9. NARS IN THE WANA REGION: AN OVERVIEW AND A CROSS-COUNTRY ANALYSIS[1]

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The analysis in this chapter is based mainly on the monographs of the 18 NARSs of the WANA region, presented in Chapters 4 to 8, and the methodology used for their preparation (Chapter 3). After a brief introductory section related to the historical background of agricultural sciences and agricultural research (AR) in the region, the chapter stresses successively on the structure of the NARSs and their resources, with cross-country comparisons of their human and financial resources, then their research activities and relations with development.

9.1 HISTORICAL BACKGROUND

9.1.1 Distant History

"Agriculture has never been discovered nor invented" (Harlan); it resulted from a very long evolutionary process which began during the Neolithic era in several *Homo sapiens* groups or societies. For millennia, technical advances have resulted from the observation sense and from the imagination and creativity of farmers, raisers and craftsmen. Very early on, agricultural and livestock practices have included selection of crop and animal species and races; over generations, techniques of cultivation, irrigation, fertilization, animal selection and husbandry, transport, etc. have slowly improved. Farmers, raisers and peasant communities, who lived largely in autarchy, were at the same time centers of genesis and adoption of technical innovations.

The Near East is considered among the most ancient (10000 to 9000 BC) and among the richest of agricultural centers of origin (origin of wheat, barley, lentils, goats, sheep, donkeys, etc.)[1].

In this region, Egypt is the country with the most ancient and developed agriculture. Cereals (barley, wheat, black millet: '*durra*') were cultivated in 8000 BC; oxen were raised even earlier (coming probably from the African origin centers). Agriculture was well organized as early as 6000 BC. Throughout the pharaonic dynasties (around 3000 to 330 BC), "farmers invented and/or improved various agricultural tools and implements (hoe, reaper, yoke, draw-well, now called *shaduf*, etc.); dug canals and founded dykes and dams; reclaimed lands; knew 'surveys' as a science to draw maps for agricultural lands and ownership; and gave special attention to animal medical treatment, fattening and selection" (Erman A.). Dignitaries used to have gardens and nurseries of flowers, medicinal plants, and incense around their houses. Importing exotic plants, trees, and animals from other countries for local adaptation and crosses was frequent. Few and fragmented contemporaneous Egyptian texts are available on agriculture during that time; however, many wall paintings in tombs and monuments and very old objects[2] testify its development, as well as some Greek texts written before or after the conquest of the country by Alexander (Manniche L.)[3].

Later, Assyria (1900 to 539 BC: conquest by Darius) and Persia (625 to 330 BC: conquest by Alexander) had also known a highly flourishing agricultural era, as proven by the richness of *The Assyrian Herbal*[4] and by the numerous Persian names of plants and trees preserved later by the Arabs.

The Greek civilization may have received its agricultural knowledge mainly from Egypt. Testimonies of the level of this civilization are found in books written by Theophrastus, Kastos, and other authors[5].

A rather large amount of literature exists on agriculture of the Romans after they took over the Greeks. The best-known authors and erudites during that time are the Latin agronomists Caton (2nd Century BC), Varro (1st Century BC)[1], Columelle (1st Century AD)[2], Palladius, and Vegece.

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[1] Among the other main centers are New Guinea (10000 BC; taro and pigs), China (8500 BC; millet, cabbage, hens, pigs, oxen, etc.), Central America (9000–4000 BC; corn, beans, tomatoes, cotton, turkey, geese, etc.), South America (6000 BC; potatoes, quinoa, lama, etc.), and others.

[2] The Ancient Egyptian Agricultural Museum in Giza, Egypt, gathers the largest agricultural antiquity collection in the world, including plants, animals, tools, implements, materials/cloths, etc.

[3] Among them are Herodotus (5th Century BC), Theophrastus (4th Century BC), and Dioscorides (1st Century AD).

[4] Campbell Thompson R. published his books *The Assyrian Herbal* (1924) and *Dictionary of Assyrian Botany* (1949), based on the material available at the time (cuneiform tablets), dating to the end of the Second Millennium BC, with reference to some Sumerian texts from the Third and Second Millennia (see Manniche L).

[5] Theophrastus: *Historia Plantarium et Causis Plantarium* (470 BC), a treatise of crop physiology and cultivation considered as rather remarkable for that time; Kastos: *The Book on Greek Agriculture* (*Kitab-al-felahah-ar roumiah*) (Clément Mullet).

Ancient India has played a crucial role in agricultural development in the region (and also in Eurasia and Africa). A large number of crops of diverse origin (China, Southeast Asia, East Africa, etc.) passed through India where they were often "ennobled," then moved to the pre-Islamic world. These transfers began early in the Second Millennium BC, gaining momentum during the First Millennium BC and continuing into the early centuries of the Christian era and even later, after the Arab conquest of the province of the Sind (711 AD) (Watson).

After the rise and spread of Islam and the conquest of Persia (7th Century), there was much movement of men, goods, technology, information, and ideas (including movement for pilgrimages to Mecca). After a very short time, most regions of the Islamic world showed an astonishing mixture of people.

Arab rulers played a leading role in the advancement of agriculture and many other domains. They often competed with one another in patronizing learning, building palaces, and planting gardens. "Caliph residences and palaces often served as botanical gardens or experimental stations for setting and improving efficient agricultural techniques" (El Amami, in Ibn Al Awam, preface). Early caliphs in Baghdad and then Islamic rulers elsewhere were nearly all bibliophiles[3]. They collected books on a grand scale, sponsored ambitious programs of translation (from Greek, Syriac, Persian, Sanskrit, and Hindi). Amongst the books translated were a good number on agriculture and botany (Watson).

Available sources may have emphasized the role of these rulers, however, other agents were certainly very active. Muslim merchants, who had established merchant markets in all the caliphates and in other countries (India, China and East Africa), associating trade and missionary activities, used also to import plants and animals. Simple soldiers and peasants (Indians, Persians, Yemenis, Syrians, etc.), who migrated westward, may have carried not only these new plants but also the crucial techniques of growing them. Like men of religion, scholars—including many authors of Arabic manuals on farming, botany, and pharmacy—also traveled widely to study and teach (Watson).

Arab literature related to agriculture is abundant, with some authors well famed as Ibn Wahschiah (*Nabathean Agriculture*), Abou-Hanifah Al Dinouri (903 AD, from Dinour, a Persian town), Ben-Baçal (Abou-Abd-Allah-al-Andalisi, 1070), Hadj-Ahmed from Grenade (1160), and above all Ibn Al Awam (12th Century), an authentic scientist sponsored by the Caliph of Sevilla/Spain, author of *The Book of Agriculture* (12th Century), which is an updated collection of the agricultural sciences and practices accumulated in the Mediterranean region during that time[4].

It is worth noting the prestige and fame of the farmers of Spain, especially of Andalousia, considered as the best at the time of the Arab apogee[5]. North African agriculture, previously rather isolated from the main advances reached in the Near East, benefited from this proximity and registered significant developments[6].

With the Arab decadence and then the growth (14th to 17th Centuries) and decline (from the 18th Century to the First World War) of the Ottoman Empire, it seems that agriculture in the WANA region was subjected to relative stagnation. At that time, European countries started their economic development, which was marked by progressive industrialization, urbanization, labor division, and intensification of international circulation of products and ideas. There, industrial growth and social changes or revolutions launched at the end of the 18th Century further determined major changes in agriculture. Chemical and metallurgical companies originated the use of mineral fertilizers and more efficient plowing and harvesting tools; and the first agricultural schools and experimental farms were created by states and farmers' organizations. In the 20th Century, a path in Europe and North America largely opened to the scientific revolution, which was accelerated after the Second World War in the developed countries. In these countries, agricultural innovations came mainly from research and research–development specialized units set up by public scientific institutions (particularly agricultural research institutes and faculties of agricultural sciences), agro-industrial enterprises (public and private, national and international), and farmers' large associations.

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[1] Marcus Terentius Varro, a very prolific author, wrote 74 books on diverse fields, one of which was on agriculture (*Rural Economy*: *Rerum Rusticarum Libri*); he also built the first libraries in Rome during the Cesar empire.

[2] Lucius Junius Columelle, a Roman born in Cadix, Spain, is the author of the *Treatise of Agriculture* (*De ce rustica*), which is very precise and rich book, considered as the most complete on Roman agriculture (12 volumes).

[3] The Fatimid caliph of Egypt, Al-Aziz (dead in 996), had a library which contained between 120,000 and 160,000 volumes. By the time of Al-Hakam II (961–976), the royal library in Cordoba, Spain, contained some 400,000 volumes.

[4] El Amami (in Ibn Al Awam, preface) mentions that this erudite remained almost ignored in the Arab countries and scientific communities; only the scientific publication *Al Awamia* of the Moroccan INRA brings his name.

[5] By Ibn-Khaldun (1332–1412) in *El-Muquaddima. Discours sur l'histoire universelle* (see Bessaoud).

[6] Bessaoud testifies this stand, quoting some Arab geographers who gave a precise description of the countryside, farming systems, and urban food markets in the Maghreb region (Hassan El-Wazan, called Leon the African, 977; Al Bekri, 1068; Al Idrisi, 1150; etc.).

9.1.2 Recent Evolution

The evolution of developing countries began much later in the WANA region, except in Turkey and Egypt, countries which were fully or partly independent during the 19th Century. Graduate agricultural schools were opened in Istanbul in 1842 and 1881 (for veterinary medicine and agriculture, respectively) and in 1869 in Cairo. In Egypt, the first Directorate of Agriculture was created in 1875 and the Egyptian Royal Academy supported the establishment of some experimental farms in 1897. Also, at the end of the 19th Century, the first public agricultural institutions were established under the French rule in Tunisia (Animal Production Service in 1887, Colonial School of Agriculture in 1889) and in Algeria (*Institut Agronomique d'Alger*, for technician training, in 1898).

In the first half of the 20th Century (till the end of the Second World War in 1945), initiatives were much more numerous, particularly in the largest countries.

- In Egypt, under the British mandate (until 1922), these initiatives included the establishment of the Ministry of Agriculture (1913), the Cotton Research Council (1919), and 10 specialized research stations or laboratories considered as the origins of 10 AR institutes (ARI) governed by the present huge ARC. After independence in 1922, the new institutions were the Alexandria (research) Institute of Hydrobiology (1927), the father of the existing NIOF[1], and the Faculties of Agriculture and Veterinary Medicine of Cairo (1935).
- In Turkey, only two veterinary research centers were established in 1914 and 1921. After the establishment of the Republic in 1925, attention to agricultural sciences was remarkable (15 ARIs were founded all around the country and one graduate agricultural school at Ankara).
- Iran advanced quickly, under Razi Shah government (1925–1941), with the establishment of the Razi Serum Research and Production Institute (1925, still operating), the Agriculture College, Karaj (1926), the College of Veterinary Medicine, Tehran (1933), and three ARIs specialized in animal production, sugar beet, and tobacco (from 1933 to 1937).

Among the countries under the rule of European countries, attention to agricultural sciences varied according to colonial and colonized countries, with a generally higher preference by the former to export commodities.

- Among countries under British rule, Sudan received a preferential treatment (due to its high agricultural potential) concretized by the creation of, first, some cotton experimental farms (1902–1903) and the Central Veterinary Research Laboratory (1903); then the Gezira Research Station (1918), which became the headquarters of the AR Service (1931) and of the current ARC; and the Schools of Agriculture and Veterinary Medicine at Shambat/Khartoum (1938). In other countries, it is worth to mention the establishment of some experimental farms in Iraq, Bahrain and the United Arab Emirates, respectively in the 1920s, 1930s, and 1940.
- Among the francophone countries, Morocco acquired the *Jardin d'Essai* (botanical garden) of Rabat (1916), which currently hosts INRA headquarters; a research station for forestry (1934); and the graduate National Agricultural School of Meknès (1940, almost reserved for French farmers' sons). In Tunisia, the *Service Botanique* of Tunis (1913), the father of the existing INRAT, hosted a good number of well-known French agronomists working also for Algeria, where a few agricultural stations were established during that period. In Syria, there were only a few experimental farms around Damascus established in the last years of the French mandate (1946).
- Contribution of Italy to agricultural development (of Italian colonies) was limited to a few experimental stations in Libya (Centro sperimentale agrario e zootechnico della Libya, near Tripoli) and Eritrea.

The period 1945–1989 was the apogee of development of the NARSs in the WANA region, marked by the creation of most of the existing present institutions.

The largest countries kept their lead. In Egypt, 20 ARIs out of the 24 run by ARC were created, most of them through restructuring of already existing AR units, and ARC was established in 1983 for coordinating these institutes. Other main NARS institutions were created, such as the Desert Research Center (1950) and the National Research Center (1956); and 20 new faculties of agricultural sciences (FASs, including faculties of agriculture and faculties of veterinary medicine) were founded in the country (11 in 1950–1963 and 9 in 1964–1989). In Turkey, the period saw the creation of 47 ARIs and more than 40 FASs. In Iran, this period was also highly prolific, both under the Shah's rule (7 new ARIs, 15 new colleges) and after the proclamation of the Islamic Republic in 1979 (4 ARIs and 7 FASs), with an obvious priority given to higher education.

[1] See the acronyms of the still-existing national NARS institutions at the end of the chapter.

Some medium-size countries also registered such relative prolificacy. After independence in Algeria (1962), AR was conducted at INRAA (1966), then at 12 specialized development–research institutes, and 11 FASs were created. In Tunisia (independent in 1956), INRAT took over an existing AR unit in 1961, and 10 other agricultural scientific institutions were founded (2 ARIs and 8 FASs). In Syria, 6 directorates affiliated to the Ministry of Agriculture, mainly involved in AR activities, were established during the period 1952–1977 (including the largest one: DASR, 1964), and the creation of the FASs of Aleppo and Damascus (1960) was followed by that of 3 other FASs.

Other medium-size countries made other choices. In Morocco (independent in 1956), INRA took over the existing AR Service in 1962, and the Agriculture and Veterinary Institute (IAV Hassan II/Rabat), a graduate education institution, was established in 1966. In Sudan, AR remained centered mainly at ARC, and 7 new FASs were created. Iraq followed a rather similar path, with a main ARI (SBAR, 1980), and 2 colleges of agriculture and veterinary medicine opened by the University of Baghdad in 1952 and, later, 3 other FASs. In Yemen, South and North had their own AR stations and FASs (Aden, 1975; Sana'a, 1984) till they merged into one country (1990).

Small countries developed their NARSs during this period. Libya (independent in 1951) started with the FAS of Tripoli (1966), ARC (1970), and then 3 new FASs. The Jordanian NARS began with some research stations managed by a directorate in charge of research and extension, taken over in 1985 by NCARTT, the current dominant national ARI; in addition to 2 FASs established by the Universities of Amman and Irbid (1970, 1986). Lebanon opened its first AR station in Tel Amara in 1946 with French support, which became LARI in 1964; while 4 FASs were established, the first by the American University of Beirut in 1952, with its Agricultural Research and Education Center (AREC) in the Bekaa Valley. In Bahrain (independent in 1971) and the United Arab Emirates (UAE) (established in the same year), AR was undertaken mainly by the existing stations and by ministry directorates; and one FAS was created by the UAE University in 1980.

The last 10 years (1990–1999) were dedicated to restructuring in the largest countries. In Egypt, ARC received for its modernization very large support from the Government and USAID (mainly a grant of US$ 205 million for 10 years), and 4 new FASs were added. In Iran, most of the numerous ARIs (including 13 new ones) were affiliated to two large organizations under the Ministries of Agriculture (AREEO under MOA) and Jihad Construction (MOJC), and no new FASs were created. In Turkey, 6 new ARIs were established but most of the numerous ARIs were regrouped under the General Directorates of AR (GDAR) and of Rural Services (GDRS), and 9 new FASs are being established. Ethiopia decided in 1997 to merge its ARIs into one organization, EARO, responsible for the national AR policy.

In the medium-size countries (Algeria, Iraq, Syria), there were few changes. In Morocco, it was a time of consolidation and growth of the existing NARS institutions. In Tunisia, the Ministry of Agriculture established IRESA as responsible for its research and higher education policy. In Yemen, one single ARI, AREA, was created for all the country, and two new FASs were added.

In the small countries, the addition of three new FASs in Jordan is worth mentioning. In Eritrea (independent in 1991), one college of agriculture (CAAS, 1992) and one directorate in charge of AR (DART, 1992, named as DAHRD in 1997) were established.

9.2 THE CURRENT NARS STRUCTURE

The analysis of the current structure of the NARSs is concerned with the relative importance of the three categories of NARS institutions, the degree of fragmentation/concentration of the NARSs—a concept related with the nature, number and size of institutions making up the NARSs—and the degree of integration of the NARSs, related with the national AR governing organizations.

9.2.1 Relative Importance of the Main Categories of NARS Institutions

Table 1 on the relative importance of the three main categories of scientific and technical institutions (STIs) of the NARSs shows:

- The major role of the ARIs which mobilize (on average for all the WANA region) around 62% of the total potential research years (pRYs or full-time researchers) and 78% of the total financial resources (see Sections 9.3.1 and 9.3.2).
- The relative importance of the scientific potential of the FASs (23% of the total pRYs) and their limited financial capacity (7% of the total financial resources). However, in many countries, a good number of academic staff members are working in research programs implemented by ARIs and other NARS institutions, taking advantage of the financial resources of those institutions.
- The considerable contribution of the other NARS institutions (around 15% of the total pRYs and total financial resources) which, no doubt (as said before), is slightly underestimated.

Table 1 - Structure of the WANA NARSs: Categories of Institutions (1996–1998)

ARIs: AR Institutions. FASs: Faculties of Agricultural Sciences. OIs: Other institutions.
*: Total without the NARSs of Iraq and the United Arab Emirates (no available data on their financial resources).

	Country/ Sub-Region	AR Potential Research Years (pRY)				AR Expenditures (E)			
		Total NARS (units)	Breakdown per category of institutions (% of total)			Total NARS (US$ million)	Breakdown per category of institutions (% of total)		
			ARIs	FASs	OIs		ARIs	FASs	OIs
1	Algeria[a]	575	7	27	66	13.7	13	21	66
2	Libya	261	50	38	12	13.1	73	9	18
3	Morocco	606	64	18	18	40.3	63	12	25
4	Tunisia	368	61	25	14	15	72	15	13
A	**North Africa**	**1813**	**43**	**25**	**32**	**82.1**	**58**	**14**	**28**
5	Egypt	6710	57	22	21	67.6	77	6	17
6	Eritrea	61	77	23		1.8	78	22	
7	Ethiopia	475	86	14	-[b]	8.3	97	3	-[b]
8	Sudan	595	67	29	4	3.1	92	6	2
B	**Nile Valley/Red Sea**	**7841**	**59**	**22**	**19**	**80.8**	**80**	**6**	**10**
9	Cyprus	40	100			5.5	100		
10	Iraq	770	32	49	19	…	…	…	…
11	Jordan	198	67	25	8	6.1	79	18	3
12	Lebanon	83	65	28	7	3.8	88	11	1
13	Syria	1058	66	19	15	15.3	70	5	25
C	**West Asia**	**2149**	**55**	**30**	**15**	**30.7***	**79***	**8***	**13***
14	Iran	3610	87	11	2[b]	98.7	93	5	2[b]
15	Turkey	2288	52	37	11	110.7	78	4	18
D	**Highlands**	**5898**	**73**	**21**	**6**	**209.4**	**86**	**4**	**10**
16	Bahrain	32	66		34	3.2	73		27
17	United Arab Emirates	73	77	18	5	…	…	…	…
18	Yemen	245	76	16	8[b]	6.1	70	4	26[b]
E	**Arabian Peninsula**	**350**	**75**	**15**	**10**	**9.3***	**71***	**17***	**12***
F	**Total WANA**	**18051**	**62**	**23**	**15**	**412.3***	**78***	**7***	**15***

a: Algeria: approximate data. **b**: Ethiopia, Iran, and Yemen: Resources of OIs are most likely underestimated.

Source: Ratios calculated from Tables 5 and 9.

These global features are valid in most of the countries with few noticeable exceptions: Cyprus is the single country having only one institution (an ARI), while Eritrea and Bahrain have no "other institutions" (OIs) and FASs, respectively. Iraq is remarkable for the very large importance of the FAS human resources (49% of the pRYs). Algeria is the only country in the region with relatively strong ARIs: the most important NARS institutions are agricultural "development–research institutes" which allocate a prominent part of their resources to development and service activities (seed production, extension, soil analysis, etc.) and are therefore classified as OIs. In Morocco, Tunisia and Jordan, FASs enjoy relatively better financial resources than in the other countries.

9.2.2 Degree of Concentration/Fragmentation of the NARSs

A NARS is considered to be concentrated when it is comprised of a number (small or large) of large scientific and technical institutions (STIs) and, on the other hand, fragmented when it is made up of a large number of small STIs; the magnitude of both number and size is relative to the size of the NARS itself.

The appreciation of the degree of concentration/fragmentation of a NARS relies on the assessment of the nature, number, and size of institutions making up the NARS[1]. Table 2 gives an idea of this degree through the relative importance of the financial resources of the two largest STIs of each NARS[2]; which leads to a conventional classification of the NARSs into five categories:

- "Very highly concentrated" NARS: Cyprus, Ethiopia and Lebanon, where the two largest STIs mobilize more than 88% of the NARS financial resources.
- "Very highly fragmented" NARS: Algeria, where this percentage is only 15%.
- "Highly concentrated," "rather concentrated," or "rather fragmented" NARS, where the largest or the two largest STIs mobilize intermediate percentages of the NARS financial resources.

This initial classification does not imply a categorical judgment of the NARS structure. At this stage, it may be worth mentioning the disadvantages often met in fragmented NARSs, such as: competition between STIs for allocation of human, physical, and financial resources; high costs implied by the multiplicity of directorates and services, experimental farms, libraries, etc.; overlapping or gaps in research programs; and relative isolation of scientists in small STIs. But a country with a NARS with efficient governing bodies and good communication/information services could overcome these weaknesses and exploit the acknowledged benefits of small institutions, i.e., easier management; greater dynamism; proximity to users for STIs having a specific or commodity mandate; etc. We will now see that this is not the case throughout the WANA region.

9.2.3 Degree of Integration of the NARSs

The degree of integration of a NARS refers to the capacity of the political and administrative authorities concerned to define and implement through the NARS STIs a national AR policy adapted to the social demands/needs and to the national and external resources available. According to this definition, the following is a discussion of the nature of these authorities and the consistence of their relations with the STIs.

Authorities Responsible for the National Scientific Research Policies and National AR Policies (Table 3)

The nature of the authorities responsible for national research and AR policies (formulation of the policies; main decision making related with resource allocation, STI structure and operation; etc.) is highly variable in the WANA region. Despite changes taking place throughout the years—as a result of changes of government or ministerial appointments—the current nature of these authorities is highly significant in terms of their way of managing the NARSs and their STIs.

[1] For some NARSs endowed with "multi-organizational" ARIs (such as IRESA in Tunisia, ARC in Egypt, etc.), the major issue related with this degree of concentration/fragmentation is the assessment of the nature of these ARIs and the actual status of the institutes within them (degree of autonomy: see Chapter 3, Section 3.2.2).

[2] As seen in Table 2, the largest STI is an ARI in all countries, and the second largest is also an ARI for half of the countries, an FAS in six countries, and an OI in one country (Egypt).

Table 2 - Structure of the WANA NARSs: Relative Size of the NARS Institutions (1996–1998)

a: ARI: AR Institute; ARI°: ARI which governs a relatively large number of ARIs with limited autonomy (see notes); FAS: Faculty of Agricultural Sciences; OI: Other institution.
b: Degree of NARS concentration: VH: very high; H: high; m: medium; L: low; VL: very low. **c**: Total without the NARSs of Iraq and UAE (no available data on their financial resources).

Country/ Sub-Region	Total AR Potential Res. Years (pRYs)	Total AR Expend. (TE: US$ million)	Number Ag. Sc. Institutions		A. Largest NARS Institution							B. Second Largest NARS Institution							A + B: % total		Degree of NARS Concentration[b]				
			Auton. ARIs[a]	FASs[a]	Acronym	Status[a]		pRYs		TE		Acronym	Status[a]		pRYs		TE								
								Units	%	US$ mil	%				Units	%	US$ mil	%	pRYs	TE	VH	H	M	L	VL
1 Algeria[d]	575	13.7	2	15	INRA	ARI	Auto.	32	*6*	1.5	*11*	ENASA	FAS	Auto.	40	*7*	0.5	*4*	*13*	*15*					VL
2 Libya	264	13.1	3	7	ARC	ARI	Auto.	112	*42*	7.9	*60*	ASRC	ARI	Auto.	13	*5*	1	*8*	*47*	*68*		H			
3 Morocco[e]	606	40.3	4	3	INRA	ARI	Auto.	270	*45*	18	*45*	INRH	ARI	Auto.	70	*12*	4.7	*12*	*57*	*57*			M		
4 Tunisia[f]	368	15	6	8	INRA	ARI	S/auto.	73	*20*	3.8	*25*	IRA	ARI	Auto.	37	*10*	2.2	*15*	*30*	*40*				L	
A North Africa	**1813**	**82.1**	**15**	**33**				**487**	***27***	**31.2**	***38***				**160**	***9***	**8.4**	***10***	***36***	***48***					
5 Egypt[g]	6710	67.6	3	26	ARC°	ARI	Auto.	3140	*47*	42	*62*	NRC	OI	Auto.	950	*14*	8	*12*	*61*	*74*		H			
6 Eritrea	61	1.8	2	1	DARHRD	ARI	S/auto.	27	*44*	1.1	*60*	CAAS	FAS	S/auto.	14	*23*	0.4	*22*	*67*	*83*		H			
7 Ethiopia[h]	475	8.3	9	5	EARO°	ARI	Auto.	306	*64*	6.6	*80*	RARCs	ARI	Adm.	105	*22*	1.4	*17*	*87*	*97*	VH				
8 Sudan	595	3.1	3	23	ARC	ARI	Auto.	212	*36*	1.9	*62*	ARRC	ARI	Auto.	146	*25*	0.7	*22.1*	*70*	*84*		H			
B Nile Val./R. Sea	**7841**	**80.8**	**17**	**55**				**3685**	***47***	**51.6**	***64***				**1215**	***16***	**10.5**	***13***	***63***						
9 Cyprus	40	5.5	1		ARI/C	ARI	Auto.	40	*100*	5.5	*100*								*100*	*100*	VH				
10 Iraq[i]	770	…	2	8	SBAR	ARI	Auto.	200	*26*	…	...	CA/Bagd.	FAS	S/auto.	127	*17*	…	...	*43*	...			M		
11 Jordan	198	6.1	3	5	NCARTT	ARI	Auto.	121	*61*	4	*66*	FA/Amm.	FAS	S/auto.	20	*10*	0.6	*10*	*71*	*76*		H			
12 Lebanon	83	3.8	2	4	LARI	ARI	Auto.	44	*53*	3.2	*85*	NCMS	ARI	S/auto.	10	*12*	0.1	*3*	*65*	*88*	VH				
13 Syria	1058	15.3	7	6	DASR	ARI	Adm.	378	*36*	5.1	*33*	DS	ARI	Adm.	129	*20*	2.7	*19*	*56*	*55*			M		
C West Asia	**2149**	**30.7**	**15**	**23**				**783**	***37***	**17.8**[c]	*58*[c]				**286**	***13***	**3.4**[c]	***11***[c]	***50***	*69*[b]					
14 Iran[j]	3610	98.7	2	24	R/MOJC°	ARI	Auto.	1576	*44*	47	*48*	AREEO	ARI	Auto.	1399	*39*	38	*39*	*83*	*86*		H			
15 Turkey[k]	2288	110.7	4	52	GDAR°	ARI	Adm.	881	*39*	60.9	*55*	GDRS	ARI	Adm.	143	*7*	17.1	*17*	*46*	*72*		H			
D Highlands	**5898**	**209.4**	**6**	**76**				**2457**	***42***	**107.9**	***52***				**1542**	***26***	**55.1**	***26***	***68***	***78***					
16 Bahrain	32	3.2	2		ARD	ARI	Adm.	11	*35*	1.5	*47*	FD	ARI	Adm.	10	*31*	0.8	*26*	*66*	*73*		H			
17 UA Emirates	73	…	5	1	ARD	ARI	Adm	34	*46*	…	...	FAS	FAS	S/auto.	13	*18*	…	…	*64*	…			M		
18 Yemen	245	6.1	2	4	AREA	ARI	S/auto.	164	*67*	4.2	*68*	FAUA	FAS	S/auto.	19	*8*	0.2	*3*	*75*	*71*		H			
E Arab. Penins.	**350**	**9.3**	**9**	**5**				**209**	***60***	**5.7**[c]	***61***[c]				**29**	***11***	**1**[c]	***11***[c]	***74***	***72***[b]					
F Total WANA	**18051**	**412.3**	**62**	**192**				**7621**	***42***	**214.2**[c]	*52*[c]				**3252**	***18***	**81.4**[c]	***20***[c]	***60***	***72***[b]					

d: Algeria: Approximate data. **e.** Morocco: IAV, a FAS with 79 pRYs and US$ 4.3 million for AR, has around the same AR resources as INRH. **f**: Tunisia: IRESA oversees 4 ARIs and 9 FASs (222 pRYs and US$ 7.7 million, i.e., 60% of the pRYs and 51% of the financial resources of the NARS), each one with rather large autonomy. **g**: Egypt: ARC has 24 ARIs and Central Labs. **h**: Ethiopia: EARO has merged 7 ARIs in 1998. **i**: Iraq: Ag. and biological centers of the Iraqi Atomic Energy Center (around 100 pRYs) may have much larger financial resources than the Baghdad College of Ag.; these centers and SBAAR may be mobilizing more than 60 or 70% of the NARS financial resources **j**: Iran: 7 ARIs governed by the MOJC Research Directorate, and 12 ARIs governed by AREEO. **k**: Turkey: GDAR and GDRS have 55 and 11 ARIs, respectively.

Table 3 - Structure of the WANA NARSs: Degree of Integration

Country	National Authorities Responsible for Research Policy					National Authorities Responsible for AR Policy (Coordinating body: CB)								Relations among Main ARIs[c]			Relations ARIs – FASs[d]			NARS Coverage of Regions in the Country[e]			Degree of Integration		
	Nature		Impact on AR policy			The nat. research authority (= a or b)	One specific NARS CB	CB within Min. of Agric.		CB betw. Ministries or STIs	Formal CB power at NARS level														
	Specialized Body[a]	Ministry HER[b]	High	Mode-rate	Weak			Specific CB	ARI		High	Mod-rate	Weak	Good	Mode-rate	Weak	Good	Mode-rate	Weak	Well balanc.	Moder. balanc.	Very unbal.	High	Mode-rate	Weak
Algeria		MESRS		x				DFRV				x			x			x				x			x
Libya	NASR				x	NASR						x			x			x			x				x
Morocco		MESRS			x			DERD				x			x		x				x			x	
Tunisia	SERST			x		SERST		IRESA			x			x				x				x		x	
Egypt	MSRT				x		NARC					x		x				x				x			x
Eritrea	No	No								x	x			2 ARIs (ag+fish)			x			x			x		
Ethiopia	No	No							EARO		x			EARO larg. domin.				x		x			x		
Sudan		MHESR			x				ARC			x			x			x				x			x
Cyprus	No	No							ARI		1 ARI alone			1 ARI alone			No FAS				x		x		
Iraq		MHESR			x	MHESR			SBAAR			x		x				x		x				x	
Jordan	HCST				x				NCARTT			x			x		x				x			x	
Lebanon	NCSR			x		NCSR			LARI			x		2 ARIs (ag+fish)			x				x			x	
Syria	SCS				x	SCS						x			x			x		x					x
Turkey	STRCT				x	STRCT			GDAR			x			x			x			x			x	
Iran	NCSR			x		NCSR						x			x		x				x			x	
Bahrain	BCSR				x	BCSR						x		2 ARIs (ag+fish)			No FAS				x?				x
UA Emirates	MHESR			x		MHESR				x		x			x			x			x?				x
Yemen	No								AREA			x		2 ARIs (ag+fish)				x				x			x

a: Specialized governmental body (ministry, council, etc.). **b**: Ministry of Higher Education and Research. **c**: Concrete AR relations (joint programs and resources) among ARIs involved in the same large fields (agriculture or fisheries). **d**: Concrete AR relations between ARIs and FASs. **e**: NARS coverage of the large agroecological zones of the country (with permanent qualified staff and physical resources allocated in these zones), with three scales: well balanced, moderately balanced and very unbalanced.

Authorities Responsible for the National Scientific Research Policies

At present, some countries have a ministerial authority specifically (and only) in charge of research (and technology), these are: Egypt, which has a ministry, and Bahrain, Iran, Jordan, Lebanon, Libya, Syria, Tunisia, and Turkey, which have a specific national authority generally directly affiliated to the Prime Minister[1]. The role of these ministerial authorities is decisive in terms of some general aspects affecting all research institutions (statutes/rules of the institutions, nominations of their leaders jointly with the concerned governing ministries, career scheme and salaries of researchers and other staff, etc.). Regarding the AR policy, the role of these authorities is:

- relatively strong in Iran, Lebanon, and Tunisia: in these countries, the ministerial authorities have set up one or several AR commissions, generally composed of representatives of the ministries and main STIs concerned, which play an effective role in the formulation of the national AR policies and fund allocation; in addition, they are directly involved in the NARS as a governing authority of some NARS STIs (Tunisia and Lebanon);
- rather weak in Bahrain, Egypt, and Turkey (limited role in the formulation of national AR policies; no financial resources).

In a few countries (Algeria, Iraq, Morocco, Sudan, and UAE), ministries of higher education and research are in charge of research, often through a specific directorate or unit. Generally, the power of these ministries is effective only over the NARS STIs working under their umbrella (most of the FASs[2] and sometimes some OIs), and very limited over the NARS STIs affiliated to other ministries.

Authorities Directly Responsible for the National AR Policies

Only Egypt has a specific body responsible for the national AR policy. There, the National AR Council (NARC), established by the Ministry of Agriculture and Land Reclamation (MALR) and chaired by the MALR Minister, is composed of representatives of the heads of the main NARS STIs affiliated to MALR and to other ministries. NARC has the mandates at the national and regional levels for (i) designing the general policies for AR plans, programs and projects in different research disciplines, (ii) investigating methods for funding and supporting them, and (iii) integrating and coordinating between them, and monitoring them.

In the other countries, responsibility for the national AR policy remains split among the ministries which directly govern the NARS STIs (ministries of agriculture, fisheries, higher education, research) with different situations:

- In Iran, Lebanon, and Tunisia, as seen above, there is rather good coordination among these ministries through the authorities responsible for the national research policy.
- In Eritrea and the United Arab Emirates, coordination between the ministries of agriculture and higher education or their representatives has been established on an egalitarian basis[3].
- In some countries, the ministries of agriculture (MOAs) succeeded in making other ministries acknowledge the predominant ARI under their governance as responsible for the national AR policy, either officially as in Cyprus (ARI/C), Ethiopia (EARO), and Jordan (NCARTT), or *de facto* as in Lebanon (LARI), Sudan (ARC), Turkey (GDAR), and Yemen (AREA).
- In other countries, there is no actual coordination between the ministries concerned; however, the MOAs, which are generally the ministries more involved in AR, try to coordinate NARS institutions under their umbrella in different ways:

  - In Algeria, Morocco and Tunisia, the monitoring of these institutions is operated by administrative units (DFRV, DERD and IRESA, respectively), whose mandates also cover education and extension and rely mainly on encouraging collaboration between the concerned organizations. The role of these units in the national AR policy is relatively significant only in Tunisia where IRESA is endowed with important human and financial

[1] The Libyan National Authority for Scientific Research, the Tunisian Secrétariat d'Etat à la Recherche (SERST), the Lebanese National Center for Scientific Research, the Jordanian High Council for Science and Technology, the Syrian Supreme Council for Sciences, the Iranian National Council for Scientific Research, the Scientific and Technical Research Council of Turkey (STRCT), and the Bahrain Center for Studies and Research (BCSR).

[2] Most of the FASs in Algeria, Morocco, and Tunisia are under the umbrella of the ministries of agriculture.

[3] In Eritrea, the unique ARI (DARHRD) and FAS (CAAS) have developed a strong formal relationship (steering committee and task force) under the umbrella of their respective governing bodies (Ministry of Agriculture and the University of Asmara). In the United Arab Emirates, a coordination committee between the ministries of agriculture and higher education/research has been recently set up for coordinating national AR activities.

resources, moderate in Morocco, and weak in Algeria where DFRV has limited resources and where the NARS institutions under MOA are the minority (less than 50% of the human and financial resources of the NARS);

- In Syria, where the main ARIs are directorates of MOA, there is no specific formal research coordination body (coordination insured through periodic meetings of the directorate heads, chaired by the Deputy Minister).

Linkages among the NARS Institutions and their Territorial Coverage

According to their nature and effectiveness, the national AR authorities differ in their impact on the relations between the NARS ARIs, the relations between the ARIs and FASs, and the coverage of the national agroecological regions.

Effective linkages between the NARS institutions are often rather weak, both among the ARIs and between the ARIs and the FASs.

The issue of linkages between the ARIs is relevant only for NARSs endowed with several ARIs in the same large field (agriculture or fisheries), which excludes Algeria, Bahrain, Cyprus, Eritrea, Lebanon, and Yemen. It is of little importance in the NARSs that have a highly dominant ARI (Ethiopia and Jordan, where there are limited relations with the few other ARIs). For the other countries, concrete institutional linkages (joint research programs and resources) between the ARIs are moderate in Egypt, Iraq, and Tunisia, and almost nonexistent in the other countries (Iran, Morocco, Sudan, Syria, Turkey, and UAE) despite the fact that informal relations (between ARI leaders and researchers) are generally good. Most of the time, such few linkages are justified by the complementary mandates (for example, ARIs specialized in crops and others in animal production, or in crop/animal commodities and natural resources, such as soil or water), which would mean that every ARI works in its own field. However, complementary mandates generally call for scientific collaboration to obtain integrated results (see Section 9.4.1 on Research Activities). The most decisive factors which could explain the lack of collaboration between the ARIs might be the abundance of qualified human resources and/or the limited funds (for capital and operation) in most of them. It is remarkable to observe that collaboration between ARIs often exists or starts in programs funded by other bodies (external donors in Tunisia and Egypt; NCSR in Iran).

Concrete AR relations between ARIs and FASs are weak[1] in almost all the countries due to the above-mentioned factors (abundance of qualified human resources and limited funds in both sets of institutions) as well as to other specific factors (in particular, lack of time and professional and financial motivation of the academic staff in most countries; large differences in social/salary conditions between researchers and academic staff members). However, those relations are moderate and often based on personal commitment of the academic staff members in Egypt, Jordan, Lebanon, Morocco, and Tunisia, probably because of specific aspects of the national environment (mainly, relatively good salaries of both the researchers and the academic staff; research activities/achievements taken into consideration in the academic staff's career; external funds available). Relations seem good only in Eritrea, certainly due to pressure from the national authorities and donors.

It is worth to briefly mention the relations between ARIs and "other institutions" (OIs), which are rather significant only in Algeria (see Section 9.2.1). In Yemen, it seems that AR activities within development projects are concerned mostly with regions and scientific fields (mainly natural resources) that are poorly covered by its main NARS institution, AREA, and the FASs.

Territorial coverage of the NARS refers mainly to the presence of permanent qualified staff and, secondly, to the available physical resources in the large agroecological/administrative zones of the country. This issue is particularly relevant in medium and large countries (in terms of area and agroecological diversity).

Territorial coverage is rather well balanced and satisfactory in Eritrea, Ethiopia, Iraq, Syria, and Turkey, and rather satisfactory in Iran, Libya, and Morocco. In Algeria, Egypt, Sudan, Tunisia, and Yemen, relatively large numbers of researchers and academic staff members are concentrated in and around the capital and in the most favored agricultural zones.

These degrees of "regional integration" are essential for the relations between the NARS STIs and development organizations (see Section 9.4.2).

[1] In most of the countries, relations in other domains are often considered satisfactory: FASs are directly involved in graduate training of young researchers; academic staff members and, often, ARI researchers assist students in their diploma studies.

9.2.4 A Tentative Structural Typology of the NARSs

Table 4, which combines elements of Tables 2 and 3, proposes a tentative typology of the NARSs according to their size and structure.

Among the small NARSs, those of Cyprus, Eritrea, and Lebanon are very concentrated or at least concentrated and well integrated. The Jordanian and Libyan NARSs are concentrated and moderately integrated, while the Bahrain and UAE NARSs are concentrated or rather concentrated but not integrated.

All the medium NARSs are moderately integrated and more or less concentrated, with different situations regarding regional integration. Sudan and Yemen enjoy the best situation among this group. The Algerian NARS is facing the most acute structural problems in the WANA region.

Among the larger NARSs, the Ethiopian is now well shaped with the recent creation of EARO. The Egyptian, Iranian, and Turkish NARSs are concentrated and moderately integrated.

Finally, this structural analysis confirms the large diversity of the NARS situation in the WANA region. Each country has a specific structural profile with only few similarities among the different countries.

9.3 NARS RESOURCES

Following is an overview of the human and financial resources of the 18 NARSs, with a cross-country comparison of these resources and some information on the material resources.

9.3.1 Overview of the NARS Human Resources

This section deals with the numbers and qualifications of the graduate scientific and technical staff members (gsm) and with the support staff.

Graduate Scientific and Technical Staff

Numbers of the Graduate Scientific and Technical Staff (Table 5)

More than 38,000 gsm are engaged in AR activities, representing about 18,000 potential research years (pRYs). 99% of the gsm are national. There are only 406 expatriates, 76% of whom are hosted by three countries: Libya (141 expatriates, mostly in the faculties of agricultural sciences), the United Arab Emirates (117 expatriates, who represent around two-thirds of the graduate staff in the three categories of NARS institutions), and Yemen (51 expatriates, relatively numerous in development projects included in the category of "other NARS institutions").

The graduate human resources are unevenly distributed among the countries. Egypt alone possesses 37% of the total gsm and pRYs. Iran and Turkey together gather 30% of the gsm and 33% of the pRYs of the WANA region. All the other countries count for less than one-third of the scientific potential of the region.

The breakdown of this scientific potential among the three large categories of NARS institutions deserves some comments (see also Section 9.2.1):

- More than 16,000 gsm are working in AR institutes (ARIs) and are equivalent to a little more than 11,000 pRYs, which means that the graduate staff members allocate around 70% of their time to AR activities and 30% to other activities (administration, development/extension, education, etc.).
- Less than 17,000 gsm are in faculties of agricultural sciences (FASs) and represent 4,100 pRYs, as they are assumed to allocate a normative 25% of their time to AR (see Chapter 3, Methodology).
- At least 5,300 gsm work in the other NARS scientific and technical institutions and devote around 50% of their time to AR. The importance of this category of NARS institutions is most certainly higher, as the related inventory was incomplete in some countries (Ethiopia, Iran, Libya).

Qualifications of the National Graduate Scientific and Technical Staff

The qualifications of the NARS gsm is a sensitive issue. For all the NARSs (except Algeria), relatively accurate data is available for the national staff of the ARIs and FASs, which are the two largest categories of NARS institutions (Table 6). Other data concerning expatriate staff (mostly PhD holders) and the other NARS institutions (around 40% PhD holders) is incomplete.

Table 4 - Structure of the WANA NARSs: Tentative Structural Typology of the NARSs

Country/ Sub-Region		Degree of NARS Concentration					Degree of NARS Integration			Typology of the NARS		
		Very high	High	Med-ium	Low	Very low	High	Mod. rate	Weak			
Small Countries	Cyprus	VH					H			NARS very concentrated and well integrated	1 ARI highly dominant	Coverage of the agroecological regions of the country moderately balanced, except Eritrea (good coverage)
	Lebanon	VH						M				
	Eritrea		H				H			NARS concentrated and well integrated	1 ARI and 1 FAS highly dominant	
	Jordan		H					M		NARS concentrated and moderately integrated	1 dominant ARI. Important sci. potential in FASs marginally involved in AR	
	Libya		H						W			
	Bahrain		H						W	NARS concentrated or rather fragmented and not integrated	Relatively large number of small ARIs and OIs without relations	
	UA Emirates			M					W			
Medium-size Countries	Yemen		H						W	NARS concentrated and moderately integrated	1 dominant ARI. Large scientific potential in FASs marginally involved in AR	Coverage of the agroecological regions very unbalanced
	Sudan		H									
	Iraq			M				M		NARS rather fragmented and moderately or not integrated	Relatively large number of STIs with limited relations	Good/moderate coverage of the agroecological regions
	Morocco			M					W			
	Syria			M					W			
	Tunisia				L			M		NARS very fragmented and moderately integrated	Large number of STIs partially integrated through IRESA	Coverage of the agroecological regions very unbalanced
	Algeria[a]					VL			W	NARS very fragmented and not integrated	Large number of small STIs weakly linked	
Large Countries	Ethiopia	VH					H			NARS very concentrated and well integrated	One ARI highly dominant	Good coverage of the regions
	Egypt		H					M/W		NARS concentrated and moderately integrated	Large main complementary ARIs with limited/poor relations. Numerous FASs marginally involved in AR	Regional coverage: very unbalanced in Egypt; moderately balanced in Iran and Turkey
	Iran		H					M/W				
	Turkey		H					M/W				

Source: Degree of NARS concentration: see Table 2. Degree of NARS integration: see Table 3.

Table 5 - The WANA NARSs: Graduate Human Resources (1996–1998)

ARIs: AR Institutes. FASs: Faculties of Agricultural Sciences. OIs: Other institutions.
Italics: Approximate data.

	Country/ Sub-Region	**Graduate Scientific & Technical Staff** (Units)					**AR Potential Research Years** (pRYs)				
		Total NARS		Breakdown per category of institutions			Total NARS		Breakdown per category of institutions		
		Total	Expatriates (included in total)	ARIs	FASs	OIs	Total	Expatriates (included in total)	ARIs	FASs	OIs
1	Algeria	*2110*	*0*	*46*	*720*	*1344*	*575*	*0*	*41*	*155*	*379*
2	Libya	622	141	179	404	*39*[b]	264	35	131	101	32
3	Morocco	1073	29	453	440	180	606	20	387	111	108
4	Tunisia	797	0	276	362	159	368	0	223	91	54
A	**North Africa**	**4602**	**170**	**954**	**1926**	**1722**	**1813**	**55**	**782**	**458**	**573**
5	Egypt	14320	0	6380	5900	2040	6710	0	3800	1480	1430
6	Eritrea	115	10	79	36		61	4	47	14	
7	Ethiopia	733	5	475	258	-[a]	475	1	411	64	-[a]
8	Sudan	1331	0	588	680	63	595	0	400	170	25
B	**Nile Valley/Red Sea**	**16499**	**15**	**7522**	**6874**	**2103**	**7841**	**5**	**4658**	**1728**	**1455**
9	Cyprus	40	0	40			40	0	40		
10	Iraq	2134	0	324	1510	300	770	0	244	376	150
11	Jordan	449	24	201	181	67	198	8	133	49	16
12	Lebanon	165	6	60	89	16	83	3	54	23	6
13	Syria	2290	0	933	1033	*324*	1058	0	701	203	154
C	**West Asia**	**5078**	**30**	**1558**	**2813**	**707**	**2149**	**11**	**1172**	**651**	**326**
14	Iran	5623	5	3954	1555	*114*[a]	3610	5	3158	389	*63*[a]
15	Turkey	5657	0	1746	3360	551	2288	0	1157	840	291
D	**Highlands**	**11280**	**5**	**5700**	**4915**	**665**	**5898**	**5**	**4315**	**1229**	**354**
16	Bahrain	62	18	30		32	32	11	21		11
17	United Arab Emirates	166	117	94	53	19	73	50	56	13	4
18	Yemen	529	51	320	149	*60*[a]	245	25	187	38	*20*[a]
E	**Arabian Peninsula**	**747**	**186**	**444**	**202**	**111**	**350**	**86**	**264**	**51**	**35**
F	**Total WANA**	**38216**	**406**	**16178**	**16730**	**5308**	**18051**	**152**	**11191**	**4117**	**2743**

a: Ethiopia, Iran, and Yemen: Resources of OIs are most likely underestimated.

Table 6 - The WANA NARSs: Highest Academic Level of the National Graduate Staff' at the Agricultural Research Institutes and Faculties of Agricultural Sciences (1996–1998)

	Country/ Sub-Region	A. AR Institutes (ARIs)					B. Faculties of Agricultural Sciences (FASs)					C. For ARIs: % of PhD and MS Holders out of the Total ARIs + FASs	
		Total N	Including PhD	%/N	Including MS	%/N	Total N	Including PhD	%/N	Including MS	%/N	PhD[c]	PhD + MS[d]
1	Algeria[a]	(46)	…	…	…	…	(720)	…	...	…	…	…	…
2	Libya	179	17	*9*	46	*26*	263	167	*63*	56	*22*	*9*	*22*
3	Morocco	434	65	*15*	285	*66*	430	248	*58*	168	*39*	*21*	*46*
4	Tunisia	276	35	*13*	173	*62*	362	128	*35*	200	*56*	*21*	*39*
A	**North Africa[b]**	**889**	**117**	***13***	**504**	***57***	**1055**	**543**	***51***	**424**	***41***	*18*	*39*
5	Egypt	6380	3020	*47*	540	*9*	5900	4070	*69*	750	*13*	*43*	*42*
6	Eritrea	73	0	*0*	10	*14*	32	3	*10*	15	*46*	*0*	*36*
7	Ethiopia	475	64	*13*	218	*46*	253	50	*20*	147	*58*	*56*	*59*
8	Sudan	588	153	*26*	316	*54*	680	340	*50*	200	*29*	*31*	*46*
B	**Nile Valley/Red Sea**	**7516**	**3237**	***43***	**1084**	***14***	**6865**	**4463**	***65***	**1075**	***15***	***42***	***44***
9	Cyprus	40	22	*55*	18	*45*	0					*100*	*100*
10	Iraq	324	46	*14*	63	*20*	1510	493	*33*	465	*30*	*9*	*10*
11	Jordan	201	27	*13*	79	*40*	157	114	*73*	30	*19*	*19*	*42*
12	Lebanon	59	21	*36*	23	*39*	84	49	*58*	21	*25*	*30*	*39*
13	Syria	933	78	*8*	97	*11*	1033	571	*55*	71	*7*	*12*	*21*
C	**West Asia**	**1557**	**194**	***12***	**280**	***18***	**2784**	**1227**	***44***	**587**	***21***	***14***	***21***
14	Iran	3949	235	*6*	1431	*36*	1555	597	*38*	681	*44*	*28*	*57*
15	Turkey	1746	305	*17*	479	*28*	3360	1935	*58*	1425	*42*	*14*	*15*
D	**Highlands**	**5695**	**540**	*9*	**1910**	***34***	**4915**	**2532**	*52*	**2106**	***42***	***18***	***35***
16	Bahrain	19	2	*11*	4	*21*	0					*100*	*100*
17	United Arab Emirates	30	2	*7*	7	*23*	16	5	*31*	6	*38*	*18*	*45*
18	Yemen	301	50	*17*	93	*31*	137	87	*64*	23	*16*	*36*	*57*
E	**Arabian Peninsula**	**350**	**54**	*15*	**104**	***30***	**153**	**92**	*60*	**29**	***19***	***37***	***57***
F	**Total WANA[b]**	**16007**	**4142**	***26***	**3882**	***24***	**15772**	**8857**	***54***	**4258**	***27***	***32***	***38***

a: Algeria: Data not available. **b**: Without Algeria. **c**: PhD column: Number of PhD holders at the ARIs divided by total number of PhD holders at the ARIs and FASs. **d**: PhD and MS column: Number of PhD and MS holders at the ARIs divided by total number of PhD and MS holders at the ARIs and FASs.

The qualifications of the national gsm is highly variable according to the categories of institutions and the countries:

- At the ARIs, 26, 24, and 50% of the national gsm are PhD, MS, and BS holders[1], respectively. The ARIs of Cyprus, Egypt, Lebanon, and Sudan have the largest proportion of researchers with PhD (55, 47, 36, and 26%, respectively), while those of Eritrea, Iran, Libya, Syria, and the United Arab Emirates have very few qualified researchers (less than 9% are PhD holders). Few countries (Cyprus, Lebanon, Morocco, Tunisia, and Sudan) have ARIs with 25% or less who are BS holders; Eritrea and Syria have an inverse situation (more than 80% of the staff at the ARIs are BS holders).
- At the FASs, 54, 27, and 19% of the national gsm are PhD, MS, and BS holders, respectively. In most of the NARSs, the majority of graduate staff at the FASs are PhD holders. However, in Eritrea, Iraq, and Syria, more than one-third of the gsm at the FASs are BS holders.
- At the other NARS institutions, the academic level of the gsm seems intermediate between the levels at the ARIs and FASs[2], with highly qualified researchers at the "scientific" institutions[3] and relatively low qualified gsm at the "technical" institutions[4].

This means that for the WANA region and all categories of institutions, according to the breakdown of gsm and pRYs per category of institutions (see Table 5), around 41, 26 and 33% of the national gsm have PhD, MS, and BS degrees; and roughly 35, 25 and 40% of the total pRYs come from PhD, MS and BS holders[5], respectively. If we consider—as most of the countries do—that research can be implemented efficiently only by the PhD holders and young MS holders preparing PhD degrees under the supervision of the PhD holders[6], it would be realistic to assume that only about 50% of the 18,000 pRYs of the region are really able to undertake AR activities.

As seen above, the ARIs have few highly qualified staff, particularly when compared with the FASs; this is confirmed by the fact that the ARIs employ only 32% of the PhD holders and 38% of the PhD and MS holders of the agricultural scientific institutions (ARIs and FASs) (see Table 6, columns C). In almost all countries, this situation results from the much better career and salary schemes offered in the past—and still often prevailing—to academic staff members, which may reflect the higher priority given to university education than to research, and which still continues to this day. At present:

- the differences in career and salary schemes between the ARIs and FASs remain large in the majority of countries, both in countries where ARIs are autonomous and their researchers have specific career schemes with small salary advantages (Iran, Iraq, Jordan, Libya, Sudan, Turkey), and in countries where ARIs are not autonomous and their researchers have the same career and salary schemes as gsm or public servants working in administrative directorates or services (Bahrain, Eritrea, Syria, UA Emirates);
- researchers are enjoying similar status and salaries[7] as academic staff members only in autonomous ARIs of a few countries (Egypt, Lebanon, Morocco, Tunisia,); Ethiopia is the only country where researchers are receiving slightly better advantages.

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[1] These percentages, as well as the following, refer to the highest degree obtained.

[2] Which means that at the OIs, around 41, 26 and 33% of the national gsm are PhD, MS and BS holders, respectively.

[3] Such as the National Research Center in Egypt; the Marmara Research Center in Turkey; the nuclear energy organizations or research institutes in Egypt, Iraq, Iran, Syria, and Turkey; specialized departments or units of faculties of science, technology, engineering, economic sciences, arts, etc. in Jordan, Syria, and Turkey.

[4] Such as sectorial "research–development" institutes or directorates; sectorial or regional development projects (the huge GAP in Turkey; numerous relatively small projects in Yemen); sectorial development directorates, services or projects (remote sensing centers in Lebanon, Libya, and Syria; soil laboratories in Tunisia and Ethiopia; water agencies/directorates in Tunisia; etc.); public agro-industrial enterprises (cotton in Syria, tobacco in Iran and Turkey, etc.).

[5] The latter includes all gsm (national and expatriate, where expatriates represent less than 1% of the total gsm), whereas the former breakdown of staff qualifications is related to national gsm per degree.

[6] It is also highly significant that in most of the FASs only PhD and MS holders are considered as academic staff and BS holders as "support staff" or technicians.

[7] It is worth to note that improvement of the career and salary schemes of researchers in Morocco and Tunisia is recent (within the last 10 years) and has been decided within the context of the global renovation of the Moroccan

It is also worth to note the large differences between salaries of researchers in the WANA countries and salaries or incomes of other employee groups. Researchers' salaries are generally much lower (around 50%) than the salaries earned by employees with the same academic qualification in the private sector (which globally offer a limited number of jobs). However, as seen in Table 7, related to some countries, senior researchers' salaries are relatively high in their country.

- They are relatively very high in Ethiopia, Eritrea, Morocco, and Tunisia (37, 33, 12, and 8 times the gross domestic product—GDP—per capita, respectively), and should allow the full dedication of researchers to their research activities.
- They are relatively very low in Turkey (1.8) and relatively low in Syria (2.8 times the GDP per capita, despite some recent improvements), where most of the staff (researchers and other staff members) often have to seek other sources of income.
- They are intermediate in other countries (Egypt, Iran, Jordan, Lebanon, Sudan). In Sudan, researchers are receiving the lowest salaries in the entire WANA region, which explains their strong attrition (leaving their positions to join the private sector in the country or for jobs out of the country).

The consideration of these issues of career and salary schemes is essential for recruitment of researchers, stability, and productivity. It is highly significant that in the process of renovation of some ARIs and NARSs, undertaken with the support of the World Bank (Moroccan INRA, Tunisian NARS), improvements in these fields were included among the stipulations dictated by the Bank for gaining its support and obtaining loans. For some countries where the academic level of the gsm at the ARIs is particularly low (0% PhD holders in Eritrea, 6% in Iran, 7% in UA Emirates, 8% in Syria, 9% in Libya, 11% in Bahrain), action is urgently required in that direction.

Support Staff

Table 8 gives some information about the support staff, including technicians and other categories of human resources with medium and low qualifications ("other support staff," OSS: clerks, laborers, drivers, etc.). It warrants some comments related to the relative numbers, quality, and status of this staff in the two main categories of scientific institutions of the NARSs: the AR institutes and the faculties of agricultural sciences.

AR Institutes, in all countries, suffer a more or less strong imbalance in the numbers of technicians and OSS compared to the general agreed upon standards of 2 technicians and 3–4 OSS per researcher. Situations differ according to country and to the ARIs within each country.

- The Cyprus ARI possesses slightly unfavorable ratios (just under the standards), but its support staff, whose number is only slightly deficient, is certainly much better employed (high level of technology at the research stations).
- In Egypt, the huge ARC enjoys rather well-balanced numbers of support staff; however, they are considered as superfluous as many of the BS holders are acting as technicians; other ARIs are much less endowed.
- In Bahrain, Lebanon, Libya, Morocco, Sudan, Tunisia, and Yemen the main ARIs are in an "intermediate stage," with relatively satisfactory numbers of technicians or OSS; the numbers of technicians are insufficient in Lebanon, Morocco[1], and Tunisia, and the OSS are too few in Libya and too numerous in Sudan. Other ARIs in Morocco and Sudan have a strong deficit in both.
- In Eritrea, Ethiopia, and Iran (AREEO), ARIs have only 0.6 to 0.7 technicians per researcher.
- In Jordan, Syria, Turkey, and the UA Emirates, ARIs show an acute lack of technicians (0.1–0.2 per researcher) and a deficit in OSS, partly compensated for in Jordan and Syria by the use of BS holders as technicians.

Most of the ARIs also complain about the low quality of their support staff, especially technicians, mainly due to the very low salaries offered in a large majority of countries[2] which discourages good candidates, and to the limited opportunities for upgrading[3] and to budget constraints.

INRA and the Tunisian ARIs, undertaken with the support of the World Bank (the related decisions were among the stipulations dictated by the Bank for providing its loans, and thus considered as an essential step for the targeted renovations). It is surprising that such stipulations were not enforced in Jordan when NCARTT received similar a loan.

[1] At INRA, the largest ARI in Morocco, the actual deficit of technicians is larger because many of them are assigned to administrative positions (clerks, etc.).

[2] At the ARIs, the largest discrepancies in salaries between senior researchers, technicians, and OSS are evident in Egypt (technicians' salaries are 10 times less than those of PhD holders), Ethiopia, Morocco, etc.; while the smallest discrepancies are in Syria and Iran (3 and 3.5 times less, respectively), where unqualified staff is relatively well paid.

[3] However, Jordan ARIs consider that the numbers and skills of technicians and other support staff are insufficient due to the very low salaries offered by the public institutions and to the possibilities for technicians to prepare higher diplomas.

Table 7 - Salaries at the Agricultural Research Institutions (1996–1998)

Average salaries per month for researchers with PhD and 10 years of professional experience at the main ARI (salaries plus fringe benefits in some countries)

Country/ Sub-Region	**A. Income/Month** (US$)			B. Coefficient for Parity Income (1996)	**C. Adjusted Researcher Income/Month** (US$) = a × B
	a. Researcher (1996–1998)	b. GDP per capita per month (1996)	a:b		
Morocco	1300	110	11.8	2.8	3640
Tunisia	1300	168	7.7	2.6	3380
Egypt	440	89	4.9	3.6	1580
Eritrea	500	15	33	5.3	2650
Ethiopia	330	8.9	37	4.3	1420
Sudan	130	24	5.4	3.8	490
Jordan	700	140	5	2.5	1750
Lebanon	2000	360	5.4	1.1	2200
Syria	260	93	2.8	4.8	1250
Iran	500	126	4	2.7	1350
Turkey	450	248	1.8	2.1	950

Source: a. Monographs. b. and B. Chapter 2, Table 1.

Table 8 - The WANA NARSs: Technicians and Other Support Staff in the Main Scientific Institutions (1996–1998)

Techn.:gsm = Number of technicians per graduate staff member. OSS:gsm = Other support staff per graduate staff member.
Algeria and …: Data not available.

Country/ Sub-Region		A. AR Institutes			B. Faculties of Ag. Sciences			Observations
		Acronym	Techn.: gsm	OSS: gsm	Acronym	Techn.: gsm	OSS: gsm	
1	Libya	ARC ASRC	1.9 1.3	0.7 1.3	FASs[a]	…	…	a. 7 FASs: BS holders acting as technicians; technicians and OSS very few and mobilized in education activities.
2	Morocco	INRA CNRF	1.1 0.7	3.8 …	IAV ENA-Mek.	0.4 0.5	2 …	
3	Tunisia	IRESA[b] IRA	1.2 0.8	4.7 3	IRESA[c]	0.3	1.8	b. 4 IRESA AR institutes. c. 9 IRESA academic institutions.
4	Egypt	ARC[d] DRC[d]	2.8 0.3	3 1	FASs[e]	…	…	d. Most of the BS holders are acting as technicians. e. 26 FASs: Acute lack of technicians and OSS.
5	Eritrea	DARHRD	0.7	0.15[f]	CAAS	…	…	f. Only clerks (OSS: part-time employees).
6	Ethiopia	EARO	0.6	5.7	AUA	…	…	
7	Sudan	ARC ARRC	2 0.1	7.6 0.2	FAUK FASUG	0.2 0.1	… …	
8	Cyprus	ARI/C	1.7	1.8				No FAS.
9	Iraq	SBAR	1.4[g]		CA/Bagd.	…	…	g. 1.4 technicians and OSS per gsm.
10	Jordan	NCARTT	0.16[h]	2.3	FA/Amm.	…	…	h. BS holders acting as technicians.
11	Lebanon	LARI	1	4.7	FASs	…	…	
12	Syria	DASR[i] DIWU[i]	0.16 0.7	1.8 1.5	FASs[j]	0.24	…	i. Many BS holders working as technicians. j. 6 FASs: BS holders considered as support staff.
13	Iran	AREEO MOJC	0.7 0.4	2.3 1.7	FASs[k]	0.15	1.8	k. 24 colleges.
14	Turkey	GDAR GDRS	0.1 3[m]	2.6	FASs[l]			l. Research assistants (MS holders) acting as SS. m. 3 technicians and OSS per gsm.
15	Bahrain	ARD	1.7	5.7				No FAS.
16	Un. Arab Emir.	ARD	0.18	…	FAS	0.17	…	
17	Yemen	AREA	1.1	2.1	FAUA[n]	…	…	n. Tecnicians and OSS are scarce.

Another category of support staff deserves some comments: the highly qualified administrative staff. This staff, necessary for good management of the human, material and financial resources, is very scarce in most of the ARIs, which means that the related tasks are generally taken over by the best scientists at the expense of their scientific responsibilities.

At the FASs, the previous imbalances are generally more acute. Technicians and other support staff are very few and are mobilized to assist in teaching activities. The Moroccan FASs (IAV/Rabat and ENA/Meknès) are the least disadvantaged on this issue. In some countries, the support staff's tasks are usually covered by BS holders (Egypt, Jordan, Libya, Sudan, Syria) or even by MS holders (Turkey[1]). Such gaps represent a large waste of qualified human resources and partly explain the actual limited commitment of the FASs in AR.

All these imbalances and deficiencies in support staff constitute a strong limiting factor that constrains the research efficiency of the scientists. However, few ARIs are conscious of such weakness; support staff career and salary schemes are rarely among their priorities.

9.3.2 Overview of the NARS Financial Resources

The total financial resources or expenditures (TE) allocated to AR in the 18 WANA countries amount to around US$ 412 million (Table 9), consisting of:

- US$ 376 million funded by the countries (91% of TE), comprised of public/budgetary allocations from the government and some self-generated resources (AR contracts funded by national public and private organizations; production, services and/or development activities: seed, plant and vaccine production; soil/water/feed analyses, soil studies, socioeconomic studies, etc.);
- US$ 17 million from loans, mainly provided by the World Bank, taken up by a few countries (Jordan, Morocco, Tunisia, Turkey, Yemen); and
- less than US$ 19 million granted by national and international donors or agencies.

The financial resources are unevenly distributed among the countries: Iran and Turkey gather 50% of the total financial resources of the WANA region, then comes Egypt (16%) and Morocco (10%); all the other NARSs meet the remaining resources (24%).

A good number of NARSs rely only on national resources (Algeria, Bahrain, Iraq, Iran, Libya, UAE). Foreign grants are significant in Eritrea and Yemen, where they are much higher than the national contributions; while they are relatively significant in Egypt, Ethiopia, and Jordan, and marginal in Cyprus, Lebanon, Morocco, Syria, Tunisia, and Turkey.

Areas of expenditure vary according to country and institution. In most of the NARSs, ARIs allocate a larger part of their financial resources to personnel expenses (salaries and allowances), and a relatively small part to operational and capital costs (OCC). OCC covers the researchers' direct working resources, general expenses of the institution, depreciation of infrastructure and equipment, hiring of seasonal staff, etc. "Relatively" means that OCC is often insufficient and far from covering the research needs, which results in a rather low rate of actual employment of the researchers; this concept will be developed in Section 9.3.3. Also, in most of the NARSs, the FASs are facing a more difficult situation with respect the availability of OCC for research, which explains their low actual involvement in AR activities.

The breakdown of the total financial resources/expenditures among the three large categories of NARS institutions calls for some comments (see also Section 9.2.1). The bulk (78%) of these resources is mobilized by the ARIs, and 15% by the "other institutions" (OIs). Only 7% of the NARS resources belong to the FASs; however, this percentage underestimates the real situation because in many countries, academic staff members are involved in AR activities funded directly by the two other categories of institutions (ARIs and OIs) within the framework of contracts between their faculties and their research partners or through personal relations.

[1] In this country, all the academic staff members are PhD holders, and the remaining staff is mainly made up of research assistants, generally MS holders preparing PhD degrees, who usually act as support/technical staff for the former.

Table 9 - The WANA NARSs: Annual Financial Resources (1996–1998)
(US$ million)

ARIs: AR Institutes. FASs: Faculties of Agricultural Sciences. OIs: Other institutions.
…: Data not available.

	Country/ Sub-Region	National (NE)	% total NE/TE	Loan (LE)	Foreign grants (FE)	Total (TE)	TE: Breakdown per Category of Institutions		
							ARIs	FASs	OIs
1	Algeria [a]	13.7	*100*			13.7	1.8	2.9	9
2	Libya	13.1	*100*			13.1	9.6	1.2	2.3
3	Morocco	36.3	*90*	3	1	40.3	25.2	4.9	10.2
4	Tunisia	12.8	*85*	1.8	0.4	15	10.8	2.2	2
A	**North Africa**	**75.9**	*92*	**4.8**	**1.4**	**82.1**	**47.4**	**11.2**	**23.5**
5	Egypt	60.8	*90*		6.8	67.6	52.2	4.3	11.1
6	Eritrea	0.4	*22*		1.4	1.8	1.4	0.4	
7	Ethiopia	6.8	*82*		1.5	8.3	8	0.3 [b]	- [b]
8	Sudan	2.9	*94*		0.2	3.1	2.8	0.2	0.1
B	**Nile Valley/Red Sea**	**70.9**	***88***		**9.9**	**80.8**	**64.4**	**5.2**	**11.2**
9	Cyprus	5.4	*99*		0.1	5.5	5.5		
10	Iraq	…	*100*		…	…	…	…	…
11	Jordan	4.3	*75*	0.2	1.6	6.1	4.8	1.1	0.2
12	Lebanon	3.3	*87*		0.5	3.8	3.3	0.4	0.1
13	Syria	13.7	*90*		1.6	15.3	10.6	0.8	3.9
C	**West Asia [c]**	**26.7**	*87*	**0.2**	**3.8**	**30.7**	**24.2**	**2.3**	**4.2**
14	Iran	98.7	*100*		-	98.7	92	5.4	1.3 [b]
15	Turkey	99.6	*90*	9.9	1.2	110.7	86.5	3.8	20.4
D	**Highlands**	**198.3**	***95***	**9.9**	**1.2**	**209.4**	**178.5**	**9.2**	**21.7**
16	Bahrain	3.2	*100*			3.2	2.3		0.9
17	United Arab Emirates	…	*100*		…	…	…	…	…
18	Yemen	1.4	*23*	2.1	2.6	6.1	4.3	1.6	0.2 [b]
E	**Arabian Peninsula [d]**	**4.6**	***49***	**2.1**	**2.6**	**9.3**	**6.6**	**1.6**	**1.1**
F	**Total WANA [e]**	**376.4**	***91***	**17**	**18.9**	**412.3**	**321.1**	**29.5**	**61.7**

a: Algeria: Approximate data. **b**: Ethiopia, Iran, and Yemen: Resources of OIs are most likely underestimated. **c**: West Asia: Total without Iraq. **d**: Arabian Peninsula: Total without United Arab Emirates (UAE). **e**: WANA: Total without Iraq and the United Arab Emirates.

It is worthwhile to emphasize the complexity of managing the financial resources, which prevails in almost all countries and institutions.

- ARI leaders generally complain about the difficulties faced in that respect: public budgets, officially agreed upon by the governing ministries or bodies, are, at times, far from being actually allocated; actual budgets are unstable over the years; delays in fund liquidation are frequent; fund categories (staff, operation, capital) are too rigid; financial relations with suppliers and with public or private research partners are complicated; etc. These difficulties are particularly acute in those ARIs without administrative and financial autonomy, e.g., the AR institutions directly managed by ministries (department, directorate or division). These institutions sometimes do not have direct responsibility for managing their human, material and financial resources (Bahrain, Eritrea, Syria, UA Emirates).
- Most of the FASs face an even harder situation: their limited resources are directly managed by their universities according to the available funds, with priorities generally given to education and to staff and student issues and not to research. Frequently, their deans do not have control of their resources and are sometimes unaware of the actual extent of their total or research resources. FASs of the francophone countries (Algeria, Morocco, Tunisia) are in a much better position as they are autonomous and are not governed by universities.

9.3.3 Cross-Country Comparisons of the NARS Human and Financial Resources

International comparisons of NARS resources rely on some ratios relating to human and financial resources. Attention will be given, first to the most significant ratios, and then to other ratios.

Most Significant Ratios (Table 10)

Actual Employment Rate (AER) of the Scientific Potential

AER represents the ratio of total actual RYs[1] to total potential RYs (AER = aRYs ÷ pRYs). Despite its rough, approximate value, it constitutes the most comprehensive yardstick of the degree of "quantitative efficiency" of the NARS.

AER is rather low (36%) for the whole region, with large variations among countries.

- Fig. 1 shows a positive but rather weak correlation between AER and the wealth of the countries (measured by the GDP per capita); the richest countries seem to have more efficient NARSs, but among the more numerous poorer countries, there are very large differences.
- Fig. 2 relates to the size of the countries (measured by their population). It shows two groups of countries: (i) in the group with less than 30 million inhabitants, AER is negatively correlated with population, i.e., NARS efficiency is higher in the small countries than in the medium ones (except Morocco); and (ii) in the largest countries, AER is low (ranging from 25% in Egypt to 48% in Ethiopia).
- AER is satisfactory (more than 70%) in a few countries (Bahrain, Cyprus, Eritrea, Lebanon, Libya, Morocco) which have the following characteristics: their main ARI institutions enjoy good levels of operation and capital budget (OCC) per graduate staff member or pRY, their FASs are in a relatively favorable financial situation, and their graduate staff members are able to devote to AR activities an actual percentage of their time which is close to the normative 25% used for estimating the pRYs.
- AER is very low (less than 30%) in other countries (Algeria, Egypt, Iran, Iraq, Sudan) which have the opposite characteristics: due to their very limited OCC, their main ARI institutions are far from providing sufficient working resources for their researchers, and their FASs are generally in a less favorable situation, which means that their graduate staff members are poorly committed to AR activities.
- Other countries (Ethiopia, Jordan, Syria, Tunisia, Turkey, Yemen) are in an intermediate position.

[1] aRY was estimated through different criteria, especially the available amount of OCC per pRY (see Chapter 3, Section 3.3.1).

Table 10 - The WANA NARS: Most Significant Ratios for Cross-Country Analysis

F = Actual RYs to potential RYs. **I to L** = AR expenditures to Agricultural Gross Domestic Product (AGDP).

Italics: Approximate data. …: Data not available.

	Country/ Sub-Region	Data on Economy[a]			AR Research Years		Ratio aRYs : pRYs (%)	AR Expenditures (E: US$ million)		Ratio AR Expenditures : AGDP (%)			
		GDP per capita (US$)	AGDP (US$ billion)	AGDP + I – E[b] (US$ bill.)	pRYs	aRYs		National (NE)	Total (TE)	NE/ AGDP	TE/ AGDP	NE/ (AGDP + I – E)	TE/ (AGDP + I – E)
		A	B	C	D	E	F	G	H	I	J	K	L
1	Algeria	1510	5.4	8	*575*	*150*	*26*	13.7	13.7	0.25	0.25	0.17	0.17
2	Libya	4460	2	3.3	264	160	61	13.1	13.1	0.67	0.67	0.40	0.40
3	Morocco	1320	5.3	6.1	606	540	89	36.3	40.3	0.68	0.76	0.60	0.66
4	Tunisia	2010	2.4	2.9	368	200	54	12.8	15	0.53	0.63	0.44	0.52
A	**North Africa**	**1730**	**15.1**	**20.3**	**1813**	**1050**	**58**	**75.9**	**82.1**	**0.50**	**0.54**	**0.37**	**0.40**
5	Egypt	1070	12.1	15.5	6710	1600	24	60.8	67.6	0.50	0.56	0.39	0.44
6	Eritrea	180	0.6	2.8	61	50	82	0.4	1.8	0.67	3.0	0.14	0.64
7	Ethiopia	105	3.4	3.5	475	220	46	6.8	8.3	0.20	0.24	0.19	0.23
8	Sudan	285	3.1	3.1	595	65	11	2.9	3.1	0.09	0.10	0.09	0.10
B	**Nile Valley/Red Sea**	**540**	**19.2**	**24.9**	**7841**	**1935**	**25**	**70.9**	**80.8**	**0.37**	**0.42**	**0.28**	**0.32**
9	Cyprus	12100	1	1.2	40	*40*	*100*	5.4	5.5	0.54	0.54	0.45	0.46
10	Iraq	1280	(7.9)	(8.9)	770	*225*	*29*	…	…	…	…	...	…
11	Jordan	1640	0.6	1.1	198	125	63	4.3	6.1	0.72	1.0	0.39	0.55
12	Lebanon	4360	1.6	2.7	83	60	72	3.2	3.7	0.20	0.23	0.12	0.14
13	Syria	1120	4.9	4.9	1058	500	47	13.7	15.3	0.28	0.31	0.28	0.31
C	**West Asia**	**1670**	**8.1**	**9.9**	**2149**	**950**	**44**	**26.7**[c]	**30.7**[c]	**0.33**[c]	**0.38**[c]	**0.27**[c]	**0.31**[c]
14	Iran	1520	20	22	3610	1100	30	98.7	98.7	0.49	0.49	0.45	0.45
15	Turkey	2980	28	28	2288	1280	56	99.6	110.7	0.36	0.40	0.36	0.40
D	**Highlands**	**2250**	**48**	**50**	**5898**	**2380**	**40**	**198.3**	**209.4**	**0.41**	**0.44**	**0.40**	**0.42**
16	Bahrain	7890	0.05	0.35	32	24	75	3.2	3.2	6.4	6.4	0.91	0.91
17	United Arab Emirates	16100	(0.7)	(2.4)	73	…	…	…	…	…	…	…	…
18	Yemen	340	0.9	1.6	245	105	43	1.4	6.1	0.18	0.76	0.09	0.38
E	**Arabian Peninsula**	***5650***	**1**	**2**	**350**	**129**[d]	**47**[d]	**4.6**[d]	**9.3**[d]	**4.8**[d]	**0.98**[d]	**2.4**[d]	**0.48**[d]
F	**Total WANA**	**1840**	**91.4**	**107.1**	**18051**	**6444**[e]	**36**[e]	**376.4**[e]	**412.3**[e]	**0.41**[e]	**0.45**[e]	**0.35**[e]	**0.38**[e]

a: Source: Table 2, chapter 2. **b**: AGDP + Ag. imports – Ag. exports: see text, section 3.3. **c**: Without Iraq. **d**: Without United Arab Emirates. **e**: Without the two previous countries.

See Figs 1 to 3b in annex

These different values of AER may reflect the role of public institutions in the national socioeconomic policies in each country. In the first category of countries (satisfactory AER), it seems that ARIs and FASs are mainly considered as important tools for development and receive appropriate attention: balanced budget allocations for staff expenses and OCC in both categories of institutions and low ratios of students to academic staff member, which are adapted to realistic conditions for employment, preserving the quality of education and allowing academic staff to implement research. In the second category of countries (very low AER), ARIs (like other public institutions) may be considered mainly as institutions securing jobs for qualified staff regardless of their efficiency, and FASs (and universities in general) have to provide education to as large a number of students as possible, often at the expense of education quality, for alleviating the sociopolitical pressure of young generations facing the the difficult problem of underemployment.

Average values of AER for each of the five sub-regions (North Africa, Nile Valley and Red Sea, West Asia, Highlands, and Arabian Peninsula) have no meaning as AER is highly variable among the country members of these sub-regions.

Ratio of AR Expenditures to Agricultural Gross Domestic Product

This ratio, which compares national (NE) and total expenditures (TE) allocated to AR to the agricultural gross domestic product (AGDP), is by far the most used criterion for cross-country comparisons.

Average NE/AGDP and TE/AGDP for the entire WANA region were estimated at 0.41 and 0.45%, respectively, with large variations among countries. These ratios are much under the 1% (sometimes, even 2%) recommended for developing countries by some international organizations (World Bank, European Union, IFPRI, etc.[1]), which suggests that the investments in AR are largely insufficient. However, these recommended ratios are questionable.

- First, these ratios were proposed largely on the basis of a comparison with the ratio of 2% or more prevailing in developed countries[2], without taking into account the main structural differences between countries (CIHEAM/ Casas, 1988; FAO/Casas, 1998).
  - In developed countries, AR expenditures are the sum of public and private financial resources, and are largely allocated to food technology[3], whereas private contributions and allocations to food technology are very low or nonexistent in most of the developing countries. Thus, for wealthier countries, AR expenditures should be related not to the AGDP but to the sum of the agricultural and agricultural/food industry GDP, which, in the most-developed countries, is twice the AGDP[4].
  - In the poorest developing countries, it is essential to take into account the low capacity of public funding due to the importance of food consumption at the farm level ("autoconsumption") (certainly higher than 50% of the AGDP in Eritrea, Ethiopia, Sudan, and Yemen) and the very limited possibilities for tax recovery on the AGDP.
- Second, the recommended ratios do not take into account the size and diversity of the agricultural sectors in developing countries. Obviously, research needs are relatively higher in small countries than in large countries which can benefit from the economies of scale on the research costs. They are also higher in countries with a diversified agricultural sector than in countries with very few main commodities (as is generally the case in the poorer countries where four or five commodities often account for more than 80% of the AGDP), and higher in countries with more complex ecological conditions where preservation of natural resources is a main issue.

These observations lead to the conclusion that a ratio of 1% is undoubtedly too high for the WANA countries with middle and low incomes per capita.

NE/AGDP and TE/AGDP range from less than 0.1% (Sudan) to 6.4% (Bahrain), which illustrates the large differences in the attention given to AR in the different countries. Statistical analyses show that there is no clear relation between the values of these ratios and the wealth of the countries (GDP per capita) (see Figs 3a and 3b related to NE/AGDP). There is also no correlation between these values and the size/population of the countries (figures not presented).

[1] For example, IFPRI proposes that "all developing countries should invest at least 1% of the value of their agricultural production in AR, and move towards 2% within the next 5 to 10 years" (IFPRI, October 1995, p. 6).

[2] Slightly less than 2% for middle-income developing countries and above 2% for high-income countries (IFPRI, 1995).

[3] In general, the proportions of private contributions and of research allocated to food technology are higher in richer countries.

[4] For example, in France, in 1985, the ratios of public TE/AGDP and public TE/(AGDP + AFGDP)—with AFGDP as the Agro-food Gross Domestic Product—were estimated at 3.1 and 1.5%, respectively (Casas, 1988).

As most of the WANA countries are net agro-food importers, the same exercises were applied to the national agricultural gross domestic "product and consumption" (AGDPC), equivalent to: AGDP + (Ag. imports – Ag. exports), which reflects the actual importance of this sector in a country[1]. In this case, there was also no clear relation between NE/AGDPC or TE/AGDPC and the wealth or size of the country (figures not presented).

Finally, the relative financial efforts dedicated to AR seem to be very specific to every country, regardless of its wealth or size, which is unexpected since most of the similar previous studies revealed a strong positive correlation between AR expenditures and wealth of a country, on the one hand, and a negative correlation between expenditures and size, on the other.

A few countries are in line with these general correlations found in other regions or worldwide. Bahrain, one of the smaller and richer countries, is devoting the highest relative efforts to AR; while Ethiopia, Sudan, and Yemen, which are among the poorest countries, are in an opposite position.

The other countries do not portray "logical" differences (with regard to their wealth or size), for example:

- Lebanon, a rather small country with relatively high per capita income (US$ 4,360), is among the lagging countries in terms of attention devoted to AR; while Eritrea, having the same size but a very low per capita income (US$ 180), gives high priority to AR and receives large external assistance.
- Among the countries with medium per capita income and medium size, the NARS of Morocco is enjoying a rather favorable situation (NE/AGDP = 0.68%, TE/AGDP = 0.76%), which is not the case of Algeria (NE/AGDP and TE/AGDP = 0.25%) and Syria (NE/AGDP = 0.28%, TE/AGDP = 0.31%).
- Egypt, Iran, and Turkey, with about the same large populations, are dedicating AR efforts in a slightly inverse relation to their wealth, Egypt being the country with the smallest per capita income of the three countries and the most extensive national and external efforts.

Other Ratios (see Table 11)

Some of the other ratios involve the agricultural labor force (ALF).

- aRYs/ALF and pRYs/ALF demonstrate a positive correlation with the wealth of the countries[2] (see Figs 4 and 5) such as that for the Mediterranean countries in 1987 (Casas/CIHEAM/1988). This would mean that richer countries are able to mobilize more RYs in relation to their ALF, and would be consistent with the fact that in the richer or more developed countries of the WANA region, ALF is relatively smaller and more productive than in poorer or less developed countries. These ratios are not related with the size of the countries (figures not presented).
- NE per million agricultural laborers (NE/ALF) are highly correlated to the wealth of the countries, which indicates that richer countries are allocating more efforts in terms of their agricultural population (see Fig. 6). This is consistent with the fact that ALF is considerably lower in richer countries, which means that the same AR expenditures will benefit a relatively smaller agricultural labor force. Such high correlation exists between TE/ALF and GDP per capita (figure not presented).
- NE/ALF (as well as TE/ALF) seems to decrease with the population of a country, which would mean that the smaller the country, the higher its NE/ALF and TE/ALF ratios (see Fig. 7). This seems coherent because in the WANA region, the smaller countries are among the richer ones. However, statistical correlations are not highly significant.

The two ratios, pRYs/AGDP and aRYs/AGDP, do not demonstrate, globally, a clear relationship with the wealth and size of the countries (figures not presented).

As a conclusion to this section, it seems that most of the NARSs have specific profiles regarding their human and financial resources, conditioned by the history, culture, and sociopolitical environment of their countries and institutions.

[1] For the few WANA countries which are net agro-food exporters (Sudan, Syria, Turkey), AGDPC is equal to AGDP.

[2] This correlation is even stronger if we exclude the two richest countries: Bahrain and Cyprus (no data related to the aRYs).

Table 11 - The WANA NARS: Other Ratios for Cross-Country Analysis

ALF: Agricultural labor force. *Italics*: Approximate data. …: Data not available.

	Country/ Sub-Region	RYs/ALF (Units/million laborers)		E/ALF US$ per ag. laborer		RYs/AGDP Units/US$ million	
		pRYs/ALF	aRYs/ALF	NE/ALF	TE/ALF	pRYs/AGDP	aRYs/AGDP
1	Algeria	*250*	*65*	6	6	*106*	*28*
2	Libya	2200	1330	109	109	132	80
3	Morocco	144	129	8.6	9.6	114	101
4	Tunisia	409	222	14	17	153	83
A	**North Africa**	**242**	**140**	**10**	**11**	**120**	**70**
5	Egypt	790	132	7.2	8	555	132
6	Eritrea	47	38	0.3	1.4	508	416
7	Ethiopia	21	10	0.3	0.4	134	65
8	Sudan	86	9	0.4	0.4	192	21
B	**Nile Valley/Red Sea**	**203**	**50**	**1.8**	**2.1**	**451**	**104**
9	Cyprus	1000	*1000*	135	138	40	*40*
10	Iraq	1100	321	…	…	97	*28*
11	Jordan	1237	781	29	38	330	208
12	Lebanon	*1660*	*1200*	*64*	*74*	52	38
13	Syria	790	373	10	11	216	102
C	**West Asia**	**1343**	**593**	***17***[a]	***19***[a]	**143**	**63**
14	Iran	*840*	*256*	*23*	*23*	181	55
15	Turkey	197	110	8.3	9.5	82	46
D	**Highlands**	**371**	**150**	***12***	***13***	**123**	**50**
16	Bahrain	*3200*	*2400*	*320*	*320*	*640*	*480*
17	United Arab Emirates	1042	…	…	…	*104*	…
18	Yemen	144	62	*0.8*	*3.6*	272	117
E	**Arabian Peninsula**	206	75[b]	***2.7***[b]	***5.5***[b]	***206***	***292***[b]
F	**Total WANA**	**277**	**99**[c]	**5.8**[c]	**6.3**[c]	**184**	**66**[c]

a: Without Iraq. **b**: Without the United Arab Emirates. **c**: Without the two previous countries.

See Figs 4 to 7 in annex.

9.3.4 The NARS Physical Resources

The NARS physical resources are highly variable according to their nature (infrastructure, equipment, etc.) as well as to the country and institutions. However, it is possible to point out some common features and to outline some national characteristics.

With respect to infrastructures (buildings, stations, farms), they are excessively numerous in many NARSs, including:

- the highly fragmented NARSs (composed of a relatively large number of institutions: see Section 9.2.2), each institution having its own set of facilities regardless of the others; this situation prevails in Algeria, Iraq, Tunisia, and the United Arab Emirates, and to a relatively lesser extent in Morocco[1] and Syria;
- NARSs with "multi-organizational ARIs" which govern a large number of semi-autonomous institutes but, often, still maintaining separate facilities, also NARSs with a large number of FASs: this is the case of Egypt, Iran, and Turkey.

In countries with the above both sets of NARSs, as mentioned in the monograph on the Turkish NARS, the facilities considerable are both in number and size, and possess a huge set of separate units and infrastructures[2], the management and maintenance of which are very costly. An obvious solution would be to rationalize and reduce these facilities by gathering most of them in a small number of "campuses" (at least one per large region) that would accommodate the essential human and physical resources. This should allow providing common infrastructures and services (conference halls, library, communication facilities, purchase offices, etc.) at a much lower cost and should offer more opportunities for interaction and collaboration among scientists. The physical separation of ARIs and FASs, which generally prevails in the WANA NARSs[3], partly explains their very limited scientific collaboration.

Infrastructures are also often unevenly distributed throughout a country; in many cases, the best-endowed stations, laboratories, and farms are located in and around the headquarters, the capital, and the most favorable agroecological zones. This is true not only in the NARSs with a low "degree of regional integration" (Algeria, Sudan, Tunisia, Yemen) (see Section 9.2.3), but also in NARSs with "moderate regional integration" which had recently improved their facilities (renovation of existing facilities or establishment of new ones) such as Egypt, Iran, Jordan, and Morocco.

Equipment (scientific and farm equipment, computers, transportation/communication facilities) is often insufficient in quality and quantity and needs to be renovated or reinforced. Shortages of spare parts seem frequent, as a consequence of the lack of standardization or due to difficulties in purchasing in foreign currencies. Few ARIs enjoy good conditions (at least in their main stations and laboratories), especially those which have recently benefited from large national investments (Iran) or external support (Egypt, Jordan, Morocco, Tunisia, Turkey).

Central libraries in the main ARIs are rather satisfactory at least in terms of facilities (buildings), but wide variations among the different libraries are observed in their content, equipment, and operation (particularly services to remote stations). The Egyptian ARC has a very modern library with the most up-to-date computerized information storage and retrieval systems, electronic network, up-dated collections of books, periodicals and journals, etc.[4] INRA/Morocco, INRAT/Tunisia, NCARTT/Jordan, ARD/UAE are all well endowed. However, the situation seems much less favorable in Algeria, Sudan, and Syria as well as in most of the FASs.

All physical resources (infrastructures, equipment, libraries) have suffered large degradation in the internationally isolated countries (Algeria, Iraq, Libya, Sudan).

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[1] Where INRA drastically reduced the number and size of its experimental stations some years ago.

[2] For the entire Turkish NARS, farms total more than 40,000 ha, while for Morocco it is 7,000 ha (despite the recent strong reduction which took place within INRA), 5,500 ha in Tunisia, and 6,600 ha solely for the farms of the STIs affiliated to the Ministry of Agriculture in Algeria.

[3] It seems that in the entire region, there is only one example of a campus associating ARIs and FASs; in Meknès/Morocco, the INRA regional center is located in the National Agricultural School, ENA.

[4] The Egyptian National Agricultural Library, ENAL, was established in 1995 in Giza, with the support of a very large USAID grant (cost: US$ 6.3 million); it serves ARC, all MALR units, the universities, and all individuals involved in agriculture.

9.4 RESEARCH ACTIVITIES AND RELATIONS WITH DEVELOPMENT

9.4.1 Research Activities

This section deals with research management processes (planning/programming, monitoring/evaluation), research programs (content, deficiencies, trends, scientific dissemination), and international scientific linkages.

Research Management Processes

Research Planning and Programming - Few countries have prepared formal AR national long- and/or medium-term plans (LTP and MTP, respectively) for their entire NARS, including priority-setting exercises and allocation of resources by research domains or programs[1]. These are: Tunisia (LTP, 1984), Iraq and Jordan (both countries prepared a national strategy for AR and technology transfer, respectively in 1995 and 1996), Lebanon (national AR strategy, 1996), Eritrea (AR MTP 1997–2002), and Yemen (national AR strategy has been recently prepared).

In most of the other countries[2], AR national plans have been included as components of national economic development plans. They cannot be really considered as AR plans as they generally consist of brief presentations (a few pages) of the most sensitive governmental policy priorities related to the involvement of the NARS institutions, the main priorities in the research programs (sectors, themes, regions), national commitments for resources allocation (often mainly in terms of investment), etc.

Among these other countries, the largest national ARIs have promoted a more or less integrated way of planning/programming in order to guide strategic decisions (relating to research programs and resource allocation) and help establish better equilibrium among the research programs.

- ARC/Egypt[3] and both GDAR and GDRS/Turkey[4] have designed their own "master plan" (medium-term plan applied to one institution).
- INRA/Morocco has developed in the last 10 years a programming system based on consultations between INRA researchers, farmers, and extension agents, and assessment of market demand.
- ARC/Libya and ARC/Sudan have developed priority-setting exercises, based on the analysis of the challenges facing agricultural production in the country (economic importance of the commodity branches, food security, etc.), scientific experience, and information.

Monitoring and Evaluation - These processes include the follow-up and assessment of the research programs (adaptation to the plans or programs of the NARS or NARS institutions, scientific consistency, scientific results: content, publication). Information related with these issues is rather fragmented and uneven according to the countries.

It seems that most of the largest and/or experienced ARIs have set up specific bodies for monitoring and evaluating their research programs; sometimes the researchers' scientific activities as well. These bodies are mainly scientific councils or committees attached to ARI directorates or boards of trustees and to large research programs or

[1] These plans were prepared directly under the responsibility of the Government, represented by the Ministry of Agriculture (Eritrea, Tunisia), or of the largest national ARI (Jordan, Lebanon, Yemen), by scientists from the main NARS institutions. None of these plans, except the Tunisian one, have included resource allocation by region (which is a major issue for NARSs characterized by an unbalanced regional breakdown of their human and physical resources), nor have they been designed with significant participation of farmers' representatives.

[2] All except Bahrain and UAE (no mention of national economic plan). Iran intends to prepare a national AR strategic plan in the near future. As for Ethiopia, in the early 1990s, efforts to formulate and implement a national AR policy were not sustainable, largely due to the lack of sufficient political commitment and the necessary resources. These efforts have been re-initiated with the creation of the National AR Council, operating under the auspices of the Ethiopian Science and Technology Commission (the recent establishment of EARO, officially mandated to coordinate and guide the national AR policy, may change this situation).

[3] At ARC/Egypt (62% of the total financial resources of the NARS), the latest master plan is the fourth five-year (1997/98–2001/02) research/extension/training program, which is guided by the strategy for agricultural development, in line with what has been accomplished during the previous research plans. This plan, as the previous, has been prepared and is implemented closely with the other national institutions and scientists associated with the ARC programs.

[4] The master plans of GDAR and GDRS (55 and 17% of the NARS total financial resources, respectively) established formal priority-setting mechanisms for the research agendas and set up systematic national, multidisciplinary, multi-institutional research programs for all research activities and topics; they were prepared within the implementation of the Turkish AR Project (TARP, designed in 1990 with the support of the World Bank).

departments, which generally include representatives of other NARS institutions. Some ARIs and countries deserve a few comments.

- In INRA/Morocco, the sectorial committees (cereals, citrus, etc.) include representatives of professional agricultural and agro-food organizations.
- In Tunisia, research committees have been set up at the level of the Ministry of Agriculture (through IRESA), gathering scientists from the NARS institutions concerned as well as agronomists from development agencies.
- In Egypt, four Regional Research and Extension Councils, established in 1992 to promote coordination and cooperation between scientists, researchers, extensionists, technologists, decision-makers, and farmers on a regional basis, are responsible (among their other mandates) for monitoring and evaluating the achievements in research and extension programs in their zone.
- IAR, the largest Ethiopian ARI (now replaced by EARO) used to organize a National Research Review Meeting that included its research leaders and scientists from other NARS institutions. This meeting was held annually to review and approve research projects, particularly those of the IAR centers, as the universities or regional centers were not legally bound by decisions passed in the review system.

Few FASs (Eritrea, Turkey) have started to establish research priority areas.

The research management processes presented above may be considered more or less efficient. However, as will be seen in the following section on research programs, the many national AR plans and master plans have been only partly implemented or sometimes forgotten[1], programming and priority-setting have often induced limited changes in research programs and resource allocation, and monitoring/assessment bodies have not been always operational.

Research Programs

Information related with the characteristics of the research programs and their scientific dissemination is also rather fragmented and uneven in some NARSs. However, some of the most common characteristics are listed below.

- Small NARSs and the Algerian NARS (as a medium-size, very fragmented, and weakly integrated NARS) face difficulties in organizing programs endowed with the essential resources (especially qualified human resources) required for achieving significant results.
- In these countries, as well in most of the FASs of the WANA region, research programs are mainly conducted on an individual basis (either by experienced scientists or young scientists preparing PhD degrees).
- In the medium and large NARSs (except Ethiopia), overlapping of research programs is frequent (more frequent in the highly fragmented and moderately or weakly integrated NARSs: Algeria, Egypt, Iran, Iraq, Morocco, Syria, Tunisia, Turkey).

In many monographs, some characteristics are also mentioned for the main ARIs.

- Priority is given to applied and adaptive research. Only a few NARSs (mainly Egypt, Turkey, and, to a lesser extent, Morocco) are currently involved in modern sciences with wide use of biotechnology, isotopes, remote sensing, expert systems, and computers.
- Frequently, there is secondary emphasis on forestry, animal production, food technology, economy, and farming systems. Research programs on crops and natural resources are generally the most established and better covered[2].

The lack or weakness of permanent research teams on farming systems deserves further comments, given their importance for agricultural development. "Integrated multidisciplinary research on farming systems at the national level is essential for promoting more intensified and sustainable farming systems. Rather than AR and development efforts being directed towards the issue of productivity and how to increase it, the emphasis should be shifted towards ensuring the sustainability of production and the implications of agricultural intensification on the natural-resource

[1] The national AR strategy is being followed by NCARTT/Jordan, but does not serve as an active reference for the FASs and the other NARS institutions.

[2] In Yemen, unbalanced resource allocation between research fields and regions in the main ARI (AREA) is partly compensated for by AR activities conducted by the temporary agricultural projects/programs.

base (soil and water) and the environment, in general" (Egypt monograph)[1]. Significant efforts in that direction have been made in some countries (Eritrea, Jordan, Morocco, Tunisia) and initiated in others (Algeria, Egypt, Iraq, Sudan, Syria, Turkey). However, in countries with ARIs covering crops, animal production, and natural resources separately (mainly Algeria, Iran, Libya, Sudan), implementation of the farming systems research approach remains difficult[2].

Dissemination of research output is through diverse channels: publications (scientific papers, journals, books, bulletins), organization of and participation in seminars and workshops, etc. The situation of publications in the different NARSs is very diverse (limited precise data is available on this issue). The small countries rarely have specialized AR scientific journals, and even if they existed, such publications have been sometimes discontinued (Lebanon). Among the medium-size countries, Morocco seems to have a very active publishing policy: each large NARS institution (INRA, INRH, IAV) has its own publications (total of four scientific journals, many technical bulletins, newsletters, magazines). Although a very large number of MS and PhD theses have been prepared at the FASs, only IAV/Morocco seems to be concerned with supporting the publication of this knowledge. Some of the large countries have a large number of specialized AR scientific journals; in Egypt, several FASs produce periodic journals, open for publication to all AR scientists, and ARC produces its own quarterly journal.

From the monographs, it is difficult to form a reasonable judgment of the scientific productivity (quantity and quality) of the NARSs. The low rates of actual employment of the human scientific potential and the insufficient weight given to scientific achievements in terms of their influence on the researchers' careers in many countries suggest that this scientific productivity is, in general, rather modest if we take into consideration the large number of agricultural scientists in the WANA region.

Regional and International Scientific Linkages

Scientific collaboration with national scientific institutions of developed countries as well as with international and regional scientific/technical organizations (international AR centers, particularly ICARDA; FAO; CIHEAM; ACSAD; AOAD; etc.) is very variable according to the countries and their institutions.

On the whole, it is active and diversified (the main NARS institutions have relations with both national and international partners) in Egypt, Eritrea, Jordan, and Yemen, which are countries that benefit from rather large external financial support (grants and loans). It is also rather well developed in Ethiopia and Morocco.

However, international scientific linkages remain moderate or limited in Tunisia, Lebanon, Syria (mainly with ICARDA and ACSAD, which have their headquarters in the country), Turkey (relations are well developed for GDAR, but rather limited for the other institutions), Bahrain, and UAE; and deficient in Algeria, Iran, Libya, and Sudan. In these countries, which are relatively isolated for political reasons, international AR centers (particularly ICARDA) are basically the only windows to the international scientific community.

For all countries, it is worth to stress on: (i) the rather limited scientific cooperation between the WANA NARSs, which takes place essentially through networks organized by international and regional organizations, particularly ICARDA, CIHEAM, FAO, the Arab Center for Studies of the Arid Zones and Dry Lands (ACSAD) and the Arab Organization for Agricultural Development (AOAD), and (ii) the positive role of international financial agencies (Arab Fund for Economic and Social Development, IFAD, Islamic Bank of Development, the World Bank) and countries (European Union, France, Germany, the Netherlands) in the development of international linkages (North/South as well as South/South).

9.4.2 Relations with Development

Relationships between NARS Institutions and Development Organizations

Channels for these relations are relatively numerous and diversified, but vary from country to another. They exist mainly in the AR institutes and may include:

[1] See Chapter 2, Sections 2.3.2 and 2.4, related to, respectively, the very limited natural resources (land and water) available in the WANA region, and the strategic importance of farming systems research for developing intensified and sustainable production.

[2] ICARDA is playing an active role in setting up or reinforcing research teams on farming systems in the WANA region through the Nile Valley and Red Sea Regional Program (NVRSRP: Egypt, Eritrea, Ethiopia, Sudan, Yemen) and the Mashreq/Maghreb project (which involves the four North-African countries and four countries of West Asia: Iraq, Jordan, Lebanon, Syria). It is worth to mention that these projects have provided opportunities to develop not only regional collaboration but also national linkages between NARS institutions which sometimes ignored each other in the past.

- Participation of representatives of public and private development organizations in the management and research committees or special units set up by the NARSs and its institutions (planning/programming committees, scientific councils, research–development councils at national and regional levels, etc.), which may allow better research prioritization according to users' needs (farmers, public and private agro-industrial companies).
- Specific research contracts with public and private development organizations.
- Services (soil/water/feed/animal disease analysis, etc.), soil mapping, direct technical assistance, and utilization of libraries and databases.
- Demonstration experiments in farmers' fields set up and evaluated jointly with extension agents and farmers.
- Field days in experimental stations; workshops, and training courses.
- Preparation of information packages for extension services and farmers (extension leaflets, information on technologies in mass media), etc.

These channels seem rather well organized in:

- Morocco, where INRA and IAV have developed perhaps the most diversified channels, including rather large involvement of the public and private development organizations (some of them directly created at their initiative);
- Egypt, where the Ministry of Agriculture and Land Reclamation has designated ARC as technically responsible (through the ARC Directorate for Extension) for its extension activities supervised by the Central Administration for Agricultural Extension; and where ARC oversees the Regional Research and Extension Councils[1] and national campaigns for commodities[2];
- Jordan, where relationships of NCARTT with development agencies, extension services, and farmers are, in general, well established, primarily through the MOA Directorate of Agricultural Extension and Information;
- Syria, where the main ARIs are directorates of the Ministry of Agriculture which have comfortable relations with the other directorates in charge of extension/development at national and regional levels; and
- Iran, where extension activities are actually incorporated within the same main NARS institutions.

Linkages between NARS institutions and development organizations have largely improved over the last years in other countries, such as:

- Tunisia, where the recently established "regional development poles" (one per large agroecological zone) offer a good framework for bringing together all the partners concerned with agricultural research and development, including development agencies and farmers' representatives;
- Iraq, where linkages of the NARS institutions with extension/development organizations and with farmers have improved with the recent implementation of the national strategy for agricultural research and transfer of technology;
- Lebanon, where dissemination of research findings to farmers is direct in some areas (cereals, grain legumes, plant nutrition, pest management, etc.) and often takes place through public and private organizations, and local, national and international NGOs (which are playing an increasing role in this process);
- Turkey, where GDAR has recently created a Research–Extension Liaison Department in most of its ARIs and proposed increased support and incentives for scientists to undertake collaborative research with development organizations; and
- Yemen, where the process of research decentralization and the higher attention given to farming systems research within AREA are promising for the future.

[1] These Regional Research and Extension Councils are responsible for discussing problems of agricultural production in the zone and suggesting solutions; discussing and approving research and extension programs in the zone; suggesting methods for funding and supporting research and extension programs in the zone; and monitoring and evaluating the achievements in research and extension programs in the zone.

[2] The national campaigns for commodities were set up for improving the production of cereals (maize, rice and wheat), oil crops, sugar crops, citrus, and banana; in these campaigns, experts and scientists from research centers, universities, and implementing agencies work together in order to guide producers to the use of technology packages developed by researchers.

In some countries, regional and international agriculture centers/organizations play a catalytic role in linking research and extension.

In most of the FASs of the WANA region, there is no formal institutional relationship with extension services or farmers and no mechanism for technology transfer; thus, relations with development/extension organizations are very limited and are manifested mainly in contacts made essentially on an individual basis according to the research outputs available. The Moroccan and Egyptian FASs are exceptions as they have developed their own relationships (Morocco) or have integrated linkage organizations where an ARI assumes the leadership role (Egypt).

In any case, whatever their degree of organization, and even for the countries with the best organized linkages, the actual efficiency of relationships between research and development depends on other objective factors related to the NARS features (structure; human, physical and financial resources; etc.) and to the national development/extension organizations. Actual linkages can only be globally weak in countries where NARS and/or development/extension organizations have acute weaknesses, i.e.:

- where NARSs (essentially their main ARIs), with a large extent of variation in their capacities, qualifications, and coordination:

  - are highly fragmented and have a moderate or low degree of integration (Algeria, Libya, Sudan);

  - have researchers with inadequate qualifications and, consequently, with insufficient scientific productivity (Algeria, Bahrain, Eritrea, Iran, Iraq, Libya, Syria, UAE);

  - suffer strong unbalanced regional allocation of resources, leaving large parts of the country without the permanent presence of significant human and physical resources (Algeria, Egypt, Sudan, Tunisia, Yemen); and

  - mobilize very limited financial resources, especially operation and capital budgets (Algeria, Ethiopia, Sudan, Yemen).

- where development/extension organizations are unfavorably structured at national and regional levels (mainly composed of highly centralized public organizations, with lack of well-organized professional and private organizations, such as cooperatives, unions, and sectorial organizations), and have very limited qualified human resources and very low financial resources. A few monographs contain explicit reference on these issues, as shown below:

  - In Morocco and Tunisia, development/extension organizations seem relatively dynamic and diversified (strong agricultural unions at least in some areas).

  - In Egypt, relations with development are hampered by many factors, such as inadequate extension policies, insufficient coordination in MALR directorates and between the ministries concerned, overstaffing and few numbers of staff with high qualifications (especially at the middle level), poor physical facilities in the extension services, etc.

  - In Sudan, "weakness of the extension services (with poor human, physical, and financial resources) and farmers' organizations is a strong limiting factor for technology dissemination."

  - In Jordan, the MOA Directorate of Agricultural Extension and Information has recently developed a National Strategy for Agricultural Extension (such initiative has not been mentioned in any other monograph).

  - In Iran, NARS "should provide adequate incentives to the private sector and NGOs for their active investments and participation in the NARS."

  - In Turkey, "farmers' unions and cooperatives are government-controlled and operated."

Moreover, the actual efficiency of relationships between research and development rely mainly on the features of the farmer/grower communities themselves. Advances in agriculture are generally few and slow in countries where the majority of peasants are illiterate and their physical environments receive little attention (poor communication facilities), and where credit/financial and commercial needs are not satisfied.

Finally, in all the countries of the WANA region, relationships between research and development are hampered, to a large extent, by the above constraints, which may explain the following comments on the impact of NARS on production.

NARS Impact on Production

The monographs provide limited information on the impact of AR on agricultural production, which is a rather complex issue.

- In Algeria, the relatively high increase in national agricultural production observed since 1980 is certainly due less to technical innovations proposed by the NARS institutions than to other factors (privatization of the socialist and cooperative farms, liberalization of agricultural marketing, easier imports of inputs and technologies).
- In Morocco, INRA claims the release of about 65 cultivars of various cereals, forages and food legumes, now marketed by the National Seeds Marketing Society.
- In Tunisia, technologies developed by the NARS that have been successfully adopted include improved cultivars of cereals, legumes, vegetables, and fruit trees; biological and chemical control of plant diseases; better utilization of annual feed resources; and improved local sheep breeds. However, it is difficult to obtain an inventory of research output, or to evaluate the impact of research on agricultural development. This aspect may be explained by the lack of evaluation of research output. The technologies generated appear to be more readily adopted by large-scale farmers, agricultural development agencies, rural development societies, and state and cooperative farms, rather than by the majority of medium- and small-scale farmers.
- In Egypt, the impact of AR on production is difficult to estimate as progress in production results also from many other factors and from the agricultural reform policies. What is sure is that without AR support and results, the large increases in the yields of major crops (wheat, maize, rice, etc.[1]) observed during the last 10 years would not have taken place, and prospects of the national food balance would not have changed so dramatically. According to 1994 statistics, the food gap for grain by the year 2000 was estimated at 4.5 million tons, against 26 million tons according to 1982 statistics, recording a reduction of about 83%.
- In Syria, it is well recognized that AR has contributed significantly (along with other national public services and public and private organizations) to national agricultural development, which has been rather good over the last 10 years; the AGDP has registered 50% growth during the period 1985–1995. The impact of AR has been important in some areas such as field crops (cereals, food legumes, fruit, etc.) and cotton (Syria has the highest yields in the world).
- In Turkey, GDAR has provided valuable research output to the nation's agriculture, mainly in plant breeding and crop management and protection, where it has a relatively well-trained scientific cadre and adequate research facilities. In addition, it has a core group of qualified research staff and a growing research capacity in plant genetic resources conservation. However, GDAR's research potential and past accomplishments have been rather limited in animal breeding, husbandry, health, and fisheries.
- In Yemen, in spite of the many constraints and weaknesses, AR activities seem to have met some of the development objectives of the country; for example, self-sufficiency in vegetables and fruits has been achieved.

Most of the previous observations and verbal statements made by NARS leaders suggest that AR has had a rather significant positive impact on agricultural development. To date, there have been no formal studies related to the impact of NARS on agricultural production at the national level; only a very limited number of studies have been conducted on some commodities in a few countries (mainly Egypt and Turkey). These studies, based on *ex post facto* benefit–cost analysis of technologies, have generally demonstrated the high profitability of AR programs; however, most of these studies (and the similar ones carried out in other regions/countries of the world) are questionable, as they often underestimate the research costs and overestimate the benefits, thus overestimating AR profitability which might be positive but not as high as calculated[2] or suggested.

[1] The national yields for wheat, maize, and rice have increased from 3.20, 4.13 and 5.70 t/ha in 1982 to 6.07, 7.88 and 8.33 t/ha, respectively, in 1995.

[2] Most of these studies do not take into account (or, instead, they minimize) such factors as (i) the indirect costs (common research charges, costs of other national and foreign research work useful for advancing the program) throughout the duration of the program, and (ii) the depreciation of human investment (cost of staff training) developed before the conception and start of the program. Regarding the benefits, the studies allocate them essentially to research, and they underestimate the role of other important components of the extension process (agricultural extension; agricultural and general training; infrastructure, such as dams or new or improved roads, etc.). They also ignore some problems related to the negative impact of agricultural growth on natural resources (for example, the decrease of water reserves, soil pollution). For a severe criticism of these *ex post facto* AR benefit–cost analyses, see Montes-Llamas (1986) and Casas/FAO (1999).

At this point, an interesting observation is worth noting. Referring to the agricultural production growth indices (total or per capita) of 1996 compared to those of 1980 (estimated by FAO, see Table 4, Chapter 2), it may be concluded that there is no obvious relationship between both the features of the NARSs and the research–development linkages, as descried above, and the performance of national agriculture (except probably in the very long term). This may be seen from the following:

- Some countries with NARSs that have numerous and acute deficiencies have had rather good agricultural growth; among them are Iran (FAO indices: total = 221; per capita = 128), Algeria (FAO indices: total = 196, per capita = 126), and Syria (FAO indices: total = 167, per capita = 93[1]).
- Other countries with better-structured and endowed NARSs have had lower performance: :Egypt (FAO indices in 1996: total = 181, per cap. = 123), Turkey (FAO indices: total = 140, per capita = 100), Ethiopia (FAO indices: total = 138, per capita = 88), Cyprus (FAO indices: total = 105, per capita = 83), and Eritrea (FAO indices: total = 103, per capita = 88).

As a final word, with a few exceptions, most of the NARSs in the WANA region may have actually achieved until present only modest impact on national agricultural development due to the above-mentioned shortcomings and constraints related to the NARSs, national development organizations, and farmers' conditions and environment. The NARSs are not responsible alone for such a situation; the deficiencies in agricultural policies and the socioeconomic underdevelopment in most countries do not generally provide favorable circumstances for agricultural research and development and dissemination of innovations. Such considerations lead to the final conclusion.

9.5 CONCLUSION

The above analysis showed the diversity of the NARS profiles in terms of structure, resources, research activities, and productivity, which reflects the diversity of the countries themselves. Despite this diversity, some common issues have been outlined, which deserve further attention within a historic perspective.

The NARSs are relatively young. They have been progressively set up in countries which got their full formal independence and self-governance after the Second World War, and even much more recently for some countries. Most of these countries have experienced difficult "political" periods and changes at the time of independence or later, and have generally had other priorities than agriculture and research. Most of the NARSs have experienced very rapid growth. Although this has inevitably given room to understandable mistakes, it has created experience and maturity at the same time. This now warrants future improved evolution.

Thus, most of the NARSs have suffered unstable changes in their environment over the years. In some countries, the national authorities governing the NARS institutions have changed too often, frequently as a result of governmental and political considerations, and sometimes, if not often, as a result of reasons that are far from being organizational or scientific. Such unstable environments have induced instability in the NARS structures, resources, and scientific and administrative leadership. However, it seems that such unstable environments have become less and less damaging as most countries now have one or two well-established, dominant ARIs, generally affiliated to a ministry of agriculture. These ARIs are endowed with highly qualified staff, which makes the NARSs less vulnerable to political changes.

The growing numbers of NARS institutions is a feature in all countries. In the past, and until present for some NARSs, ARIs and their researchers suffered discrimination compared to the FASs and their academic staff members. This was, and still is, understandable in the "younger" countries, where priority was given to educating graduate staff members who were a rare resource in the past. But the situation has changed in most countries, where public institutions specialized in administration and development are now (or are starting to be) endowed with sufficient numbers of graduates, even if the level of their qualifications remains questionable (see below). Therefore, the allocation of scientists at the ARIs is no more a sensitive issue, except when career and salary schemes are still much less favorable than at the FASs and some other public institutions, and may discourage recruitment and stability of the best researchers. Fortunately, ARIs in many of the NARSs have recently implemented some positive changes in this domain, and can now attract, train, and retain motivated and qualified researchers. Regarding other human resources, the problem of recruiting technicians and other qualified support staff has almost never been taken into consideration, despite the fact that these categories of staff have a highly significant role on the scientists' efficiency.

The unbalanced allocation of human and physical resources is a major issue in many NARSs; the lack or scarcity of permanent scientific and technical staff in vast regions of each country, which are often the less favorable

[1] Most of the total growth has been registered within the last 10 years.

agroecological zones and farming systems, results in inadequate research activities and relations with development organizations in those regions. This situation reflects the unbalanced national socioeconomic development policies which have generally paid more attention to urban development and to rural areas closer to the capitals and large cities. Things are also improving in this domain, albeit rather slowly. Now, within the framework of large political and economic decentralization processes which would allow more balanced regional development, and through the preparation of national AR strategic plans, NARSs should improve the territorial allocation of their resources.

Most of the NARS leaders have complained about insufficient financial resources, especially the small operation and capital budgets, considered as the most limiting factor to research efficiency. However, data presented in most of the monographs show that such a situation may be improved if certain issues are taken into consideration. In many NARSs, it seems that: (i) the number of scientists or researchers could be reduced without affecting the productivity of research, as their actual employment rate is often rather low; (ii) employees with low qualifications (laborers, drivers, etc.) are rather numerous; and (iii) the networks of research centers, stations, and farms are oversized and could be rationalized and made less expensive.

Research activities are still frequently subject to many deficiencies, such as their inadequate quality due to the rather low qualifications of the scientists (at the ARIs), unbalanced coverage of scientific domains and regions, lack of monitoring and assessment, and limited international scientific cooperation, especially among the WANA NARSs. However, the main ARIs are aware of these deficiencies and are progressively overcoming them through intensive training efforts; preparation of national strategic AR plans or ARI master plans; and dynamic relations with regional and international AR centers and organizations, particularly FAO, ICARDA, ACSAD, AOAD, and CIHEAM, which have contributed considerably to strengthening agricultural research and capacity building in the WANA countries, in addition to enhancing coordination at the national and regional levels. All these efforts are paving the road for more active and balanced relations within the region.

Linkages with public and private development organizations are also concerns of the main ARIs, which have already set up diversified channels for intensifying them. As seen above, the improvement of these linkages may rely on further changes within these organizations and in the national agricultural policies.

Finally, scientific results and impact on agricultural production may seem rather modest when the large amounts of resources allocated to the NARSs are taken into account, but this issue may be considered within a long-term perspective. Most of the NARSs have almost completed the stage of quantitative growth and are now entering into the era of consolidation.

For the future, the major challenges to the NARSs will be the appropriate balance with their partner organizations—public agricultural administrations, public and private development organizations, and farmers' unions—which apparently are facing more acute problems of management and resources. Countries certainly need well-organized and efficient NARSs, but such NARSs can not serve their purpose without partners having the same features. This issue may require the NARSs to pay higher attention to certain activities that could reinforce these partner organizations (such as training of their senior staff and leaders and temporary transfer of researchers to these organizations) and to some research domains which would help development and farmers' organizations to better understand their own situation, such as multidisciplinary research on farming systems and also research on sociology focussed on rural communities and organizations.

Acronyms of the NARS Institutions Mentioned in the Text and Tables

Algeria: ENASA: Ecole Nationale des Sciences Agronomiques (Alger). INRAA: Institut National de la Recherche Agronomique d'Algérie. DFRV: Directorate of Training, Research and Extension.

Libya: ARC: Agricultural Research Center. ASRC: Animal Studies and Research Center. MBRC: Marine Biology Research Center.

Morocco: ENA: Ecole Nationale d'Agriculture de Meknès. IAV Hassan II/Rabat: Institut Agronomique et Veterinaire Hassan II. INRA: Institut National de la Recherche Agronomique. INRH: Institut National de Recherche Halieutique. DERD: Directorate of Education, Research and Development).

Tunisia: INAT: Institut National Agronomique de Tunis. INRAT: Institut National de la Recherche Agronomique de Tunisie. IRESA: Institution de la Recherche et de l'Enseignement Supérieur Agricoles.

Egypt: ARC: Agricultural Research Center. DRC: Desert Research Center. NARC: National Agricultural Research Council. NARP: National Agricultural Research Project. NIOF: National Institute of Oceanography and Fisheries. NRC: National Research Center.

Eritrea: CAAS: College of Agriculture and Aquatic Sciences of the University of Asmara (UOA). DARHRD: Department of Agricultural Research and Human Resource Development.

Ethiopia: EARO: Ethiopian Agricultural Research Organization. IAR: Institute of Agricultural Research.

Sudan: ARC: Agricultural Research Corporation. ARRC: Animal Resources Research Corporation.

Cyprus: ARI: Agricultural Research Institute.

Iraq: SBAR: State Board for Agricultural Research. CWSR: Center for Water and Soil Research.

Jordan: NCARTT: National Center for Agricultural Research and Technology Transfer. UOJ: University of Jordan (Amman). WERSC: Water and Environment Research and Study Center.

Lebanon: LARI: Lebanese Agricultural Research Institute.

Syria: DASR: Directorate of Agricultural Scientific Research. DCB: Directorate of Cotton Bureau. DIWU: Directorate of Irrigation and Water Use. DS: Directorate of Soils.

Iran: MOJC: Ministry of Jihad Construction. MOC: Ministry of Commerce. MOH: Ministry of Health. AREEO: Agricultural Research, Education and Extension Organization.

Turkey: GDAR: General Directorate of Agricultural Research. GDRS: General Directorate of Rural Services. ARI: Agricultural Research Institute. HCA: High Council of Agriculture (MARA).

Bahrain: ARD: Agricultural Research Directorate.

United Arab Emirates: ARC: Agricultural Research Center of the MAF Department of Agriculture and Animal Husbandry, Al-Ain. ARD: Agricultural Research Directorate of the MAF Department of Research and Plant Production.

Yemen: AREA: Agricultural Research and Extension Authority.

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Annex 9.1 - Figs 1 to 7

Fig. 1 - The WANA NARSs: Actual Employment Rate (aRYs/pRYs) in Relation to GDP per Capita

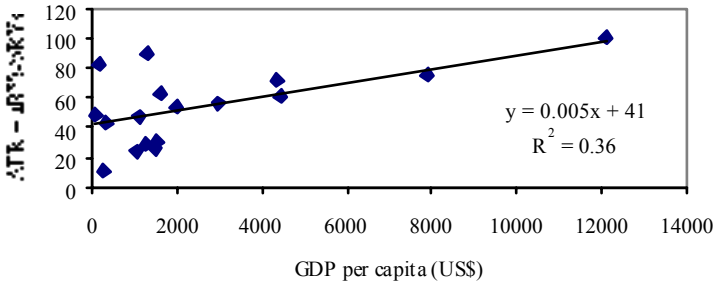

Fig. 2 - The WANA NARSs: Actual Employment Rate (aRYs/pRYs) in Relation to Population of the Countries

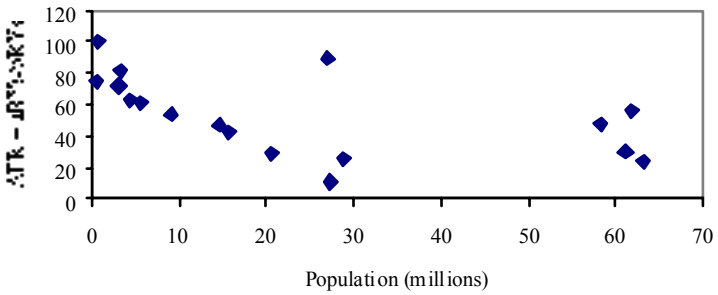

Fig. 3a - The WANA NARSs: Ratio of National AR Expenditures (NE) to AGDP in Relation to GDP per Capita

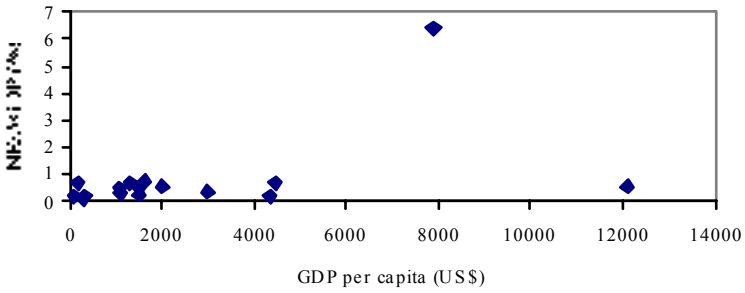

Fig. 3b - Same as Fig. 3a, but using a larger scale and without Bahrain and Cyprus (GDP/capita: US$ 7,890 and 12,100, respectively)

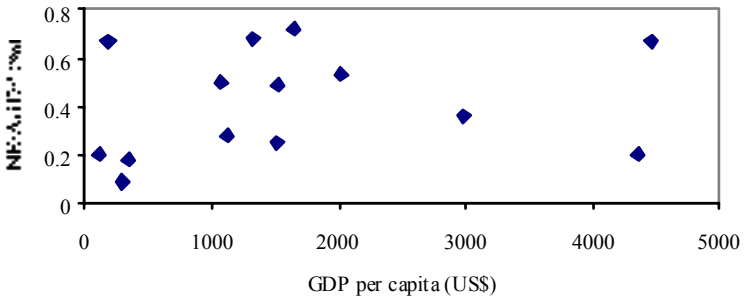

Fig. 4 - The WANA NARSs: Number of pRYs per Million Agricultural Laborers in Relation to GDP per Capita

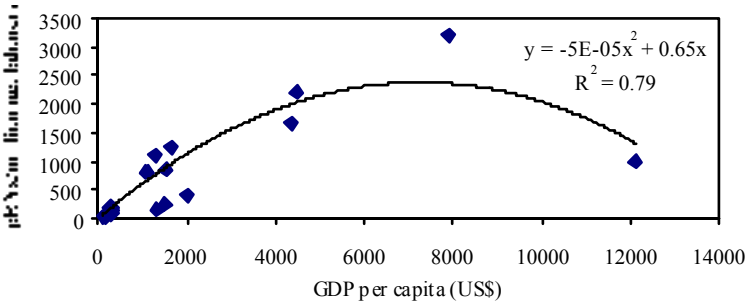

Fig. 5 - The WANA NARSs: Number of aRYs per Million Agricultural Laborers in Relation to GDP per Capita

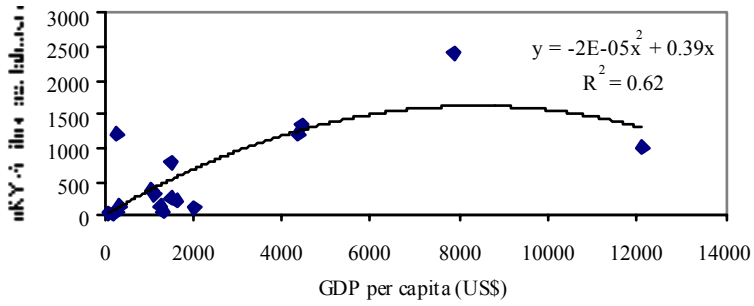

Fig. 6 - The WANA NARSs: Ratio of National AR Expenditures (NE) to Million Agricultural Laborers in Relation to GDP per Capita

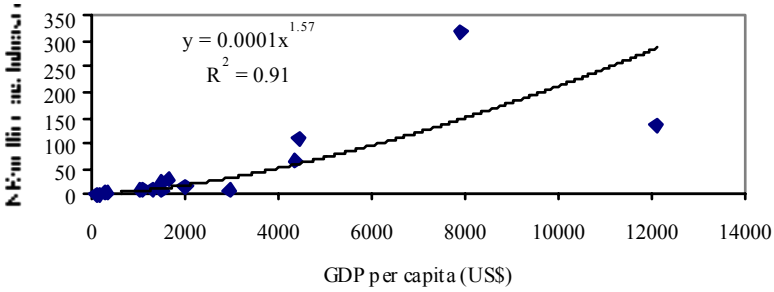

Fig. 7 - The WANA NARSs: Ratio of National AR Expenditures (NE) to Million Agricultural Laborers in Relation to Population of the Countries