agricultural Research Corporation (ARC), the Animal Resources Research Corporation (ARRC), three research institutes within the National Center for Research (NCR), and the Hydraulic Research Station of Gezira, respectively within the governance of the Ministry of Agriculture and Forestry (MAF), the Ministry of Animal Resources (MAR), MHESR, and the Ministry of Irrigation (MI). These units, presented in Section 2.2, gather around 67% of the potential research years (pRYs or equivalent full-time researchers) and 92% of the total financial resources of the whole NARS.
- The faculties and colleges of agricultural sciences (all agriculture specialties in Sudan, including marine fisheries/oceanography), which are affiliated to MHESR: they represent together around 29% of the pRYs and 6% of the financial resources of the NARS (see Section 2.3).

Some other institutions for which AR activities represent a relatively small part of their mandate fill the remaining marginal place in the NARS; they are briefly presented in Section 2.4.

MHESR is mandated with defining and implementing the national scientific research policy; however, it has very limited influence on the NARS institutions affiliated to other ministries. So far, there is no national body actually responsible for the national AR policy; accordingly, this policy remains split among the NARS institutions and their governing ministries, and subjected to the personal links of their leaders.

2.2 The Agricultural Research Institutes (see Table 1)

Agricultural Research Corporation (ARC)

Mandate and Organization

ARC is the major institution of the Sudanese NARS (around 36% of the pRYs and 62% of the financial resources of the NARS). Its research activities are focussed mainly on crops, land and water, forestry, forage, pasture, and food processing in different agroecological zones. Although their primary function is to conduct AR, ARC researchers allocate only around 70% of their time resources to this activity. The remaining is directed towards extension (15%), teaching, training, and consultancies.

Wad Medani hosts ARC headquarters, two national centers, two national laboratories (pesticides, tissue culture), a genetic resources unit (genebank), and a seed production unit. Research is coordinated by 12 coordinators for commodity programs and two for disciplinary programs (socioeconomics, agricultural engineering), and the directors of the four centers (soil/water and crop protection based at Wad Medani, forestry and food processing based at Khartoum).

Human, Physical and Financial Resources

ARC currently (January 1998) has 3195 national permanent full-time staff, of whom 303¹ are scientific and technical graduate staff on duty¹, 600 technicians, 400 clerks, accountants and storekeepers, and 1892 laborers (certainly too

¹ Against 14 scientific and technical senior staff members in 1960 and 160 in 1980.

numerous). Among the 303 graduate staff, 97, 126, and 80 hold PhD, MS, and BS degrees, respectively; and represent around 212 pRYs². About 25% of the senior staff are females.

ARC has been suffering a strong turnover of its scientific staff over the years (more than 20 researchers have left ARC during the period 1992–97, most of them for positions in Arab countries). This brain drain is partly justified by the low salaries provided by the Government (see Section 3.1).

With regard to the distribution of researchers in the various agricultural production systems, 38% are serving the modern irrigated sector (which produces all the cotton and sugar, 80% of the wheat, 40% of the groundnuts, 15% of the sorghum, and 70% of the vegetables); 25% the rainfed sector (which produces 85% of the sorghum, 60% of the groundnuts, and all the sesame, millet, gum Arabic, fuel and furniture wood); and 15% the irrigated traditional small holdings (all the cool-season legumes and date palms, 20% of the wheat, and 30% of the citrus). The remaining 22% are engaged in other research domains: natural resources (soil, water), genetic resources, tissue culture, pesticides, and food technology.

The territorial distribution of researchers is rather uneven: 80 and 61 senior researchers are concentrated in Gezira Research Station and the Khartoum units, respectively, while the remaining are thinly spread over 18 other research stations (17 regional stations and Guneid Sugarcane Station; 15 of the stations have an average of only 4 researchers) mostly located in the rainfed regions which are the poorest of the country and do not have the critical mass for meeting the regional AR needs. Some efforts have been undertaken for insuring a better territorial distribution of the staff, but conditions of life and work in remote areas are not attractive.

Research is supported, to a large extent, by adequate, appropriate, and fully operational experimental fields (total area: 2,500 ha), satisfactory but outdated laboratories and equipment, moderate application of modern computer facilities for resource management and for research. Highly specialized research equipment is centralized at Gezira and Khartoum; the 18 research stations cover key agroecological zones, but most of them are poorly equipped. This relatively satisfactory situation is due to the large financial support received through grants (USAID, the Netherlands) and loans (the World Bank and IFAD)³ during the period 1979–95.

In 1997, the total resources of ARC amounted to LS 3,600 million (US\$ 2.3 million), funded mostly by the country (LS 3,300 million, provided essentially by the Government, of which 1,850 was for salaries/allowances and 1,450 for operations⁴), and by external grants (LS 300 million). These resources are mostly allocated to research activities; the available operational/capital funds, estimated at around LS 7.1 million (US\$ 4,470) per pRY, are very low and indicate that: (i) researchers are far from getting the necessary resources for working actually full-time on research and may be largely underemployed; and (ii) ARC is not able to fund the maintenance or replacement of its capital (buildings, equipment).

Research Activities and Linkages

Among the research programs, irrigated crops (49 researchers, including wheat: 7, maize: 2, cotton: 14, sugarcane: 5, vegetables: 14, fruits: 7), crop protection (44 res.), land and water (36 res.), food processing (21 res.), and forestry (20 res.) receive the highest attention. Rainfed crops (millet: 2, groundnuts: 5, sorghum: 5), range/forage (3), and economics (10), are understaffed and will be reinforced. Farming system research has been recently introduced (in the eastern part of the country). The priority-setting exercise recently conducted⁵ will help establish better equilibrium among these programs.

ARC has few collaborative research projects with other NARS institutions. Numerous informal linkages with faculties of agricultural sciences are concentrated on teaching and some supervision of graduate students. Linkages with external scientific and funding institutions were well developed in the past years (the Netherlands; USA; international and regional AR centers; World Bank; IFAD; FAO; etc.), but are currently weak and insufficient (political reasons). Present linkages with ICARDA, ICRISAT, IPGRI, CIMMYT, ASARECA, etc. are highly

¹ Among the senior staff on duty, around 70 are on study courses in Sudan; ARC staff also includes 17 researchers on study courses abroad, 15 researchers on secondment to other institutions (of whom 7 are abroad), and 15 researchers on leave without pay.

² 303 graduate staff members on duty × 70% (percentage of their time allocated to AR).

³ The joint USAID/World Bank Western Agricultural Savannah Research Development Project, implemented during the period 1979–85 afforded the full renovation of the research station of El-Obied. The Agricultural Research, Training and Extension Project (1986–93), funded (loan) by the World Bank, was centered on the Central Region and benefited principally the ARC stations of Gezira, New Halfa and Rahad, and also the Faculty of Agricultural Sciences of the University of Gezira.

⁴ No expenditure for equipment in 1996 and 1997.

⁵ Based on the analysis of the challenges facing agricultural production in the country (economic importance of the commodity branches, food security, export potential), experience and available information.

appreciated. Efforts are now being made to strengthen internal and international linkages, especially after the creation of an External Relations Directorate within ARC.

Animal Resources Research Corporation (ARRC)

Mandate and Organization

ARRC is responsible for all research in animal production, health and feeding, wildlife, and fisheries. Around 65% of its research staff's time is allocated to AR, and the remaining to development (epidemiological surveys/diagnosis, vaccine production, biological analysis, etc.), consultancies, teaching, and training. It has four research centers:

- the Central Veterinary Laboratory Research Center (CVLRC), which specializes in animal health and includes the former VRLA facilities, with the research complex of Soba (several departments and supporting units: pathology and epidemiology of various animal diseases, assessment of drugs, vaccine production) and six regional research laboratories;
- the Animal Production Research Center (APRC), which includes the former APRA facilities, with the research complex of Kuku near Khartoum North (five departments: animal breeding, animal nutrition, meat production and technology, dairy production, poultry production) and five regional research stations;
- the Fisheries Research Center supported by four research stations (Red Sea, White Nile, Lake Nubia, Shaqara); and
- the Wildlife Research Center with five regional stations in the major national parks and game reserves.

Human, Physical and Financial Resources

ARRC currently (1998) has 305 national permanent full-time staff consisting of 225 scientific and technical graduate staff (50 PhD, 155 MS, 30 BS, 10 of whom are on secondment), who represent around 146 pRYs. It is suffering from excessively high concentration in Khartoum (over 90%), large turnover of its senior staff, and acute lack of qualified technicians (30) and other support staff (50).

The current state of the infrastructure (centers and stations) and equipment is moderate but outdated. The stations/farms cover 500 ha and are too split in the country.

In 1997, ARRC budget amounted to around LS 2,000 million (US\$ 1.26 million), coming from government (90%) and self-generated sources (no external grants in 1997; less than LS 0.2 million in 1996). Expenditures cover salaries and allowances (LS 940 million) and operational/equipment costs (LS 1,060 million, more or less equally distributed between research activities and production of vaccines). The AR budget represents roughly LS 1,100 million, with an operational/equipment budget of LS 530 million, i.e., LS 3.6 million (US\$ 2,270) per pRY, which implies very large underemployment of the staff, and the current impossibility to maintain or rehabilitate the central and regional facilities.

Research Activities and Linkages

Priority research on animal health (121 graduate staff based at Soba/Khartoum, few others in the six regional laboratories) covers diagnosis and research in epidemic diseases of livestock, and research and production of vaccines. Research on animal production (48 graduate staff at Kuku/Khartoum, few other in the five regional stations) cover mainly livestock feed resources and animal breeding (characterization and upgrading of the indigenous breeds of cattle, sheep, goats and camels). Research on fisheries (5 researchers) and wildlife (6 researchers) are respectively directed to freshwater and marine aquaculture and fisheries, and mapping of wildlife resources and studies on conservation of endangered species. However, few research programs are currently active due to the lack of financial resources and technicians.

ARRC has numerous informal linkages with other NARS institutions (faculties of agricultural sciences, especially the faculties of veterinary sciences; ARC; etc.), but no actual collaborative research programs. Past linkages with external scientific and funding institutions (Ford Foundation, ACSAD, AOAD, ILRI, UNDP, FAO, etc.) are currently very weak.

AR-Related Institutes of the National Center for Research (NCR)

Three NCR institutes are mainly involved in AR: the Environment and Natural Resources Research Institute, the Medicinal and Aromatic Plant Research Institute, and the Remote Sensing Institute.

The Environment and Natural Resources Research Institute (ENRRI) - ENRRI allocates around 60% of its resources to AR, and 40% to teaching, training, extension, etc. It has 109 national permanent full-time staff (1998), of whom 32 researchers are on duty (3 PhD, 20 MS, 9 BS), representing 19 pRYs. It is organized into five departments: Desert and Dry Land Research (soil and water, crop breeding, irrigation, etc.: 6 scientists), Biofertilization (5 sc.), Integrated Pest Management (8 sc.), Animal Resources/Fisheries (8 sc.), and Environmental Pollution Studies (5 sc.).

Research activities and results at ENRRI are very limited because of

- Its small number of technicians (19, among whom 10 are preparing BS degrees and soon leaving their technician status) and clerks/laborers (48);
- Its very poor physical resources (one research station at Khartoum and two small experimental farms close to the capital) (for 5 years, there has been no capital budget for renovating or maintaining buildings/labs, equipment, and vehicles);
- Its very limited national budget: LS 220 million (US\$ 0.14 million) in 1997, of which LS 170 million was for salaries paid directly by NCR and LS 50 million for operations (i.e., LS 2.6 million or around US\$ 1,640 per pRY);
- The absence of foreign/external scientific and financial support.

The Medicinal and Aromatic Plant Research Institute (MAPRI) - 15 graduate staff members allocate around 80% of their time to the research domains of the Institute, and represent some 12 pRYs.

The Remote Sensing Institute (RSI) - This Institute has 10 researchers, of whom 8 are involved in AR fields. As it was till recently an ENRRI department, it presents similar conditions.

Hydraulic Research Station of Gezira

This Station, which was established by the Ministry of Irrigation in 1975, conducts research (100%) on irrigation scheduling, water requirements of the major crops, and salt and weed management in the Gezira Scheme. It has 5 researchers (2 PhD, 3 MS). Physical and financial resources are good because it has good linkages with IMMES. Linkages with ARC are informal (some joint research projects with ARC scientists). Prospects of merging with ARC are remote.

2.3 Faculties and Colleges of Agricultural Sciences (see Table 2)

Overview

As reported in Section 1, the national agricultural higher education system has dramatically evolved during the past few years. At present, it is rather complex and still changing; accordingly, a precise presentation of this system is a difficult task.

The 23 faculties and colleges of agricultural sciences (designated later as FASs) are semi-autonomous and are affiliated to different universities within MHESR: 5 are within the University of Khartoum (UK), 2 within the Sudan University of Science and Technology, Khartoum (SUST), 3 within the University of Gezira (UG), and 13 within other universities. They cover all the agricultural sciences, with a range of fields varying according to the FAS¹.

Teaching is their main mandate; research and extension activities are generally limited (see below). All FASs provide undergraduate education; most of the oldest ones offer PhD and MS degrees; few still offer diploma education. Some of the oldest FASs have set up specialized centers for developing community services and research in specialized fields².

Human, Physical and Financial Resources

The 23 FASs (1997: see Table 2 and associated comments) comprise around 680 graduate academic staff members (including about 340 PhD, 200 MS and 140 BS holders, of whom 16% are females), who represent 170 potential RYs³. In general, the older ones have the largest and highest qualified academic staff (average of 59 staff members, with about 50% with PhD), and the newer ones are endowed with very limited permanent staff numbers (average of

¹ The Faculties of "agriculture" are involved in sciences related with crops, land, and water; the faculties of "veterinary science" are specialized in animal (production and health) sciences; the faculties of "agricultural sciences" or "agriculture and natural resources" cover all these scientific fields; the University of Khartoum (through its Marine Biological Laboratory of Suakin) and the Faculty of Oceanography and Fisheries of Elsharq University deal with oceanography.

² Such as the Faculty of Agriculture of UK which has a Central Analytical Lab, an Agricultural Service Center (which provides/sells services and inputs to surrounding farmers), and the recently established Desertification and Desert Cultivation Studies Center (with education and research which mobilize staff members of all the UK FASs). The Faculty of Agricultural Sciences of the UG has a Plant Pathology Center and has established in 1996 the Horticulture Export Crops Institute as an autonomous branch for postgraduate studies and research.

³ Taking into account the normative rate of 25% of the academic staff members' time allocated to AR activities adopted for the analysis of all the WANA NARS (see methodology of the study).

17 staff members, 5 faculties have less than 10), and have to hire staff members from the older faculties and from AR institutes (ARC, ARRC).

Almost 75% of this staff is concentrated in Khartoum area (including the Faculty of Agriculture of Omdurman, and the FASs of Juba and Bahr El Ghazal Universities, temporarily located in Khartoum). Low salaries result in loss of talented staff and technicians.

Technicians and other support staff (laborers, clerks) are very few and are essentially involved in training activities (for example, FAUK has 0.23 technician/staff member, FASUG: 0.12).

Physical facilities in the Universities (buildings, libraries¹, laboratory equipment, computer facilities, farmlands, machinery, vehicles, etc.) are generally inadequate in quantity and quality (poor maintenance, no replacement), except for the farms (every FAS has one or two farms for demonstration/training and for production). Electricity and water supplies are irregular or lacking.

The FASs' national financial resources (roughly estimated at LS 1,400 million) are essentially government-funded, with few limited self-earned sources. They are mainly allocated to salaries and wages (around 60–70% in the older FASs; more in the new ones). External grants are limited (LS 200 million) and mainly allocated to AR activities. Operational/capital budgets are generally poor: they amount to LS 1 million or US\$ 630 per staff member (average), with a maximum of LS 1.5 million per staff member in the best endowed FASs. Lengthy administrative procedures hamper timely availability of supplies and materials.

Linkages with Scientific Institutions

Linkages between "old" and "new" FASs relate to education activities, and are generally developed on an individual basis. Linkages to the national AR institutes and extension services are moderate and informal. External (regional and international) relations with scientific institutions and funding agencies are rather poor.

Research in the Faculties (Taher/Hamdoun, 1996)

In general, University AR suffers from a number of major constraints and limitations, namely:

- Lack of research policy of the FASs;
- Promotion criteria for the staff members, too heavily based on their degrees (MS, PhD);
- Heavy teaching loads², which limit the staff members' availability for other activities;
- Inadequate research resources, reflecting the resource limitations presented above (lack of skilled technicians; poor physical facilities; decreasing, very limited and variable national and external funds for research);
- The weakness of the linkages with the national AR institutes.

Accordingly:

- AR is currently carried out mainly by young staff members and graduate students (with very limited direct involvement of the senior staff members);
- The actual percentage of human and financial resources allocated to AR activities is very low. The oldest FASs (affiliated to UK and UG) claim that their staff members dedicate 20–25% of their time to AR; however, their actual AR activities do not exceed 10% as reported in surveys done in 1995 and 1997. The other FASs (especially the 11 FASs established during the last 6 years) hardly conduct any AR at present;
- When research projects are implemented, their objectives are largely identified and chosen on a personal-interest basis and rarely according to the priority needs of the agricultural sector.

2.4 The Other Institutions of the NARS (see Table 3)

Most of the other institutions of the NARS are **scientific institutions**, namely:

¹ Only the library of the UK Faculty of Agriculture is relatively adequate, but is not equipped for taking full advantage of international data banks and information communication networks.

² In 1995, the number of students enrolled in the FASs was 9619 (49% of whom were females), which meant a ratio of students to teachers of 12:1; this ratio was 16:1 in the six FASs surveyed by Taher/Hamdoun (FAO, 1996). The current worst ratio is observed in FASUG (40:1 in 1998).

- The NCR Economic and Social Research Institute: This Institute, created in 1970, has 10 full-time researchers involved in research on the national policy and carry out studies that take into account the agricultural sector (which represents 40% of the GDP and employs 72% of the population), who roughly count for 5 pRYs;

- Some other university units: Most of the Faculties of Sciences and Economics of the Universities and some specialized units include staff members highly qualified in AR-related scientific fields (natural resources, plant and animal biology, agricultural engineering, food processing, rural social sciences), among which there are:

- The Department of Agricultural Engineering of the UK Faculty of Engineering, which has 10 academic staff members (3 PhD, 2 MS, 5 BS);
- The Institute of Environmental Study (IES) of UK: it offers postgraduate education on agricultural/rural, urban and industrial environmental issues; it has only 5 permanent scientific staff (3 PhD, 2 MS), but is supported by a rather large number of scientists (almost all are from UK). AR activities are mainly conducted as part of the PhD/MS thesis.

A precise inventory of the scientific potential concerned is not available, but according to a rough survey, it may total at least 40 academic staff members, who should represent 10 pRYs.

Within the category of other institutions there are also “**other non-scientific NARS institutions,**” among which is the Research Section of the Kenana Sugarcane Company. This unit has 13 researchers (5 PhD, 5 MS, 3 BS) specialized in breeding, agronomy, weed control, entomology, pathology and chemistry; it possesses good physical and financial resources, and maintains good complementary relations with the ARC sugarcane research station, also located at Kenana (5 researchers).

3. AR RESOURCES

3.1 Human Resources (see Table 1)

The NARS involves more than 1,300 graduate scientific and technical staff members, all nationals, who represent 590 pRYs. The AR institutes gather around 44% of this staff who have an academic education (26% with PhD, 54% with MS). This is lower than in the FASs (around 50% with PhD and 40% with MS), which have been meeting the large majority of the highest qualified staff of the NARS (66% of the PhD holders).

The graduate scientists of the NARS are highly concentrated in/around Khartoum and the Gezira (more than 50 and 20% of the total, respectively).

A brain drain of qualified scientists (15–20%) to outside the NARS (the private sector and NGOs or abroad) was quite evident in the last 20 years. It was attributed to the deterioration of the salaries (reduction by around 30–40% in actual terms over the last decade because of the national economic crisis and the devaluation of the LS) and their poor level (currently LS 200,000 or US\$ 130 per month for a PhD holder; US\$ 80 and 50 for MS and BS holders)¹.

ARC is the only NARS institution which employs a relatively good number of technicians (2 per researcher); most of the other institutions suffer a more severe deficit (ARRC: 0.13 per researcher; ENRRI: 0.6; FASs: 0.1; against the “norms” of 2–3 technicians per researcher in AR institutes). Qualified technicians are very much underpaid (US\$ 30/month), and opportunities for upgrading their education are limited. A similar situation is observed for the other support staff (laborers, clerks).

3.2 Physical Resources

The NARS is endowed with a large network of research stations and farms, which covers most of the agroecological zones. With a few exceptions (part of ARC; Hydraulic Research Station of Gezira; Research Section of the Kenana Sugarcane Company), the other physical resources (offices; farm buildings; laboratories; and scientific, computer, transport, and communication equipment) are insufficient and poorly maintained.

The central library of ARC and that of the UK Faculty of Agriculture are satisfactory. However, most the other NARS units and institutions lack documentation facilities.

¹ These salaries are much above the average annual per capita income in the country which amounted (1995) to US\$ 260 (according to the official exchange rate) and US\$ 1,100 in terms of “parity revenue” estimated by the World Bank (according to the cost of life). In addition to their salaries, most of the scientists are provided with either housing or housing allowance and often with transport; FAS scientists receive other incentives coming from extra academic load/teaching and supervision of postgraduate students.

3.3 Financial Resources (see [Table 1](#))

The national AR financial resources have been decreasing over the last years. In 1997, total funding (national and external) reached around LS 4,970 million (US\$ 3.1 million), of which 4,560 million (US\$ 2.9 million) came from national sources (the Ministry of Treasury and institutions' self-earned resources), and LS 410 million (US\$ 0.2 million) from external funds essentially secured through bilateral or multilateral grants provided by few donors. The NARS national and total resources represent around 0.09 and 0.10%, respectively, of the agricultural gross domestic product (AGDP, estimated at US\$ 3.1 billion in 1996). Such ratios are among the lowest in developing countries.

In all institutions, delays in fund liquidation are frequent, the budget is unstable, and may be reduced during the growing season. Areas of expenditure vary considerably between the institutions: salaries and allowances represent 37% of the national budget of ARC, around 50% at ARRC, and much more in the other scientific institutions (ENRRI, FASs). The funds allocated to operating and capital costs (OCC) are highly variable and range from LS 7.1 million (US\$ 4,470) per pRY at ARC, LS 3.6 million at ARRC, LS 2.6 million at ENRRI, and LS 1 million per academic staff member in the FASs. The total OCC for the NARS amounts (approximately) to LS 2,300 million (US\$ 1.45 million), i.e., less than LS 3.9 million (US\$ 2,500) per pRY, which is very low and much under the "optimal" amount of US\$ 25,000–30,000 per RY used in the long-term plans elaborated by many countries in similar agroecological conditions. According to this norm, the NARS should have between 49 and 59 actual RYs (aRYs), as opposed to 590 pRYs, which means that actually the AR scientific potential is very poorly mobilized. The number of aRYs should be slightly higher (around 60–70 aRYs) because of the recent investments in ARC (during the period 1990–95), but the deterioration of capital is expected to lead to a worse situation (and less aRY) in the near future.

4. RESEARCH ACTIVITIES

4.1 Research Orientation

There is a clear division of research mandates between the two major institutes (ARC and ARRC), but their lack of coordination with the other NARS institutions which cover similar fields (ENRRI, FASs, etc.) and the absence of a national body actually responsible for the national AR policy create overlapping in the research mandates and waste of resources and facilities.

The research agendas of most of the AR institutes aim, to a large extent, to develop technically feasible, economically viable, socially acceptable and environmentally favorable technologies. Research programs of ARC and ARRC consist of an appropriate mix of laboratory, on-station, and on-farm research. At ARC, participation of target groups, researchers and management is advocated in the research programs and priority setting; programs are formulated to achieve operational research objectives and overcome challenges facing agricultural production. However, in the AR institutes, collaborative, multidisciplinary research directed towards farming systems and socioeconomic research is still not developed enough; in only few research projects, execution encompasses active involvement of researchers, extension workers and farmers to validate research results and assess new technologies.

At ENRRI and the universities, the research agendas are generally developed regardless of resource optimization and environmental concerns in the production system. Their programs have limited emphasis on validation of on-farm research under farmers' conditions, and the technologies generated and transferred are in most cases irrelevant to resource-poor farmers, resulting in inefficient technology transfer and poor adoption rate.

4.2 National and International Linkages

National Linkages

Linkages between research leaders and high-level decision-makers are witnessed in the reciprocal representation at each other's governing bodies, technical committees, and faculty boards. Linkages between the AR institutes and the FASs are informal and concentrated in the involvement of a large number of researchers in teaching undergraduate and postgraduate courses and supervising MS and PhD programs; however, very few collaborative research programs are conducted. ARC and ARRC participate in the discussion and execution of NGO and private sector research.

ARC and ARRC have developed reasonable linkages with national development agencies, extension services, and farmers through their involvement in on-farm research, demonstration plots, field days, feasibility studies, production of seeds and vaccine, soil/water/feed analysis, and training of extensionists, field inspectors, and farmers. Moreover, they publish extension leaflets and provide information on technologies in mass media, workshops, seminars, and conferences. ENRRI and the FASs play a limited role in this respect. However, the impact of research on agricultural development is rather limited because of the very high concentration of scientists at/around Khartoum and the Gezira, the shortage of

funds, and lack of mobility; and also of the weakness of the extension services (endowed with poor human, physical and financial resources) and farmers' organizations.

International Linkages

In general, external cooperation is currently much less developed than in the past decades. Most of the NARS institutions are not receiving any scientific and financial international support. ARC has succeeded in preserving rather good linkages with some international AR centers, regional organizations, and donors (ICARDA, ICRISAT, AOAD, ASARECA, etc.).

5. CONCLUSION

The strength of the Sudanese NARS arises from its high number of well-trained scientists and technical support staff, reasonable infrastructure and research facilities, and wide coverage of its AR activities over the major agroecological zones. ARC and ARRC are also seen as vital investment of public and private funds that warrants political support and long-term stability of funds at levels corresponding with their mandates and mission, as well as with national development objectives.

However, the NARS is largely underutilized by the acute shortage of funds, which has led to the decline and underemployment of human resources, the erosion of the infrastructure, and the poor effectiveness of research execution, especially in the FASs which are not able to carry out the research components of their mandates and mission.

Opportunities for greater efficiency, sustainability and impact can be achieved through allocation of adequate and sustainable funding for modernization and maintenance of equipment and research facilities and training postgraduates. Efforts to achieve this are in progress through the commercialization of some of the research outcomes, e.g., breeder and foundation seeds, food processing technologies, vaccine production, research contracts, utilization of research farms, and funding research programs by production corporations, commercial companies, and farmer associations. Promotion of formal linkages between components of the NARS at all levels are also under way to ensure maximum utilization of the available resources. Efforts to form a coordinating body encompassing all research institutions have been initiated.

Main Acronyms

MAF: Ministry of Agriculture and Forestry. **MAR:** Ministry of Animal Resources. **MHESR:** Ministry of Higher Education and Scientific Research. **MI:** Ministry of Irrigation.

AHE: Agricultural higher education. **ARC:** Agricultural Research Corporation. **ARRC:** Animal Resources Research Corporation. **ENRRI:** Environment and Natural Resources Research Institute. **FASs:** Faculties of Agricultural Sciences. **NCR:** National Center for Research. **UG:** University of Gezira. **UK:** University of Khartoum. **VRLA:** Veterinary Research Laboratories Administration.

LS: Sudanese pound.

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Table 1 - The National Agricultural Research System (1997/98)

Italics: Approximate data. ...: Data not available. *: See footnotes.

No.	NARS Institutions			AR Scientific & Techn. Graduate Staff* (Units)		Potential Res. Years*	Total Budget (million LS)		AR Expenditures/Resources (E) (million LS)			
	Name – Acronym (Head Office - Year Established)		Mandates AR Fields	Govern. Ministry	Total		(PhD , MS)	Nat.	Ext.	Nat. E NE	For. E FE	Total E TE
a	b		c	d	e	f	g	h	i	j	k	l
2.1	Agricultural Research Corporation Wad Medani	ARC 1902, 67	AR 70% - (AD) All exc. livestock, fish	MAF	303	97 , 126	212	3,300	300	2,800	260	3,060
2.2	Animal Resources Research Corporation Khartoum	ARRC 1903, 96	AR 65% - (AD) Liv., fish, wildlife	MAR	225	50 , 155	146	2,000	0	1,100		1,100
2.3	NCR : 3 Research Institutes mainly involved in AR-related sciences, Khartoum*	ENRRI (92)	AR 60% - (AD) All	MHESR	32	3 , 20	19	220	0	180	0	290
		MAPRI (70)	AR 80% - (R/AD)		15	2 , 10	12	80	0	70	0	
		RSI (96)	AR 80% - R		8	1 , 5	6	50	0	40	0	
2.4	Hydraulic Research Station, Gezira	1975	AR 100% - Irrig.	MI	5	2 , 3	5	100	...	100	...	100
1/2	Total AR Institutes				588	153 , 316	400	5,750	300	4,290	260	4,550
3	Total 23 Faculties/Colleges of Ag. Sciences (see Table 2)	1938–1996	AHE - (AR) All	MHESR	680	340 , 200	170	1,400	200	150	150	300
4	Other NARS Institutions (see Section 2.4 and Table 3)			MHESR, ...	63	23 , 21	25	...	...	120	...	120
5	Total NARS				1331	516 , 537	595	...	...	4,560	410	4,970
Exchange Rate: LS 1,000 = US\$ 0.63 or US\$ 1 = LS 1,590 (1997 average official rate)					Actual Research Years (Estimate) (aRYs) →		60–70	AR Expend. (million US\$)		2.9	0.2	3.1

MAF: Ministry of Agriculture and Forestry. **MAR:** Ministry of Animal Resources. **MHESR:** Ministry of Higher Education and Scientific Research. **MI:** Ministry of Irrigation. **NCR:** National Center for Research. **2.3:** **ENRRI:** Environment and Natural Resources Research Institute. **MAPRI:** Research Institute Medicinal and Aromatic Plant Research Institute. **RSI:** Remote Sensing Institute (8 AR researchers out of the 10 researchers).

c: Mandates: **AR** (.. %): Approximate average % of human resources devoted to ag. research (**AR**); **R:** Research; **AHE:** Ag. higher education; **AD:** Ag. development/services (for AR and AHE institutes: seeds production, soil and water analysis, extension, studies, etc.). **h, j:** 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. **j:** For the AR institutes, AR financial resources have been roughly estimated through the following formula: Total budget × [ω + 0.5(100% - ω)], where ω is the % of time devoted to AR by the graduate staff.

* **Note:** All the graduate staff members are national.

National AR expenditures (NE): **0.09%** of the Agricultural Gross Domestic Product (AGDP: US\$ 3.1 billion in 1996). Total AR expenditures (TE): **0.10%** of the AGDP.

Table 2 - The Faculties and Colleges of “Agricultural Sciences” (1997/98)

Italics: Approximate data. ...: Data not available. *: See footnotes.

The Agricultural Sciences Faculties				Staff Members (All Nationals) Total - PhD, MS	
No.	University	Name (Head Office - Year Established)	Mandate		
1	Khartoum (UK)	Fac. of Agriculture (FAUK), Khartoum/Shambat 1938	BS-MS-PhD	111	77, 16
2		Fac. of Forestry, Khartoum/Shambat 1975	BS-MS-PhD	15	12, 3
3		Fac. of Animal Production, Khartoum/Shambat 1983	BS-MS-PhD	26	14, 5
4		Fac. of Veterinary Sciences (FVSUK), Khart./Shambat 1938	BS-MS-PhD	93	52, 19
5		Suakin Marine Biological Laboratory, Suakin 19...	MS-PhD	...	..., ...
6	Sudan Univ. Khart. (SUST)	Col. of Agricultural Studies, Khartoum/Shambat 1954	Diploma-BS	48	18, 20
7		Fac of Animal Production, Khartoum/Shambat 1984	BS-MS-PhD	...	..., ...
8	Gezira (UG)	Fac. of Agricultural Sciences, Wad Medani 1978	BS-MS-PhD	80	35, 25
9		Abu Haraz Fac. of Ag. & Natur. Resour., Wad Medani 1978	Diploma-BS	26	6, 20
10	Juba	Fac. of Natur. Resou. & Environ. Studies, Khartoum* 1977	BS-MS-PhD	75*	24, 28
A	Total "Old FASs"			474	238, 136
11	Khartoum (UK)	Fac. of Agriculture, Azhari University, Khartoum 1996	BS -...	...	..., ...
12	Bahr El Ghazal	Fac. of Veterinary Sciences, Khartoum* -	BS	11	..., ...
13	Omdurman	Fac. of Agriculture, Omdurman (Khartoum) 1994	BS	10	..., ...
14	Wadi-Nil	Col. of Agriculture, Dongola 1993	Diploma-BS	24	..., ...
15	Gezira (UG)	Col. of Animal Production, Managil 1993	BS	5	1, 4
16	Sennar	Fac of Agriculture, Abu Naama 1957 - 1994	BS	28	..., ...
17		Fac. of Agriculture & Natur. Resour., Sennar -	BS	7	..., ...
18	Kassala	Fac. of Agriculture & Natur. Resour., New Halfa -	BS	13	..., ...
19	Kordofan	Fac of Agriculture & Natur. Resour., El-Obied 1990	BS	28	..., ...
20	El-Facher	Fac. of Agriculture, El Fasher -	BS	9	..., ...
21		Fac. of Agriculture & Natur. Resour., Zalengi 1994	Diploma-BS	1	..., ...
22	Nyala	Fac. of Veterinary Sciences, Nyala -	BS	8	..., ...
23	Elsharq	Fac. of Oceanography and Fisheries -	BS - ...	...	..., ...
B	Total "New" FASs			144	..., ...
C	Total A + B			618	..., ...

Source: Data provided by the FASs (1998), El Taher/Hamdoun, FAO (lines 3, 9, 10), and Casas (1998).

*: 10 and 12: These 2 faculties are temporarily located in Khartoum.

Rough estimate of the number/qualification of the academic staff members of all the FASs: Around 680 members adding an estimated 40 members for the old FASs no. 5 and 7, and around 30 members for the new ones no. 11 and 23; with around 50% with PhD, 40% with MS and 10% with BS. These percentages are based on those observed in the “old faculties” since they are the most reliable and thus could be used as a basis for calculation in the “new faculties.”

Table 3 - Other Institutions of the NARS (1998)

Italics: Approximate data. ...: Data not available. *: See footnotes.

No.	Other NARS Institutions			Scientific & Technical Senior Staff (Units)		
	Name (Head Office - Year Established)		Mandates	Total	- PhD, MS	AR pRYs*
1	Economic and Social Research Institute, NCR, Khartoum 1970		R (AR)	10	2, 5	5
2	Depart. of Ag. Engineering/Fac of Engineering, U. Khartoum 1981		HE (R-AR)	10	3, 2	10
3	Institute of Environmental Study, U. Khartoum 1979		HE (R-AR)	5	3, 2	
4	Other University Institutions (see Section 2.4)		HE (R-AR)	25	10, 7*	
A	Other NARS Scientific Institutions			50	18, 16	15
B	Research Section of the Kenana Sugarcane Company, Kenana ...		AD (AR)	13	5, 5	10
C	Total A + B			63	23, 21	25

*AR pRYs: potential RYs involved in agricultural research.

4: Estimation is based on considering these institutions to have the same % of PhD and MS holders as the university institutions no. 2 and 3.