

Report to the
Ministry of Agriculture and Water Resources

**A Review of the Agricultural
Research System in the
Republic of Yemen**

Arab Organization for Agricultural Development
International Service for National Agricultural Research
United Nations Development Programme

The mandate of the International Service for National Agricultural Research (ISNAR) is to assist developing countries in bringing about lasting improvements in the performance of their national agricultural research systems and organizations. It does this by promoting appropriate agricultural research policies, sustainable research institutions, and improved research management. ISNAR's services to national research are ultimately intended to benefit producers and consumers in developing countries and to safeguard the natural environment for future generations.

ISNAR offers developing countries three types of service, supported by research and training:

- For a limited number of countries, ISNAR establishes long-term, comprehensive partnerships to support the development of sustainable national agricultural research systems and institutions.
- For a wider range of countries, ISNAR gives support for strengthening specific policy and management components within the research system or constituent entities.
- For all developing countries, as well as the international development community and other interested parties, ISNAR disseminates knowledge and information about national agricultural research.

ISNAR was established in 1979 by the Consultative Group on International Agricultural Research (CGIAR), on the basis of recommendations from an international task force. It began operating at its headquarters in The Hague, the Netherlands, on September 1, 1980.

ISNAR is a nonprofit autonomous institute, international in character, and apolitical in its management, staffing, and operations. It is financially supported by a number of the members of the CGIAR, an informal group of donors that includes countries, development banks, international organizations, and foundations. Of the 18 centers in the CGIAR system of international centers, ISNAR is the only one that focuses specifically on institutional development within national agricultural research systems.

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CABI Descriptors:

agricultural research; government research; organization of research; research policy; The Republic of Yemen

A REVIEW OF THE AGRICULTURAL RESEARCH SYSTEM IN THE REPUBLIC OF YEMEN

Table of Contents

	Page
Acronyms	vii
Conclusions and Recommendations	ix
Summary	ix
<i>Organization and structure</i>	x
<i>Research resource management</i>	x
<i>Research policies and plans</i>	x
<i>Research-program management</i>	xi
Recommendations	xi
Introduction	1
Origin of the Study	1
Composition of the National Study Team	2
Work Program	2
Methodology	3
<i>Four-part approach</i>	3
<i>Information analysis</i>	4
THE AGRICULTURAL SECTOR	
Introduction	5
Natural Resource Base	7
Climate	7
Land Resources	9
<i>Soils</i>	9
<i>Land use</i>	9

Water Resources	11
<i>Rainwater</i>	11
<i>Underground water</i>	11
Vegetation and Agroecological Zones	11
<i>Vegetation</i>	11
<i>Agroecological zones</i>	13
Marine Resources	13
Human Resource Base	17
Population	17
<i>Size and annual growth</i>	17
<i>Age and sex distribution</i>	17
<i>Locality</i>	17
<i>Agricultural labor force</i>	18
Agricultural Production Systems	21
Agricultural Production Subsectors	21
<i>By land ownership</i>	21
<i>By land use</i>	21
<i>By availability of water</i>	21
<i>By production systems</i>	21
Plant Crop Production	27
Food and Feed Cereals	27
Dry Food Legumes	30
Industrial Crops	30
Vegetables	31
Fruit and Stimulant Tree Crops	31
<i>Fruit tree crops</i>	31
<i>Stimulant tree crops</i>	32
Forest Trees	32
Range, Forage Crops, Straw, and Crop By-products	33
Animal Production	35
Sheep and Goats	35
Cattle	35
Camels	37
Poultry	37
Fisheries Production	39
Agricultural Policies	41
Agriculture in the National Economy	41
Government Investments in Agriculture	45
Import and Export Policies	46

AGRICULTURAL TECHNOLOGY MANAGEMENT SYSTEM

Technology Generation and Transfer Policies	55
Pricing and Input Policies	55
Seed Policies	55
Transport, Storage, and Processing Policies	56
Research and Extension Policies	56
Analysis of Structure and Functions of the ATMS	59
Methodology	59
Analysis	61
<i>Policy context of technology generation</i>	61
<i>Technology generation and transfer</i>	62

AGRICULTURAL RESEARCH

Historical Background	83
Structure and Organization	87
The Agricultural Research Authority (ARA, Before Merging in AREA)	87
The Department of Research and Extension (DRE, Before Merging in AREA)	90
Agricultural Research and Extension Authority (AREA)	92
The University System	94
Other Organizations	94
Agricultural Research Linkages	97
<i>Linkages at the national level</i>	97
<i>Linkages with international and bilateral technical assistance</i>	100
<i>Linkages with sources of knowledge</i>	100
Recommendations on Structure and Organization	101
Research Resource Management	105
Introduction	105
Human Resources	107
<i>Qualification and distribution</i>	107
<i>Annual work activities</i>	107
<i>Capabilities and constraints</i>	116
<i>Conditions of service</i>	119
<i>Training</i>	119
Physical Resources	122
<i>Stations, centers, and mandates</i>	122
<i>Land</i>	122
<i>Buildings</i>	122
<i>Equipment</i>	122
<i>Central support</i>	122

Financial Resources	122
<i>Sources of funding</i>	122
<i>Flow of funds</i>	124
<i>Budget allocation to cost elements</i>	124
<i>Evolution of total expenditure</i>	124
<i>Research expenditures by subsectors</i>	126
<i>Research expenditure by commodity and theme</i>	126
<i>Evolution of research expenditure by subsector</i>	126
<i>Evolution of research expenditure by commodity or theme</i>	131
Recommendations on Research Resource Management	131
Research Policies and Plans	133
Introduction	133
Research Priorities and Five-year Plans	134
Annual Planning at AREA	145
Improving the Planning Process	148
Recommendations on Research Policies and Plans	151
Research Program Management	153
Introduction	153
Implementing the Research Program	154
<i>On-station and on-farm research</i>	154
<i>Teamwork</i>	154
Monitoring and Evaluation	155
<i>Output and impact of research</i>	155
Information Management	155
Recommendations on Research Program Management	157
Annex 1	159

Acronyms

ACSAD	Arab Center for the Studies of Arid Zones and Dry Lands
AFESD	Arab Fund for Economic and Social Development
AgGDP	Agricultural Gross Domestic Product
AOAD	Arab Organization for Agricultural Development
ARA	Agricultural Research Authority
AREA	Agricultural Research and Extension Authority
ATMS	Agricultural Technology Management System
AVRDC	Asian Vegetable Research and Development Center
CHRDP	Central Highland Rural Development Project
CPO	Central Planning Organization
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
DRE	Department of Research and Extension
EEC	European Economic Community
ERDP	Eastern Region Development Project
FAO	Food and Agriculture Organization of the United Nations
FAUA	Faculty of Agriculture, University of Aden
FAUS	Faculty of Agriculture, University of Sana'a
GCFD	General Corporation for Fisheries Development
GDP	Gross Domestic Product
GDET	General Directorate of Extension and Training
GTZ	German Agency for Technical Cooperation
IBPGR	International Board for Plant Genetic Resources
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDA	International Development Association of the World Bank
IFAD	International Fund for Agricultural Development
ISNAR	International Service for National Agricultural Research
MAAR	Ministry of Agriculture and Agrarian Reform
MAF	Ministry of Agriculture and Fisheries
MAWR	Ministry of Agriculture and Water Resources
MTRT	Multidisciplinary Research Team
MHESR	Ministry of Higher Education and Scientific Research
MOF	Ministry of Finance
MPD	Ministry of Planning and Development
MSRC	Marine Science Research Centre
NARC	National Agricultural Research Council
NARECC	National Agricultural Research and Extension Coordinating Committee
NRDP	Northern Region Development Project
NRETC	National Research and Extension Technical Committee
ODA	Overseas Development Administration
RCC	Research Coordination Committee
RDA	Rural Development Authorities
RDP	Rural Development Projects
RETC	Research and Extension Technical Committee

SARMAC	Strengthening Agricultural Research Management in Arab Countries
SMS	Subject-Matter Specialist
SSLC	Soil Survey and Land Classification Project
SURDP	Southern Upland Rural Development Project
TDA	Tihama Development Authority
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WB	World Bank

Conclusions and Recommendations

Summary

The Yemeni agricultural research system plays a central role in both generating and transferring the technology required to improve agricultural development in the Yemen Republic. It is essential for identifying technology problems and for developing appropriate technologies.

The utility of agricultural technology is determined by agroecological, socioeconomic, and policy conditions; thus, agricultural technology is generally highly location specific. It needs to be adapted to local conditions and ultimately used by a large number of farmers. The Yemeni agricultural research system must take a leadership role in technology generation and adaptation. Agricultural research leaders must be in a position to reflect upon and influence agricultural development policies, to define the country's agricultural research needs and priorities, to evaluate their findings and those of global research community under local conditions, and to contribute to the technology-transfer process through effective formal and informal linkages with extension and producers.

Whether primarily a generator or adaptor of technology, the Yemeni agricultural research system must be strong and effective if it is to contribute significantly to agricultural development in the country. However, no matter how well-trained, researchers cannot attain their fullest potential without institutional support.

A strong and effective agricultural research system requires:

- coherent research policy to meet agricultural development objectives;
- organization and structure compatible with designated objectives and functions of research;
- ability to communicate effectively with its clients, partners, and policymakers;
- adequate human, financial, and physical resources to conduct research activities;
- relevant research programs guided by research policy;
- coherent management processes which allow the system to mobilize its resources in a continuous and cost-effective way.

Within this concept of requirements for an efficient and effective research system, this review study was conducted by a national study team with backstopping from AOAD and ISNAR. Partial financial support from UNDP was provided to review and propose improvement in the areas of agricultural research organization and structure, resource management, policies and plans, and program management.

Organization and structure: Agricultural research is of recent history in the country and has gone through few structural and organizational changes since its establishment about two decades ago. At present, AREA is the major agricultural research institution and its mandate covers the whole country. It is a semi-autonomous national research institution governed by a board of directors and chaired by the Minister of Agriculture and Water Resources. The two faculties of agriculture are also involved in agricultural research.

To make the best use of its research capacity, AREA must define a structural organization that will ensure appropriate determination of research policy and strategy, setting of research priorities, and rationalizing of resource allocation, as well as better coordination and implementation of multidisciplinary research activities to address priority areas in agricultural development plans.

Mechanisms within AREA should be further developed to improve research-program planning and implementation. This especially calls for establishing an internal management committee to help develop guidelines for research proposals, coordinate research activities, improve monitoring and evaluation of research, and guide AREA management.

Linkages between AREA and extension, farmers, development projects, university research, and other sources of knowledge should be institutionalized to improve the efficiency and effectiveness of research.

Research resource management: Effective and efficient management of human, financial, and physical resources maintains the productivity of the agricultural research system and ensures the continuity of support from policymakers.

AREA has 207 professional staff — 23 with a Ph.D. degree, 67 with a M.Sc. degree, 83 with a B.Sc. degree, and 34 expatriates mainly associated with externally funded projects. About 50% of the national research staff are Ph.D. and M.Sc. holders, of which about two-third are at the El-Kod and Seiyun Centres.

Until recently, salaries for AREA technical staff have been comparable with those of academic staff with the same qualifications at the universities. There are now some differences due to the increase in salaries of academic staff.

The regional research stations and research centers network cover the agroecological zones in the country. Buildings, land, and equipment are generally adequate. However, there is a need to improve research support services and utilization and maintenance of physical resources.

Agricultural research in Yemen is mostly a public enterprise. The government finances research from local and external sources. While the operating costs of some research activities are well funded, others are less so therefore, funding of on-station and on-farm research should be improved.

Research policies and plans: Research planning is done through five-year and annual planning exercises. The five-year research plan for the north, 1987-91, contained 200

projects covering 11 programs and 14 disciplines. In the south, nine multidisciplinary research teams — five at El-Kod Research Centre and four at Seiyun Research Centre — are responsible for planning.

Annual planning is done mainly from the bottom-up and is generally guided by the five-year research plan.

Research-program management: Teamwork is used in preparing the annual and five-year plans and at implementation level. However, the shortages of technical staff at regional research stations constrain the implementation of effective research activities.

AREA has developed various mechanisms to monitor and evaluate its research progress. For efficient and effective research, a modified monitoring and evaluation system should be developed by AREA and integrated as a formal part of the research planning and implementation processes.

AREA organizes its administrative and financial information according to government procedures. Other types of information, such as library, technical information on research activities, and information on research-program management are poorly managed. Thus, there is a need to improve management of these types of information.

Recommendations

1. It is proposed that the Board of Directors of AREA should continue to work as a policy body rather than a management one to determine national research policy and strategy, secure political support for agricultural research, participate in the development of agricultural development policy, secure financial and human resources, organize the implementation of strategy, program, and budget plans, and approve five-year program and budget plans.
2. An AREA internal management committee should be established to replace the National Agricultural Research Council and the Research Coordination Committee, to reduce time spent by researchers for travel, administration, and other second-priority activities. The proposed committee's main functions would be to develop guidelines for research proposals, approve annual program and budget, coordinate research activities, organize implementation of research programs, improve documentation of current research activities and reporting system, and guide AREA management.
3. Efforts should be increased to improve the institutional mechanisms for linking AREA to extension, universities, regional and international organizations, and other national agricultural research systems.
4. AREA should guide and coordinate donors' technical assistance to research through the implementation of the approved research policy and strategies.

5. Planning and development of human resources should be organized for AREA to review future program needs in terms of various skills of researchers and research support staff.
6. Staffing, career, and training plans should be developed to assist AREA in maintaining dedicated and efficient staff.
7. AREA should maintain the present number of stations and centers — constructed or under construction — and improve their efficiency and effectiveness by developing policies and procedures for maintenance.
8. The centralized research support services at AREA should be strengthened through improving the germplasm bank, developing a central agricultural library and documentation center, improving the central laboratories, and establishing a central workshop for maintaining scientific instruments.
9. To improve the planning of agricultural research, a proposal for AREA was developed. It includes the principles of formulation and implementation of an agricultural research strategy and program. An organizational framework for decision making in the planning process was proposed.
10. National commodity and noncommodity research programs should continue to dictate the planning of research programs and facilitate multidisciplinary research within AREA and between AREA and other institutions in the country, e.g., universities.
11. AREA should integrate the MDRTs in South Yemen with national commodity coordinators in North Yemen and develop a unified system for implementing research programs by multidisciplinary research teams, especially for commodity improvement, as well as for implementing research activities across regional research stations and research centers within AREA (intra-institutional) and between AREA and other institutions in and outside the country.
12. AREA should increase support for on-farm trials to test and validate technologies and conduct joint trials with extension.
13. An improved monitoring and evaluation system should be developed to monitor and evaluate research activities to make them more relevant and of higher quality to serve the development process. This system should be an integral part of the research planning and implementation process and should include efficient periodic recording, analysis, reporting, and storage of data to be used for research management purposes.
14. An improved information technology system should be developed to improve management of research-program information and management of technical information on research activities.

Introduction

Origin of the Study

The Arab Organization for Agricultural Development (AOAD) and the International Service for National Agricultural Research (ISNAR) have jointly developed a project proposal entitled "Strengthening Agricultural Research Management in the Arab Countries (SARMAC)." The project objective is to assist national agricultural research systems (NARS) in Arab countries in their efforts to generate and adapt improved agricultural technologies through the development of stronger organizational and managerial capacity in the NARS. The SARMAC project proposal was endorsed by the Ministerial Council of AOAD at its 16th regular meeting held in Baghdad, Iraq, in 1987.

In the first phase of the SARMAC project, the field study methodology was developed by the adaptation and integration of the guidelines for ISNAR reviews and evaluations of NARS and the agricultural technology management system (ATMS) methodology. Thus, the field study methodology presented a number of tools which the country study teams could use in order to collect, analyze, and interpret data. The methodology was field tested through the review of ATMS in Sudan in late 1987, and a review report was prepared and presented to the Sudanese Minister of Agriculture and Natural Resources. A national seminar was held in August 1988 at AOAD headquarters in Khartoum, Sudan, to present and discuss findings. A final report covering the proceedings of the seminar and the review report was published and distributed in 1988.

Based on the response from NARS managers to the Sudan study, and in order to meet SARMAC objectives, AOAD and ISNAR developed the second phase of SARMAC which calls for preparation of three detailed country studies (Iraq, Yemen, and Algeria) during 1989-1991, followed by three national seminars, one for each country, to discuss study findings and recommendations, and a regional workshop to discuss common issues and lessons learned from the four country studies. Phase II is a collaborative activity involving the countries, AOAD, and ISNAR. The United Nations Development Programme (UNDP) is assisting this phase by providing partial funding.

The field studies were begun in Iraq in late 1989, and in Yemen and Algeria in late 1990. A draft review report on the agricultural research system in Iraq was prepared and presented in late 1991 to the Iraqi Ministries of Planning, and Agriculture and Irrigation. A national seminar was held in Baghdad, Iraq, in January 1992, to present and discuss findings. A final review report was published and distributed in March 1992. This review report is the third in the country studies of SARMAC.

Composition of the National Study Team

The Yemen Arab Republic (YAR) and the People's Democratic Republic of Yemen (PDRY) merged on 22 May 1990 to form the Republic of Yemen. This event has led to modification in the geographic coverage of the country study from the former PDRY to the Republic of Yemen. Thus, a national study team representing the geographic as well as disciplinary, and organizational dimensions was formed as follows:

- Dr. Ahmed Ali Mukbel, Deputy Minister of Agriculture and Water Resources; team leader.
- Dr. Abdul Wahed Mukred, Horticulturist, Director General, Agricultural Research and Extension Authority (AREA); team member.
- Dr. Abdul Rahman Nassar, Animal Production Scientist, Faculty of Agriculture, Sana'a University; team member.
- Mr. Abdul Rahman Sallam Qasem, Soil scientist, Deputy Director General, AREA; team member.

Work Program

In a two-day preparatory workshop, held in Sana'a, in August 1990, an ISNAR/AOAD preparation team introduced and discussed with the national study team the field study methodology with the objective of adapting the methodology to the Yemen situation, to improve methods of collecting data, and to develop a schedule for implementing the study, holding a national seminar, and finalizing the draft report.

The national study team has developed a schedule to collect information concerning the role of agriculture in the economy, the structure and functions of the ATMS, the research institutions, and the researchers in the country.

In collecting the various types of information, the team members have divided the work among themselves according to institutional and former geographic (North and South) affiliations, and assigned institutional coordinators to follow up in collecting information at the research institution level, i.e., research institution and researcher questionnaires.

During the period from September 1990 to November 1991, the national study team has collected data on the role of agriculture in the economy, structure and functions of ATMS, research institutions, and researchers. With backstopping from AOAD and ISNAR, the data was analyzed and interpreted. A draft report was written and submitted in June 1992 to the Yemeni Ministry of Agriculture and Water Resources (MAWR).

The review report covered an analysis of the country's agricultural sector (natural resource base, human resource base, agricultural production systems, crop production, animal production, fisheries production, and agricultural policies), ATMS (technology generation and transfer policies and structure and functions of the ATMS), and

agricultural research (structure and organization, research resource management, research policies and plans, and research-program management). A set of recommendations was provided to improve agricultural research organization and structure, resources, policies, and program management.

A national seminar was held in Taiz, Yemen, September 13-15, 1992, under the patronage of the Minister of Agriculture and Water Resources to present the draft report findings and recommendations. The seminar participants included representatives of the Ministries of Agriculture and Water Resources (MAWR), Planning and Development (MPD), and Higher Education and Scientific Research (MHESR), Rural Development Authorities (RDA), Rural Development Projects (RDP), Universities of Sana'a and Aden, and AREA's research managers and leaders.

Methodology

Four-part approach: The methodology used to test the effectiveness of the agricultural technology management system (ATMS) in the country is a four-part approach consisting of:

1. *Overview of the agricultural sector:* Information collected dealt with the country's natural resource base, human resource base, agricultural production systems, plant crop production, animal production, fisheries production, and agricultural policies. Information was obtained through literature surveys, interviews, and discussions with informed personnel in the various ATMS institutions, and team members, and the experience and knowledge of AOAD and ISNAR.
2. *Functional analysis:* All institutions and groups involved in the ATMS were identified by the team members, AOAD and ISNAR. These include the local technology sector with its subsectors — the technology-generating, the technology-transfer, and the technology-using subsectors; the politico-bureaucratic structure composed of formal representatives of the government and decisionmakers and the channels through which interests of all groups in the ATMS are made known to policymakers; the external sector composed of donors, international and regional technology-generating and technology-transfer institutions; institutions which influence the world markets for inputs and outputs and the resource base in the country; and institutions which influence the policy environment.

The purpose of the role of each of these institutions was defined. Its level of involvement in the 13 key functions which an ATMS must perform or influence was identified. The mechanism by which these institutions perform or influence functions is explained.

3. *Institutional analysis:* Forms requesting information about the structure of various research institutions, their financial, human and physical resources, allocation of resources among commodities and themes, organization and management, output, planning, agreements with other organizations, evaluation of expenditure and

scientific staff, and training targets were prepared by ISNAR. These forms were distributed by the national study team to various research institutions in the country who provided the required information from institutional records.

4. *Human resource inventory:* Forms requesting background information on scientists, their education, employment, activities, and options about human resource management issues were prepared by ISNAR. They were distributed to scientists by the national study team through teams of supporting staff, who made contact with scientists in the research institutions.

Information analysis: The data collected of the first part is used as part of the analysis of the agricultural sector, and the data of the second part is used in the analysis of the structure and functions of ATMS. The data concerning institutional analysis and human resource inventory are used as parts in the analysis of agricultural research in the country, its structure and organization, research resource management, research policies and plans, and research program management. It is worth mentioning that numbers in many tables are provided separately for the northern and southern parts of the country.

THE AGRICULTURAL SECTOR

Introduction

In this study, the agricultural sector will be dealt with some details due to: (a) the unification of the country in 1990 and (b) the need for comprehensive information on the agricultural sector to be used by policymakers as well as by research managers and leaders.

Yemen contains by far the most fertile land in the Arabian Peninsula. Agriculture has always been extensively practiced in the coastal plains, in the Wadi, in the highlands, and in the eastern plateau.

Agriculture is an important sector in the economy. It contributes about 18 to 27% to the gross domestic product (GDP) of South and North Yemen, respectively, and employs about 56% of the labor force. However, the role of agriculture is changing due to dynamism of these sectors, emigration of rural labor, and structural changes within agriculture.

The cultivated croplands comprise 1.47 million ha with an overall intensity of 0.75. An additional 2 million ha of the marginal lands are cultivated during high rainfall years. Woody vegetation and shrub growth covers about 3.3 million ha. Rangeland covers 16 million ha. The remaining land consists of rocky and desert lands.

According to the rainfall, the availability of water for irrigation, altitude, and temperature, the country has tropical, sub-tropical, and temperate agriculture.

The main commodity groups produced are cereals, industrial crops, vegetables, fruits, and livestock. Cereals are grown on about 60% of the total cultivated land. Sorghum and millet cover 80% of the cereals area. Main industrial crops are sesame, cotton, and tobacco. Main vegetables are tomatoes, potatoes, cucurbits and onions. Fruits produced include grapes, bananas, papayas, almonds, walnuts, and dates. Livestock includes sheep, goats, cattle, poultry, and fish.

Yemen is self-sufficient in sorghum and millet. However, it is not self-sufficient in total cereals, vegetable oils, sugar, and animal products. Thus, attaining self-sufficiency in food production for feeding its population is the declared policy of the government. Agriculture has been given the top priority in five-year plans, with special emphasis on production. Incentives are provided to encourage cash crops, agribusiness, livestock production, and fisheries. Newly integrated rural and agricultural development projects are bringing new lands under cultivation. Research is being promoted to produce improved technologies. Small dams and low-cost irrigation methods are increasingly introduced to improve access to water, which is a major constraint to agricultural development in the country.

Investment in agricultural research in the north of Yemen has increased in real terms fourfold during the eighties, from about 9 million Yemeni rial (Yr) in 1980 to about 36 million Yr in 1988. New regional research stations were built and equipped, and more scientists were trained. The total number of Ph.D. and M.Sc. scientists has increased from 9 in 1980 to 88 in 1989. Thus, the contribution of research in improving overall agricultural production in the country has begun to be realized through the generation and transfer of improved technologies.

Natural Resource Base

The Republic of Yemen is in the southwestern part of the Arabian Peninsula in southwest Asia. It is bounded by Saudi Arabia in the north and northeast, Oman in the east, the Red Sea in the west, and the Arabian Sea and Gulf of Aden in the south. Yemen lies approximately between latitudes 12° and 17° north, and between longitudes 43° and 56° east (Figure 1).

The area of Yemen is about 550,000 km². Topographically, it consists of a stretch of semi-arid and desert lowlands along the coastal regions, a central part of the country which is covered by a chain of mountains from south to north with interspersed plateaus at various altitudes, and an eastern and northeastern area, where mountains slope into a semi-arid region extending into the desert area of the Rub al-Khali (Empty Quarter).

Climate

In general, Yemen is situated in the northern stretches of the tropical climate zone. Temperature varies greatly due to the extreme differences in elevation. Mean annual temperatures range from less than 15° C in the central highland to 30° C in the coastal plains. Recorded temperatures may rise to 40° C during summer in the coastal plains, and to over 40° in the desert area of the eastern region. However, the winter temperatures may decrease to freezing in the highlands.

Rainfall is highly erratic in time, quantity, and location. It occurs in two periods, the first from March through May, and the second from July until September, which is the heaviest raining season. Normally there is little or no rain from November to February but there are exceptions in certain regions and years. Rainfall varies from less than 50 mm in the coastal lowland plains and eastern desert zone, to more than 1200 mm in the western mountainous highlands. In general, annual rainfall increases with distance from the Red Sea, reaching 150 mm in the Central Tihama Plain, and up to 300-400 mm on the foothills of the mountains. Again, the rainfall increases from south to north and in the western mountainous highlands. Then it decreases in the Central Highlands towards the capital, Sana'a, where it averages to about 200 mm in the northern highlands, then, gradually increases from Sana'a towards the north to Sa'ada (Figure 2).

The country can be divided into three climates:

1. *Arid tropical climate*: This climate region covers the coastal plains and lower mountain slopes in the west and south, and is characterized by high temperatures and low precipitation ranging from 0 to 400 mm.

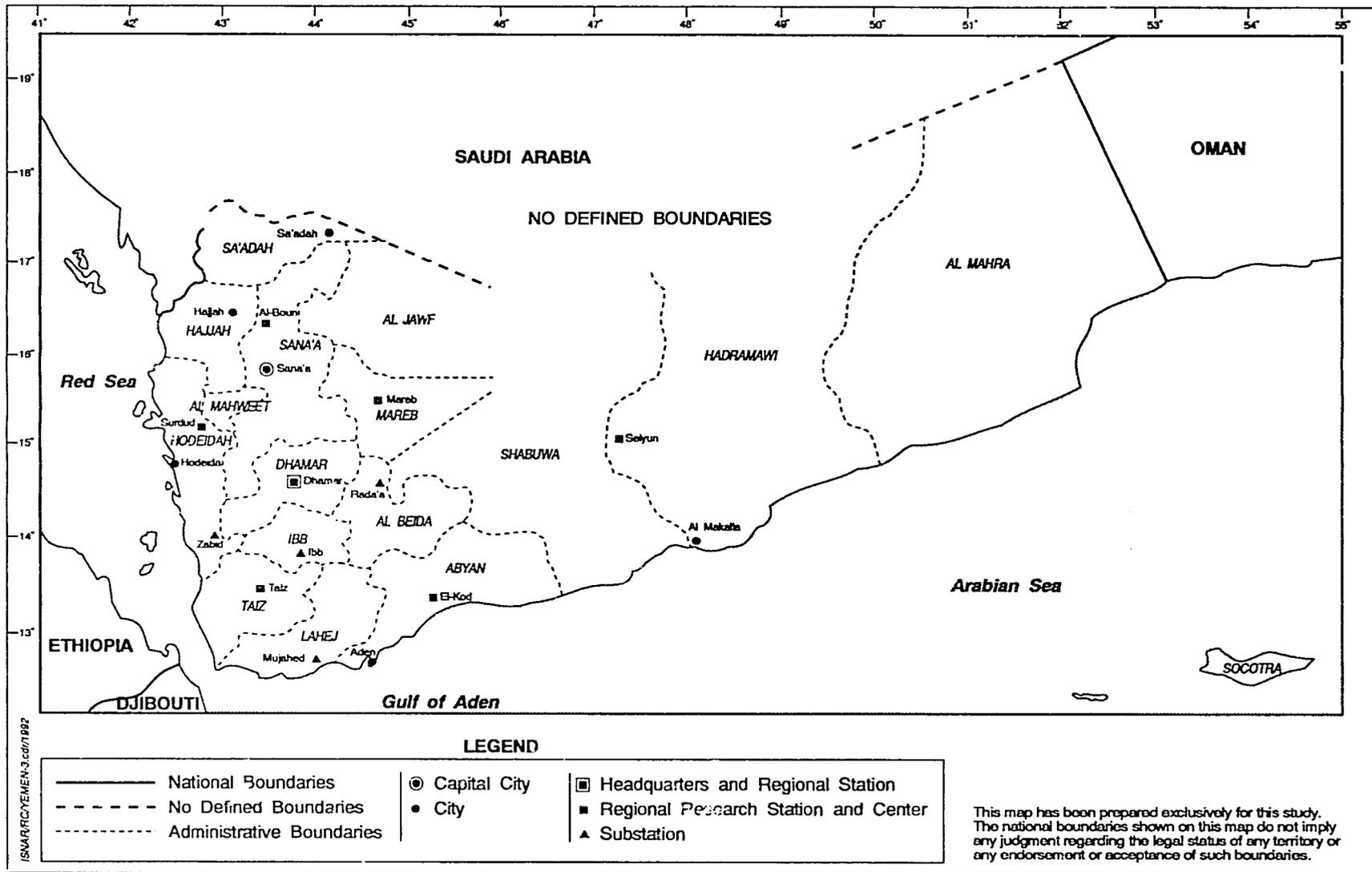


Figure 1: Administrative Boundaries and Agricultural Research Stations

2. *Arid subtropical climate:* This is a transitional climate between the tropical climate of the coastal plains and the temperate of the highland zone. Mean monthly temperature varies from 16° C to 28° C. Precipitation ranges from less than 100 mm to 600 mm. It covers the lower and upper mountain slopes and the eastern desert.
3. *Temperate climate:* This covers the mountains ranging in altitude from 1800 to 3700 m. Mean monthly temperature in this climate ranges from 10° C to 18° C. Precipitation varies from 200 mm to more than 1500 mm.

Land Resources

Soils: The country's soils are generally sandy to silty and loamy in the coastal plains, silty to loamy and clay loamy in the mountainous areas, and low in nitrogen, phosphorus, and organic matter. In many areas, shallow soils limit the amount of water available for rainfed crops. Soil erosion caused by runoff and/or winds is often serious. Sand and dust storms, which generally blast across the lowlands and highlands promote soil erosion. (Table 3 briefly describes soil types as well as other agroecological characteristics.)

Land use: Agricultural land consisting of arable land and land under permanent crops forms about 3% (of which about 77% are occupied with rainfed crops and about 23% irrigated crops), permanent pasture land forms about 29%, and forest land forms about 4% of the total area of the country of 55,000 thousand ha (Table 1). The remaining 61% is nonagricultural land.

Table 1: Land Resource Structure (1,000 ha)

Description	1987	1989	1990
Total area	55,000	55,000	55,000
Land area	55,000	55,000	55,000
Arable and permanent crops	1,479	1,481	1,481
Rainfed lands	1,171	1,167	1,133
Irrigated area	308	314	348
Permanent pastures	16,065	16,065	16,065
Forest	2,000	2,000	2,000
Marginal lands	7,000	7,000	7,000

Source: MAWR Statistics, 1992.

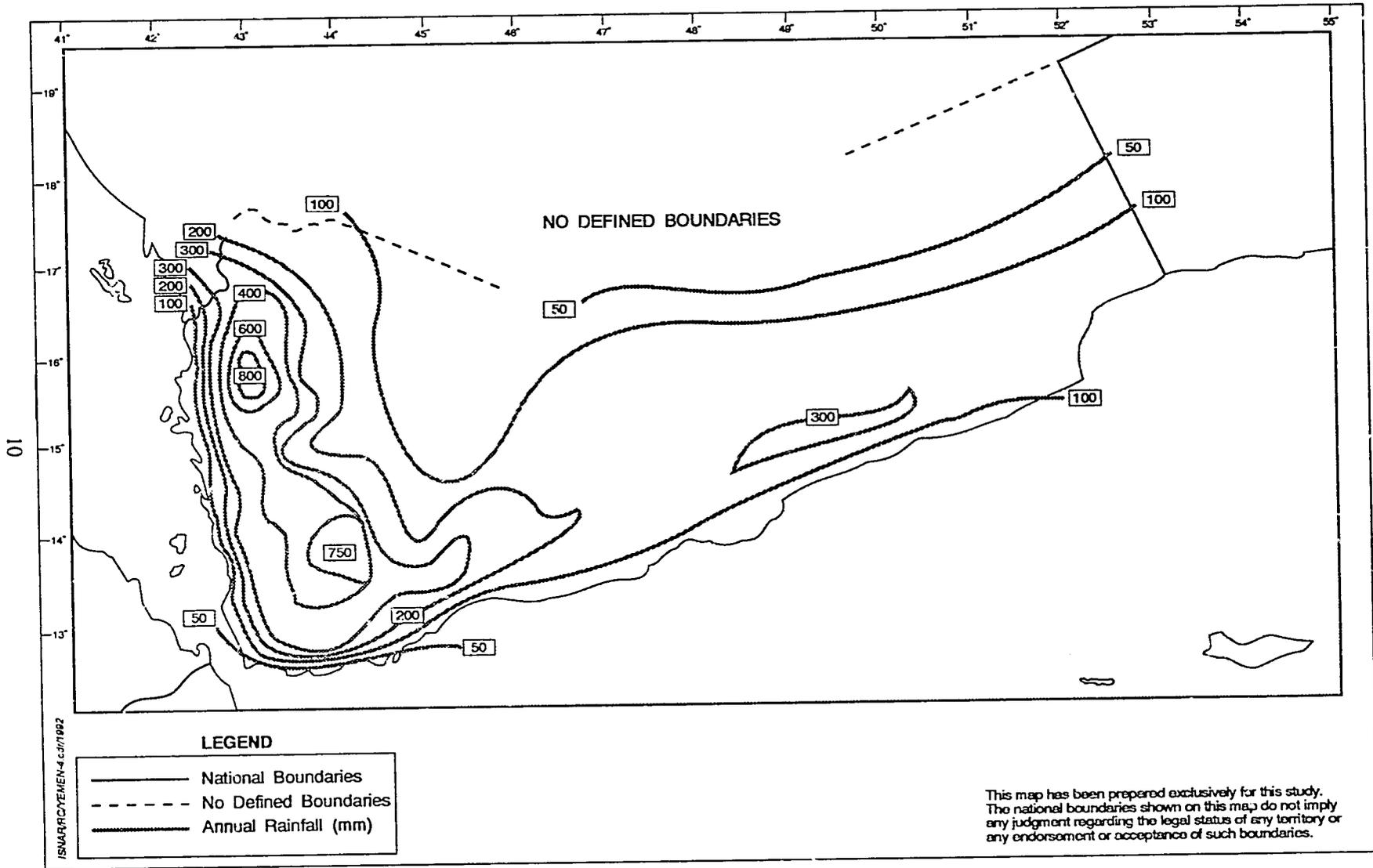


Figure 2: Mean Annual Rainfall

Water Resources

Water is scarce and vital to all aspects of development in the country. The availability of water is the major constraint to agricultural production. This situation presents a challenge to Yemen for better utilization of water resources. In its five-year plan Yemen has allocated a great proportion of its resources to develop the water sector, especially the development of water supply for irrigation.

The major two sources of water supply in Yemen are:

- rainwater;
- underground water.

Rainwater: There are no lakes or perennial rivers in the country. Rainfall is the basic water resource. Rainfall varies from less than 350 mm, which could be considered below the minimal amount needed for rainfed agriculture, to about 1500 mm per year. The highest and most consistent rainfall occurs in the southern highlands, near Ibb.

A large portion of the agricultural area relies on spate irrigation. Spate irrigation rations the occasional flood waters from storms in the mountainous catchment areas to the coastal and foothill areas. About 8% of the total cultivated area is thus irrigated and about 41% of the total permanent and semi-irrigated areas (Table 2).

Underground water: Wells and springs are important sources for domestic water supply and irrigation. These offer farmers more secure water supply than spate irrigation. Wells and springs are more common in the highlands; however, wells and floods (spate) are common in the coastal areas, where lands are irrigated to produce a wide variety of crops. Permanent irrigated area forms about 12% of the total cultivated area and about 59% of the total permanent and semi-irrigated areas (Table 2).

The large increase in the number of wells, the uncontrolled use of pumped water, and the tendency to neglect the traditional spate system are increasingly causing depletion of wells, low quality of water for irrigation, and salinization of soils.

Vegetation and Agroecological Zones

Vegetation: The main determinants of the geographic distribution of vegetation are types of soils, climate, land use, and cultivation practices. Out of the total area of 55 million ha, about 16 million ha are considered grazing land (Table 1).

Table 2: Types of Rainfed and Irrigated Areas (1,000 ha)

Type	North	South	Total
Rainfed			
> 600 mm	190	-	190
450-600 mm	220	-	220
250-350 mm	-	62	62
< 450 mm	710	-	710
Irrigated			
permanent			
wells	120	26	146
springs	25	0	25
semi-irrigated			
spate (floods)	85	31	116
Total	1350	119	1469

Vegetation in Yemen could be classified into three major types:

1. *Sahara-Sindian vegetation type*: This includes sand-dune vegetation of the Red Sea coastal type, sand-dune vegetation of the Aeolian sands of the Empty Quarter, and Arabian Sea coastal type in the east and southeast of Yemen with a few rock outcrops bearing a depauperate vegetation of the type of *Acacia-Commiphora* bushland.
2. *Savannah bushland of a Sudanian type*: This consists of undifferentiated bushland: *Acacia-Commiphora* bushland on steep slopes on the escarpment, Tihama and eastern Yemen, with modifications depending on the amount of rainfall, *Acacia-Commiphora*, and soil conditions; *Dobera* parkland on silt lands in the extreme east of Tihama; and *Euphorbia* scrub in the southeastern mountains.
3. *Mountain vegetation type*: This consists of *Acacia-origena* woodland on west-facing slopes which are now almost entirely cleared and replaced by terrace cultivation except on the steeper slopes, where secondary scrub is prevalent, and *Juniperus* woodland on mountains lying in the rain/shadow side, which are also now almost entirely cleared and replaced with low open scrub. The high plateau and eastern slopes have treeless hills with little soil. The intermountain plains are heavily cultivated or grazed with a sparse weed-rich vegetation on alluvial soils.

Agroecological zones: The variation in the topography and soils, and the influence of the seas on the climate, and other factors have created different agroecological zones which can be found in the country even within small distances from each other. However, seven to eight major agroecological zones can be identified in Yemen. Their characteristics are briefly described in Table 3, and their boundaries are shown in Figure 3.

Marine Resources

The country is endowed with rich fish stocks in its territorial waters in the Red Sea and Arabian Sea. Total catches ranged from about 58,000 metric tons in 1982 to about 71,000 metric tons in 1985 with an annual average catch of about 66,500 metric tons during the period 1982-1987.

Species of economic importance are pelagic and demersal percomorphs nei (*Perciformes*), narrow-barred Spanish mackerel (*Scomberomorus commerson*), scavengers (*Lethrinidae*), barracudes (*Sphyraena* spp.), Indian mackerel (*Rasbelliger kanagurta*), panulirid spiny lobsters nei (*Panulirus* spp.), and many other species of cuttlefishes, skates, sharks, tunas, snappers, and groupers.

Table 3: Agro-ecological Characteristics

Agro-ecological zone	Area (km ²)	% of Total Land	Annual Rainfall (mm)	Major Geological Formation	Predominant Great Soil Types	Ecological Zones/Vegetation
1. Tropical Tihama Coastal Plain Zone (North)	20,300	3.9	50-300	Quaternary alluvial deposits.	Torrifluvents, torripsamments; ustifluvents, utripsamments, salorthids.	Arid tropical desert; sand dune vegetation of the Red Sea; <i>Acacia</i> spp.
2. Southern Uplands Zone (North)	12,000	2.3	450-1000	Tertiary and quaternary volcanics.	Ustifluvents; ustorthents; torriorthents; rock outcrop.	Semi-arid subtropical mountains; <i>Acacia</i> spp., <i>Juniperus</i> spp., <i>Euphorbia</i> scrub.
3. Highlands Zone (North)	45,500	8.6	300-600	Tertiary and quaternary volcanics; sedimentary rocks; quaternary alluvial deposits.	Rock outcrop; ustrothents.	Arid to semi-arid temperate mountains; <i>Acacia</i> spp., <i>Juniperus</i> spp., weed rich vegetation.
4. Midland Slopes Zone (North)	39,200	7.4	100-300	Tertiary and quaternary volcanics; precambrian shield; sedimentary rocks.	Rock outcrop; ustrothents; torriorthents; calcirothids.	Arid subtropical mountains; <i>Acacia</i> spp., weed rich vegetation.
5. Eastern and Northeastern Desert Plateau Zone (North and South)	250,200	47.4	0-100	Quaternary alluvial deposits; sand sheets and dunes; calcareous sedimental rocky; sandy plains.	Torriorthents; torrifluvents; torripsamments, calcareous loamy and sandy plains.	Arid subtropical desert; sand dune vegetation; absent vegetation except for grasses after rainfall.
6. Coastal and Foothills Zone (South)	55,000	10.4	0-100	Hills, sand dunes and sheets; gravel and sandy to loamy plains.	Deep to shallow calcareous sandy to loamy; saline in coastal area; light yellowish in eastern part.	Arid tropical; desert and semi-desert vegetation absent by sea-saline grasses; vegetation on hills; water cockles in Wadi.
7. Middle Montane Highland Zone (South)	84,500	16.0	50-100	Hills; volcanic rock basement in the western part, and calcareous rocky plains in the eastern part; sandy to loamy sedimental complex in Wadi.	Sandy to loamy in the western part, and calcareous to loamy in the eastern part.	Arid subtropical; vegetation nearly absent, except some in Wadi and on soil and rocky plains.
8. High Montane Zone (South)	21,200	4.0	100-300	Hills; volcanic rocky plains in the west and calcareous rock in the east; sandy loamy in Wadi.	Sandy to loamy in the west, and calcareous sandy to loamy in the east.	Arid subtropical; vegetation nearly absent; some trees; grasses after rainfall.

Source: Compiled and adjusted data from Swiss Airphoto Team (for 1 to 5).

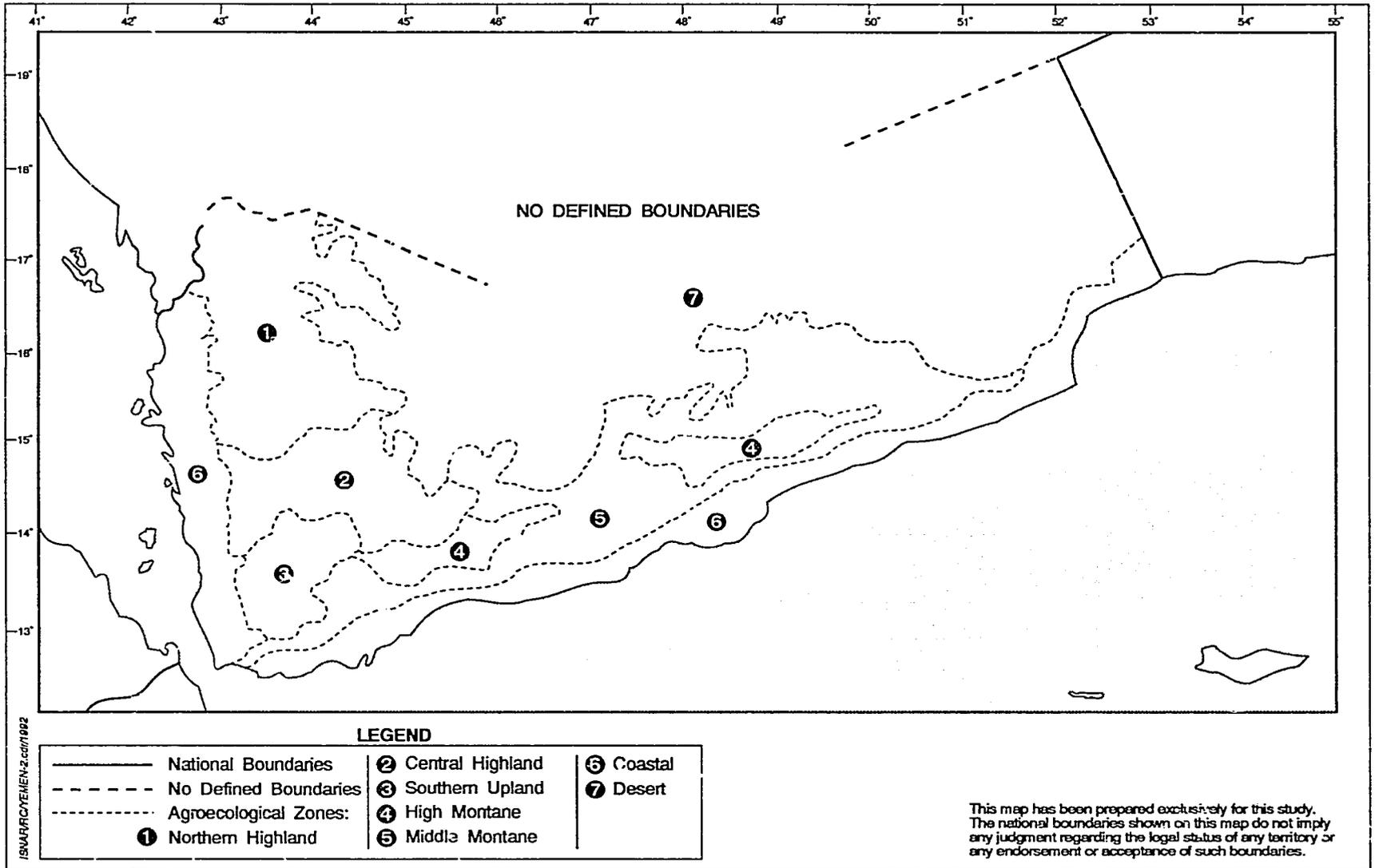


Figure 3: Agro-ecological Zones

Human Resource Base

Population

The population in 1990 by total, locality, segment, labor force, and agricultural labor force is shown in Table 4.

Size and annual growth: The Yemeni population increased from 5.4 million in 1961, to 6.3 million in 1970, to 8.2 million in 1980, to 9.7 million in 1985 to 11.7 million in 1990, with an average annual growth rate of 1.9% during the period 1961-1975, and 3.7% during the period 1975-1990. In North Yemen, about 75% of the population live in rural areas, while in South Yemen 56% live in rural areas (Table 4).

Table 4: Population by Grouping in 1990 (1,000)

Grouping	Total	Males	Females	Rural	Urban	Agric. Popul.	Non-Agric.
By sex	11,687	5,722	5,965				
By locality	11,687			8,314	3,373		
By segment	11,687					6,561	5,126
By labor force	2,795	2,431	364				
By agricultural labor force	1,554	1,383	171				

Source: FAO AGROSTAT Files, 1991.

Age and sex distribution: The average sex ratio for the entire population is 49% males and 51% females for North Yemen (1986 census) and 48% males and 52% females for South Yemen (1988 census). These percentages fluctuate from 46%-52% for males and from 48%-54% for females for both North and South Yemen. Between 46% and 52% of the total population are less than 15 years old, 43%-49% are between 15-65 years old, and 5% are above 65 years old (Table 5). The average life expectancy at birth is estimated at 46 years (1987).

Locality: While the rural population has increased by an annual rate of 2.6%, the urban population increased by 14.9%. This difference in annual growth changed the urban population from an average of 13% in 1970 to 29% in 1990 (Table 6). In 1990, about 56% of the population were agricultural and about 44% were nonagricultural (Table 4).

Agricultural labor force: From 1975 to 1990, the labor force formed 23% of the total population, with an annual growth of 4.2%. In the same period the agricultural labor force increased from about 1 million in 1975 to about 1.5 million in 1990, with an average annual growth of 3.5%. At the same time, agricultural labor force as a percentage of total labor force has declined from 65% to 56%. Males and females form 89% and 11% of the agricultural labor force, respectively (Table 6).

**Table 5: Population Distribution by Age Group and Sex
1988 Census for South Yemen and 1986 Census for North Yemen
(1,000)**

Age Group (Year)		Total Population	% of Total	Males	%	Females	%
0 - 14	N	5,057	52	2,112	52	1,973	48
	S	972	46	501	52	471	48
15 - 64	N	4,409	43	1,553	46	1,831	54
	S	1,025	49	467	46	558	54
> 65	N	460	5	174	50	176	50
	S	110	5	53	48	57	52
Total*	N	7,819	100	3,839	49	3,980	51
	S	2,107	100	1,021	48	1,086	52

* Excluding about 1.7 million Yemeni, who live outside the country.
N = North Yemen; S = South Yemen.

Table 6: Changes in Populations of the Country, Rural, Urban, Labor Force, and Agricultural Labor Force, 1970-1990 (1,000)

Year	Country Population	Rural	%	Urban	%	Labor force	%	Agricultural Labor Force					
								Total	% of Labor force	Males	% of Total Ag. L.F.	Females	% of Total Ag. L.F.
1970	6,332	5,487	87	845	13	1,749	27	1,232	70	1,147	93	85	7
1975	6,991	5,836	83	1,155	17	1,571	22	1,023	65	921	90	102	10
1980	8,218	6,561	80	1,657	20	1,887	23	1,161	61	1,038	89	123	11
1985	9,758	7,378	76	2,380	24	2,292	23	1,344	59	1,199	89	145	11
1990	11,687	8,314	71	3,373	29	2,795	24	1,554	56	1,383	89	171	11

Source: FAO AGROSTAT Files, 1991.

Agricultural Production Systems

The cultivated area in Yemen is fluctuating from year to another. The dominant factor is the amount and distribution of rainfall. The area ranges from about 1 - 3 million ha. About three-quarters or more of the cultivated area is rainfed in good rainy years (Table 2).

Agricultural Production Subsectors

By land ownership: Cultivated lands are owned by the private sector in the north, and by cooperatives (51%), the private sector (29%), and the public sector (20%) in the south (Table 7).

Early in the eighties, the size distribution of land-holdings shows that about 80% of the cumulative holders have lands between 2-3 ha each. Their area covers about 27-29% of the total agricultural land (Table 8).

By land use: The total cultivated land is about 1.4 million ha. Of this, 93% is arable land, and the remaining 7% is in permanent crops. However, pastures cover about 16 million ha, and forest about 3 million ha. Total land in cultivated arable and permanent crops did not increase much during 1973-1990, the same could be said for irrigated land (Table 1).

By availability of water: One of the main constraints in agricultural production in the country is the availability and management of water for farming use. According to the availability of water, farming in the country can be divided into rainfed, permanent irrigated, and spate (flood) irrigated farming systems (Table 2). Land areas of each of these systems are shown in Tables 9 and 10.

By production systems: Rainfed farming systems occupy about 50% of the total cultivated area in Yemen. These systems are predominantly in the central highlands and southern and western uplands of the country.

Rainfed farming systems can be classified into two sub-groups, the high rainfall farming systems (rainfall > 500 mm per annum) and low rainfall farming systems (rainfall < 500 mm). Crops grown under rainfed farming systems are sorghum, maize, legumes, barley and wheat. Barley and legumes are grown in marginal lands in these areas. Water harvesting techniques are widely used in central highlands and terraced slopes and wadis. Research has given little attention to rainfed agriculture, and no technologies have been developed to help farmers improve their production under rainfed conditions.

The low rainfall farming systems are characterized by erratic rainfall and periodic droughts. Productivity of land is low and depth of soil is limited. These areas are also subject to water and air erosion. Rangeland in low rainfall farming systems is

deteriorating as a result of overgrazing and intensive cutting of trees and shrubs for domestic purposes.

Priority areas for improvement are:

- introduction of crop varieties and livestock races suitable for these conditions;
- improvement of agriculture practices aimed at water conservation;
- introduction of appropriate machinery for land cultivation under rainfed conditions;
- improvement of overall income of farmers under rainfed conditions by means of analysis of these farming systems to determine factors affecting these farmers incomes;
- introduction of fodder crops and range plants that are known to be drought resistant, and efficiently use the limited water available.

Flood irrigated farming systems constitute about 15% of the total cultivated area. These systems are predominantly in the coastal areas in Tihama and the deltas in the southern and eastern governorates.

Flood irrigation is based on diversion of spate into agricultural land in the coastal areas. The high water holding capacity of alluvial soils permits retention of water, and allows crop growth on water residues from a single irrigation of an average of 60-80 cm depth of water per irrigation. Crops predominantly grown under spate are sorghum, millet, cotton, cucurbits, legumes, sesame, and groundnuts.

One of the major issues related to flood irrigated farming systems in the coastal areas is the continuous deterioration of land and sand dune movements. It must be noted that the abandoning of indigenous regulations in rangeland management and the extensive cutting of trees has expedited the deterioration of rangeland.

Flood farming systems were not given enough attention by research in terms of water use efficiency or diversification of crops.

Identified areas of potential improvement:

1. Introduction of varieties and expansion of crops under spate irrigation.
2. Introduction of agricultural practices for better conservation of soil moisture in pure crop stands or in intercropping.
 - Study the effect of supplementary irrigation on yield increase per unit area and calculate cost of production based on this.
 - Study factors affecting deterioration of rangelands to determine means of interference to conserve range resources and introduce techniques for soil conservation and combating desertification.

Table 7: Area of Cultivated Lands by Ownership (1,000 ha)

Sector	Area		% of Total	
	N	S	N	S
1. Private		30.4		29
a) one type tenure				
- owned	1040.1		77	
- share cropped	40.5		3	
b) more than one type tenure				
- more than 50% owned	175.6		13	
- less than 50% owned	81.1		6	
c) others (rented, etc.)	13.5		1	
2. Cooperative		53.4		51
3. Public		21.4		20
TOTAL	1350.8	105.2	100	100

Source: Agricultural Census, 1983 (North Yemen); Agricultural Census, 1986 (South Yemen)
 Note: N = North Yemen; S = South Yemen

Table 8: Size Distribution of Agricultural Land Holdings

Size of Landholding (ha)	Holders						Area					
	Number		%		Cumulative %		Ha		%		Cumulative %	
	N	S	N	S	N	S	N	S	N	S	N	S
< 0.25	110,010	-	18.6	-	18.6	-	14,810	-	1.1	-	1.1	-
0.25 - 0.50	107,893	-	18.2	-	36.8	-	42,815	-	3.2	-	4.3	-
0.50 - 0.75	63,146	-	10.7	-	47.5	-	39,632	-	2.9	-	7.2	-
0.75 - 1	58,912	-	10.0	-	57.5	-	52,336	-	3.9	-	11.1	-
< 1	-	40,803	-	36.5	-	36.5	-	6,322	-	5.6	-	5.6
1 - 2	83,071	26,998	14.0	24.1	71.5	60.6	121,649	11,833	9.0	10.4	20.1	16.0
2 - 3	51,174	16,290	8.7	14.6	80.2	75.2	126,492	12,887	9.4	11.4	29.5	27.4
3 - 4	29,026	10,867	4.9	9.7	85.1	84.9	102,906	12,574	7.6	11.1	37.1	38.5
4 - 5	19,591	5,126	3.3	4.6	88.4	89.5	88,272	7,864	6.5	6.9	43.6	45.4
5 - 10	43,758	8,534	7.4	7.6	95.8	97.1	304,594	19,345	22.5	17.1	66.1	62.5
10 - 20	19,324	2,400	3.3	2.1	99.1	99.2	263,248	11,149	15.5	9.8	85.6	72.3
20 - 50	4,639	762	0.8	0.7	99.9	99.9	133,992	2,518	9.9	2.2	95.5	74.5
> 50	527	123	0.1	0.1	100.0	100.0	60,023	28,898	4.5	25.5	100.0	100.0
TOTAL	591,071	11,903	100.0	100.0			1,350,775	113,390	100.0	100.0		

Source: Agricultural Census, 1983 (for North Yemen); Agricultural Census, 1986 (South Yemen).
 Note: N = North Yemen; S = South Yemen.

Table 9: Size of Rainfed and Irrigated Areas in North Yemen

Cultivated Land	Area Cultivated (ha)	Percent Cultivated Area	Percent of Total Area
Rainfed Land Holdings	790,283	77.5	58.5
Spate Land Holdings	85,953	8.4	6.4
Pump Well Land Holdings	118,904	11.7	8.8
Spring Water Land Holdings	24,728	2.4	1.8
Other Not-used Land Holdings	330,907	-	24.5
TOTAL	1,350,755	100.0	100.0

Source: Agricultural Census, 1983 (for North Yemen).

Table 10: Distribution of Rainfed and Irrigated Areas of Different Agro-Climatic Zones of North Yemen

Agro-Climatic Zone		Rainfed Area	Irrigated Area	Fallow Area	Total Area
Tihama Plain	ha	151055	80,022	102,530	333,607
	%	45.3	24.0	30.7	100
Southern Uplands	ha	185933	17,883	21,173	255,089
	%	82.6	7.9	9.5	100
Central Highlands	ha	82381	23,698	18,544	123,623
	%	65.8	19.2	15.0	100
Northern Highlands	ha	369157	59,707	151,598	580,462
	%	63.6	10.3	26.1	100
Eastern Plateau	ha	2757	48,275	36,962	87,994
	%	3.1	54.9	42.0	100
TOTAL	ha	790,283	229,585	330,907	1,350,775
	%	58.5	17.0	24.5	100

Source: Bematraf, A.R. 1987. Supplemental irrigation in YAR. Report.

Plant Crop Productio

Choices for growing plant crops or producing animal products are based on demand for these commodities, their production capacity, and their importance in the irrigated and rainfed production systems in the country. Therefore, about 12 commodity groups, seven in crop production, four in livestock production, and one in fisheries production, could be classified. These are food and feed cereals; dry food legumes; industrial crops; vegetables; fruit trees and stimulant crop trees; forest trees, range forage crops; sheep and goats; cattle; camels; poultry; and fisheries.

Food and Feed Cereals

About 85% of the crop-cultivated land is for field crop production. Of this field-crop land, about 85% is for cereals. About 77% of cereals land is occupied by sorghum and millet, which are the traditional basic food cereals. Thus, sorghum and, to a much lesser extent, millet are the predominant cereal crops representing about 66% of total cereals production. Wheat represents the second place in production and third in the area of cereals, occupying about 11% of cereals area and producing about 19% of the total cereals production. Maize and barley are grown each in about 6% of the cereals area and producing for maize about 8%, and for barley about 6% of the total cereals production (Table 11).

There has been a switch from sorghum and millet to oat, fruits, vegetables, wheat, and maize where sufficient water is available. In addition, with rising incomes wheat consumption has increased in the country leading to substantial increases in imports and interest in increasing domestic production.

Cereal yields have shown little change during the last two decades. The sorghum yield has increased from 712 kg/ha in 1969-71 to 914 kg/ha in 1988-90. Wheat followed the same trend. Its yield increased from 1,050 kg/ha in 1969-71 to 1,709 kg/ha in 1988-90. On the contrary, and during the same period, maize decreased from 2,000 kg/ha to 1,174 kg/ha. The barley yield, however, did not change much during the same period. It was 1,135 kg/ha in 1969-71 and became 1,111 kg/ha in 1988-90 (Table 12).

While the agricultural production index in 1990 showed an increase of up to 113.0% (1979-81 = 100), the cereals production index in the same year declined to 83.8%. The total agricultural and cereal production per capita declined in 1990 to 79.4% for agriculture and to 58.9% for cereals in particular (Table 13).

The uncertainty of cereal production can be attributed to low rainfall, poor seed varieties, inadequate cultural practices, and pest problems. In fact, Yemen has suffered the drought of the eighties in the east African horn.

Table 11: Area and Production of Main Agricultural Crops, 1987, 1989, and 1991

Crop	Area (1,000 ha)			Production (1,000 tons)		
	1987	1989	1991	1987	1989	1991
Total Cereals	852	860	640	716	864	448
Sorghum	589	521	382	470	516	247
Millet	98	140	91	38	59	25
Wheat	74	94	87	113	162	100
Maize	43	52	38	54	68	46
Barley	47	53	42	41	59	29
Total Dry Legumes	24	45	39	39	72	43
Cowpeas	16	26	21	27	37	25
Lentils	4	8	8	4	12	5
Beans	1	2	2	2	7	3
Faba beans	2	4	3	4	0	5
Fenugreek	1	2	2.5	1	3	3
Peas	0.5	2	1.5	1	3	2
Sesame	15	22	15	5	8	8
Cotton	9	16	9	6	13	7
Tobacco	3	3	4	5	4	7
Total Vegetables	40	50	50	622	731	641
Tomatoes	8	10	11	147	163	171
Potatoes	10	11	12	119	140	157
Watermelons	7	10	8	183	204	126
Cantaloupes	3	4	3	49	59	35
Cucumbers	0.5	0.5	0.5	13	14	11
Dry onions	3	5	4	45	78	59
Okra	2	2	2	14	15	14
Garlic	0.5	1	1	7	11	8
Carrots	0.4	0.6	0.7	4	7	6
Radish	0.8	0.6	0.9	11	8	12
Total Fruits	48	54	59	295	313	316
Grapes	15	15	18	129	135	139
Dates	16	16	16	31	25	21
Bananas	6	8	7	42	48	52
Papayas	2	3	3	57	57	53
Mangoes	1	1	2	7	6	7
Apricots	2	2	2	7	8	6
Oranges	3	4	6	4	8	11
Lemons	0.5	0.8	0.8	5	6	6
Mandarins	0.3	0.6	0.7	2	4	4
Peaches	0.5	0.7	0.8	3	4	5

Table 11: continued

Crop	Area (1,000 ha)			Production (1,000 tons)		
	1987	1989	1991	1987	1989	1991
Pomegranate	0.4	0.6	0.8	3	5	5
Coffee	18	22	23	5	6	5
Total Forages	56	73	58	501	651	499
Grasses	8	11	11	54	58	50
Sorghum fodder	33	45	30	349	471	322
Alfalfa	15	17	18	98	121	127
Grand Total	1067	1145	897	2195	2663	1975

Source: MAWR Statistics, 1992.

Table 12: Trends in Production, Area, and Yield of Main Crops*

Crop	Production (1,000 mt)		Area (1,000 ha)		Yield (Kg/ha)	
	1969-1971	1988-1990	1969-1971	1988-1990	1969-1971	1988-1990
Cereals (Total)	891	839	1,093	876	815	958
Sorghum	637	530	895	580	712	914
Millet		57		114		500
Maize	16	54	8	46	2,000	1,174
Barley	126	50	111	45	1,135	1,111
Wheat	42	147	40	86	1,050	1,709
Seed cotton	20	21	20	22	1,000	954
Sesame	6	8	11	17	545	470
Vegetables (Total)	120	603	-	-	-	-
Potatoes	37	131	5	10	7,400	13,100
Tomatoes	0	164	0	10	-	16,400
Watermelons	27	236	1	8	27,000	29,500
Fruits (Total)	102	330	-	-	-	-
Grapes	21	135	5	15	4,200	9,000
Coffee	5	6	11	19	454	316
Papayas	0	56	-	-	-	-
Bananas	15	59	-	-	-	-
Dates	30	27	-	-	-	-

* Means calculated from FAO AGROSTAT Files, 1991.

Dry Food Legumes

In 1990, pulses occupied about 2% of the total crops area. The pulses area, however, has fluctuated during the last three decades between 23 to 76 thousand ha, with a mean of 49 thousand ha. The total production was 47 thousand metric tons in 1990 (Table 11). Dry food legumes are grown mainly in North Yemen. They consist mainly of cowpeas, fenugreek, peas, faba beans, phaseolus beans, and lentils.

Table 13: Production Index, 1990 (%)

	Production index (1979-1981= 100)	Production per capita index (1979-1981= 100)	Production index, period 1961-1990 (1979-1981= 100)		
			Minimum	Maximum	Mean
Agriculture	113.0	79.4	71.3	118.9	92.6
Food	112.9	79.3	70.8	119.1	92.2
Non-food	115.1	80.9	78.3	115.1	99.3
Crops	91.3	64.0	64.3	109.5	84.5
Livestock production	159.6	112.3	84.2	174.0	108.7
Cereals	83.8	58.9	50.4	131.6	93.3
Meat	866.7	611.3	29.5	1,118.4	234.4
Milk	105.5	76.3	89.6	108.6	100.6

Source: FAO AGROSTAT Files, 1991.

Industrial Crops

The three main traditional crops in this group are cotton, sesame, and tobacco. These crops are grown on 2-3% of the cultivated area (Table 11).

The production and area of cotton did not change much during the last two decades; but yield has declined a little. Cotton is grown mainly in the south. Two decades ago it was North Yemen's largest export but high production cost coupled with low prices and serious damage by pests caused a drastic drop in production. Thus, cotton production is now mainly in the south. It occupied about 9 thousand ha in 1991 (Table 11).

The sesame crop increased in area but not much in production. The sesame yield declined by about 13% during the same period (Table 12). Consumption of vegetable oil in the country is increasing rapidly and is mainly dependent on imports. Attempts are underway to improve oilseed crop production through improving sesame production and introducing new oilseed crops into the country.

Vegetables

A relatively narrow range of vegetables has been grown in the country over the years, but demand for a wider variety of vegetables has expanded during the last two decades with increasing incomes and changing tastes brought about through improved communication with the outside world. There is little importation of fresh vegetables, therefore, the country could be considered self-sufficient in vegetable production. Main vegetable crops include tomatoes, potatoes, cucurbits, carrots, onions, garlic, green beans, and okra. Total vegetable production has increased from an average of 120 thousand metric tons in 1969-71 to 603 thousand metric tons in 1988-90. The total production for 1990 was estimated at 616 thousand metric tons (Tables 11 and 12).

Most vegetables are grown in small, irrigated, plots in the high and low lands and in the coastal area, where water is available for irrigation.

The tomatoes, potatoes, cucurbits, and onion crops occupy most of the vegetable area and produce more than 90% of the total vegetable production. Tomatoes, potatoes, and watermelons form about 80% of the total production (Table 11).

Tomato production has increased during the last two decades from less than a 1,000 metric tons in 1964-71 to an average of 164 thousand metric tons in 1988-90. The tomato production was 174 thousand metric tons in 1990 (Tables 11 and 12).

Potato production has increased from an average of 37 thousand metric tons in 1969-71 to 131 thousand metric tons in 1988-90. This increase was accompanied by a doubling of the area of potatoes and by a near doubling of the yield from 7,400 kg/ha to 13,100 kg/ha during the same period (Table 12).

Watermelon production has increased by about ninefold during the last two decades, from 27 thousand metric tons in 1969-71 to 236 thousand metric tons in 1988-90 (Table 12). The same trend of increase in production can be applied for cucumbers, onions, garlic, carrots, green beans, and green peppers.

Fruit and Stimulant Tree Crops

Fruit tree crops: The strong demand for fruits in the country, and the governmental ban on import of fruits since 1984 have increased the production and area of fruit trees during the last two decades. The total fruit production, excluding watermelons and cantaloupes, has increased threefold during the same period, from an average of 102 thousand metric tons in 1969-71 to 330 thousand metric tons in 1988-90 (Table 12).

The main fruit crops are grapes — about 43% of fruit production — bananas, papayas, and dates. These crops formed about 84% of the total fruit production in 1991 (Table 11).

Grape production has increased threefold in area, from 5 to 15 thousand ha, and about sixfold in production, from 21 to 135 thousand metric tons during the last decades (Table 12).

Papaya production reached an annual average of 56 thousand metric tons during 1988 (Table 12).

Banana production increased from 15 thousand metric tons in 1969-71 to 59 thousand metric tons in 1988-90. Date production, however, declined from 30 thousand metric tons in 1969-71 to 27 thousand metric tons in 1988-90, which could be attributed to government policy affecting production negatively (Table 12).

Stimulant tree crops: The stimulant tree crops include coffee and qat. The country grows an *Arabica* coffee that is still exported in small quantities. Production costs are high, but local demand for bean and husk is strong and rising, leading to local prices above world levels, which result in reasonable returns from growing coffee trees. Despite the increase in coffee area, the coffee yield has dropped from 454 kg/ha in 1969-71 to 316 kg/ha in 1988-90, which mainly is a result from drought conditions prevailing during the eighties (Table 12).

The qat (*Catha edulis*), which is native to Ethiopia, is a small tree or woody shrub grown extensively in the country at 800 m elevation and above. Based on the agricultural census of 1983, qat is estimated to occupy about 50,000 ha of arable land. Immature qat leaves are chewed daily, especially in the afternoon, by the majority of the adult male population and by many adult females. The increasing demand for qat has resulted in extensive new plantings and extremely high prices. It is easily propagated from suckers and stem cuttings and requires minimal care. It can be grown as a rainfed as well as an irrigated crop. There are no major pests, but a recent trend in qat production is the use of insecticides to protect the plant from insects. Consequently, qat leaves could be sold in the market with insecticides residues above the acceptable daily intake, which might cause oral cancer. Qat occupies newly reclaimed or marginal areas which are less suitable for main crop production in the country.

Forest Trees

The changing global climatic conditions, ever increasing tree cutting for fuel and timber, and continual heavy grazing by goats led to a spiral of deforestation in the country. The cumulative effect of forest-cover depletion is more soil erosion, runoff, and range deterioration.

The total area of woodland and shrub in the country is estimated to be 2 million ha (Table 1). As mentioned earlier, uncultivated areas in the coastal region have sparse arid tropical vegetation. In the *Wadi* along the foothills is a savannah cover in which the *Acacia* spp. dominates. Belts of tamarix and *Ficus* spp. occur mixed with date palms in the flood plains and *Wadi* openings.

The best forest conditions occur in the mountains where rainfall is higher and suitable for forest trees and for agriculture. Thus, the intensively terraced agriculture has confined natural vegetation to the margins. The dominant forest tree species are *Acacia* spp. and *Euphorbia* spp.; other most common species are *Juniperus* spp., *Cordia abyssinica*,

Tamarix spp., *Balanites aegyptiaca*, and *Salvadora persica*. Of the most common recently introduced trees are *Eucalyptus camaludensis* and *E. globulus*. Other introduced species include *Pinus alepensis*, *Casurina* spp., *Cassia* spp., and *Solonaciis rustica*.

Various forest tree species are used for fuelwood, fodder, fruits, and other minor uses. Tree ownership is more communal on the range, but trees often have private owner.

Range, Forage Crops, Straw, and Crop By-products

While in the eastern part of the country herds graze the rangelands, most agriculture has been of a settled nature. Animals are kept for their products and power.

Although there are rapid changes in the agricultural practices, the traditional system of livestock keeping still remains more or less intact at the present time. When the rain falls and the land produces new range growth, the small stocks are herded onto the range. The range, which is the predominant land use in the country, provides feed for the animals while the crops are growing. When the existing feed has been consumed at the end of the rainfall season, the animals are fed during the dry season on leaves, stripped from the stalks of the ripening sorghum and maize and on the upper stalks with the remaining leaves of harvested sorghum and maize. This system of range use, without the required consideration for range management, has resulted in poor rangeland.

In the higher rainfall areas and on irrigated farms alfalfa is grown as a very desirable forage crop. It provides a high quality supplement to the basic low-protein livestock feed. It is cut in the partial-to-full-bloom stage and sold green in bundles. The yield on green-weight basis could reach 15-25 mt/ha. The high price for quality animal feed has stimulated farmers to increase the production of green forages and silage-type maize and sorghum varieties. Table 11 shows area and production of grasses, sorghum fodder, and alfalfa for 1987, 1989, and 1990.

The straw of wheat and barley is used in the making of clay blocks for buildings, as well as for animal feed and has a high cash value; therefore, varieties with high straw yields are preferred. Residues of legumes, vegetable, and industrial crops are also used as animal feed.

Animal Production

Livestock raising in the country is practiced largely by traditional farmers. Thus, crop production and livestock are interdependent. This link is seen through the use of fallow land, consumption of crop residues, animals as draft power, and competition for land and water, in some cases, where green fodder and cereals are fed to animals.

Cattle are mainly kept for milk and meat production and draft power. Sheep and goats provide milk and meat.

Poultry production systems in the country vary from the traditional low-input/low-output types, like other farm animals, to the highly capital-intensive enterprise which is separate from crop production.

Sheep and Goats

Sheep and goats are by far the most important, and the most adapted to the climate and natural forage. They also fit well into sedentary farming as well as the traditional semi-nomadic systems. In addition, lamb, mutton, and goat meat are the preferred source of animal protein.

As mentioned earlier, the typical nutrition program of these animals is grazing range during the wet season, and crop residues and by-products during the dry season.

The total number of sheep and goats was about 6.9 million head in 1990 — 3.7 million head for sheep and 3.2 million head for goats. Their numbers have increased during the last two decades by about 61% for sheep, from an average of 2.3 million head in 1969-71 to 3.7 million head in 1988-90, and by about 15% for goats, from an average of 2.7 million head in 1969-71 to 3.1 million head in 1988-90 (Tables 14 and 15).

Sheep milk production has increased by about 50% during the last two decades, while goat milk production remained nearly unchanged (Table 15). About 50% of the total milk was produced by goats in 1990.

Beef, veal, and mutton formed about 22% of the total slaughtered meat. Poultry meat formed about three-quarters of slaughtered meat in 1988-90 (Table 15).

Cattle

Cattle are kept for milk, meat, and draft power. While women always take care of the livestock kept in the house, men use oxen for draft, and children herd sheep and goats. In many cases, cows are kept in the house and fed sorghum and millet stalks and leaves and alfalfa. In some locations, such as in Tihama, cattle graze with sheep and goats on crop residue on fallow land.

Table 14: Livestock. Total Numbers and Production, Fish Catch, and Honey Production, 1987 and 1991

ANIMAL	Total Numbers*		Production**									
			Meat		Milk		Wool		Eggs		Honey	
	1987	1991	1987	1991	1987	1991	1987	1991	1987	1991	1987	1991
Cattle	1105	1117	35 ***	37 ***	141 ****	149 ****	x	x	x	x	x	x
Sheep	3488	3568					2.2	2.2	x	x	x	x
Goats	3084	3166					x	x	x	x	x	x
Camels	153	166					x	x	x	x	x	x
Poultry			54	35	x	x	x	x	293	357	x	x
Fisheries (Marine)			70	n.a.	x	x	x	x	x	x	x	x
Bees (Honey)	x	x	x	x	x	x	x	x	x	x	0.37	0.36

Source: MAWR Statistics, 1992, FAO AGROSTAT Files, 1991, and FAO Fisheries Yearbook: Catches, 1987.

- Total numbers of ruminants = 1,000 head
Total poultry = million bird
- Production of Meat, Milk, Wool, Honey = 1,000 metric tons
Fish Catch = 1,000 metric tons; Eggs = million
- *** For red meat
- **** For Cows, Sheep, and Goats

Number of cattle has increased by about 27% during the last two decades from an average of about 0.9 million head in 1969-71 to 1.2 million head in 1988-90. Milk production of cows formed about one-third of the total milk produced by cows, sheep, and goats in 1990 (Tables 14 and 15).

Camels

Camels are used in the country as draft animals and provide transportation in the traditional areas where modern transport is not available. Their numbers declined during the last two decades from an average of 225 thousand in 1969-71 to 144 thousand in 1988-90. (Tables 14 and 15). However, MAWR statistics have shown that their numbers have increased from 153 thousand in 1987 to 166 thousand in 1991 (Table 14).

Poultry

The rise in demand for poultry products during the eighties has had an impact on poultry production in the country. This sector has grown at a fast rate during the last decade. It increased in broilers as well as in eggs production. The number of birds increased during the last two decades from an average of 3 million birds in 1969-71 to 27 million birds in 1988-90. Accordingly, the poultry meat has increased from an average of 3 thousand metric tons in 1969-71 to 66 thousand metric tons in 1988-90, and eggs from an average of 4 thousand metric tons in 1969-71 to 16 thousand metric tons in 1988-90 (Tables 14 and 15). However, there was a decline in poultry meat production from 54 thousand metric tons in 1987 to 35 thousand metric tons in 1991 (Table 14).

All large-scale poultry farms, both government and private, are based on highly sophisticated modern technologies; medium- and small-size farms are less modernized. The required feed, vaccines, one-day-old chicks, and hatching eggs are imported. Some large farms are producing their pullets locally, importing parent stocks.

Table 15: Trends in Livestock Numbers and Production*

Animal/Product	Numbers (1,000 head)		Production (1,000 mt)	
	1969-71	1988-90	1969-71	1988-90
Cattle	922	1,179	-	-
Sheep	2,289	3,682	-	-
Goats	2,710	3,131	-	-
Camels	225	144	-	-
Poultry	3,000	27,000	-	-
Slaughtered meat	-	-	18	87
Beef, veal, and mutton	-	-	14	19
Poultry meat	-	-	3	66
Milk	-	-	272	318
Cow milk	-	-	64	96
Sheep milk	-	-	41	62
Goat milk	-	-	159	155
Eggs	-	-	4	16

* Means calculated from FAO AGROSTAT Files, 1991.

Fisheries Production

The fisheries subsector in the country is small, employing about 15,000 fishermen and others in the industry. It contributes about one-quarter of the AgGDP in the south and much less in the north.

The fishing grounds of the Red and the Arabian Seas are one of Yemen's greatest potential sources of wealth for export earning after oil. Estimates of stocks vary greatly. While stocks of demersal, cuttle, and pelagic fish are declining in the continental and territorial shelf waters, stocks of mesopelagic fish just beyond the edge of the continental shelf in the Arabian Sea are estimated in the tens of millions of tons, but their exploitation cannot take place without further research and the development of appropriate technologies.

Fish and crustaceans catch in the country is carried out by the private fishermen, small-scale cooperatives sector, public industrial sector, and joint ventures with foreign vessels. Independent fishermen fish in one-man or more (a crew of 6-8 men) boats. The fishermen organized in cooperatives operate small coastal vessels, and the public national fleet has about 20 deep-sea fishing boats. The total annual catch was between 65 and 71 thousand metric tons during the period 1984-87. Part of the catch is consumed and processed locally. The rest is exported (Table 16).

There are potentials for aquaculture. The nutrient-rich water in the area of Aden could support production of fish, shrimp, and cuttle fish through controlled marine culture in cages. Several production sites have been identified by the recently established "Marine Science Resources Research Centre" in the country.

Table 16: Marine Fishery Catches and Trade, 1984-1987

Year		Production mt	Import US \$1,000	Export US \$1,000
1984	N	18,170	3,850	160
	S	47,540	241	11,928
	T	65,710	4,091	12,088
1985	N	19,532	3,610	1,080
	S	51,778	235	14,960
	T	71,310	3,845	16,040
1986	N	22,241	3,500	530
	S	47,706	380	13,320
	T	69,947	3,880	13,850
1987	N	22,254	1,690	1,130
	S	48,492	325	11,240
	T	70,746	2,015	12,370

Source: FAO Yearbook: Fisheries Statistics, Vols 64 and 65, 1987.

Note: N = Northern Governorates; S = Southern Governorates; T = Total.

Agricultural Policies

Agriculture in the National Economy

During the period 1983-1987, the AgGDP averaged an annual 25.6% and 15.8% of the total GDP of the north and the south, respectively. Other sectors' contributions in the north and south during the same period were: commerce, 11.5% and 18.3%; manufacturing and mining, 12.7% and 20.6%; transport and communications, 11.3% and 16.3%; and services, 38.9% and 29.0%. Therefore, agriculture was in the second place, after services, in contribution to the GDP of North Yemen, and next to last place in contribution to the GDP of South Yemen (Table 17). The index of the real AgGDP in 1981 prices increased annually in the north and reached 351.7% in 1988, while in the south it increased to 154.9% in 1984 and declined to 133.8% in 1988 (Table 18).

The contribution of plant production to the AgGDP of South Yemen during 1984-1988 ranged from 45.7-47.9% (average 46.8%), while animal production ranged from 23.7%-33.2% (average 26.4%), and fisheries ranged from 18.9%-30.5% (average 26.8%) during the same period.

In general, since the early seventies the economy of the country is moving from a largely self-sufficient subsistence agricultural system to an open service and commercial agricultural economy. This development effort was channelled into development plans. In the north, two three-year development plans were implemented from 1969 to 1975 followed by three five-year plans (1977-1981, 1982-1986 extended for 1987, and 1988-1992). In the south, a three-year development plan (1973-1975) was implemented followed by three five-year plans (1976-1980, 1981-1985, and 1988-1992).

Despite large investments through these plans, Yemen is still characterized as a "least-developed" country. The estimated per-capita income for 1988 was US \$565 and US \$636 for South and North Yemen, respectively. The average annual growth rate of agriculture during the last decade was estimated at about 1.7%. This growth rate is substantially less than needed to maintain per-capita food production for the country's rapidly increasing population. The agricultural production per-capita index for 1990 was 79.4% (1979-1981=100) (Table 13).

The main strategies and objectives of the five-year plans for the agricultural sector addressed the various aspects of agriculture in development and the upgrading of its performance and productivity with the aim of increasing its contribution to national development. Among these, the general objectives adopted by the third five-year plan, 1988-1992 are:

- development of rural areas through completing the infrastructure started in the second five-year plan;

Table 17a: Estimates of Components of Gross Domestic Products (GDP) at Current Producer Prices in Economic Activity (In Billions of Yemeni Rials for North Yemen, and Millions of Yemeni Dinars for South Yemen)

SECTOR	1983				1985				1987			
	Value		Share (%)		Value		Share (%)		Value		Share (%)	
	N	S	N	S	N	S	N	S	N	S	N	S
Agriculture	5.2	61.4	23.8	13.6	8.0	71.6	26.2	15.3	11.9	79.0	26.7	18.4
Commerce	2.5	86.8	11.5	19.2	3.5	89.2	11.5	19.1	5.2	72.2	11.7	16.8
Manufacturing & mining	2.4	83.2	11.0	18.4	3.7	93.4	12.1	20.0	6.7	100.7	15.1	23.4
Transportation & communication	2.3	74.5	10.6	16.5	3.5	75.6	11.5	16.2	5.2	69.9	11.7	16.2
Government services	5.7	0.7	26.6	0.1	6.8	0.7	22.3	0.1	9.4	0.4	21.2	0.1
Other services	3.6	145.7	16.5	32.2	5.0	136.8	16.4	29.3	6.1	108.2	13.7	25.1
GDP at current producers' prices	21.8	452.3	100.0	100.0	30.5	467.3	100.0	100.0	44.5	430.4	100.0	100.0

Source: CPO, 1989 (for North Yemen); CSO (for South Yemen).

Note: N = Northern Governorates; S = Southern Governorates.

Table 17b: Production Values of Agricultural Products (In Billions of Yemeni Rials)

Subsector	1987	1988	1989	1990
Crop products	13.94	14.78	14.68	18.44
Livestock products	3.42	4.33	5.03	4.95
Total Agricultural Products	17.36	19.11	19.71	23.39

Source: MAWR Statistics, 1992.

**Table 18: Total GDP and AgGDP and Index of Real AgGDP
(In Millions of Yemeni Rials for North Yemen,
and in Millions of Yemeni Dinars for South Yemen)**

Year	Total GDP		Agricultural GDP		Index of Real AgGDP (1981 = 100)	
	N	S	N	S	N	S
1980	14,147	225	3,458	11	93.8	37.9
1981	15,980	328	3,685	29	100.0	100.0
1982	19,932	392	5,035	22	136.6	75.9
1983	21,870	466	5,224	30	141.8	103.4
1984	24,756	508	6,236	31	169.2	106.9
1985	30,519	498	8,033	37	218.0	127.6
1986	38,241	383	11,136	40	302.2	137.9
1987	44,500	422	11,922	48	323.5	165.5
1988	57,536	439	12,962	69	351.7	237.9

Source: Statistical Yearbook, 1988 (for North Yemen)

Note: N = Northern Governorates; S = Southern Governorates.

Table 19: Agriculture's Share in the Public Development Plan

Year	Agriculture's share (%)	
	North	South
1969-1972	6.5	-
1973-1976	14.8	22.9
1976-1980	-	12.0
1977-1981	14.3	-
1981-1985	-	10.1
1982-1986	15.1	-
1987-1991	7.9	15.8

Source: CPO (for North); CSO (for South).

Note: North = Northern Governorates; South = Southern Governorates

**Table 20: Agricultural Sector Costs in the Second Five-Year Plan
for North Yemen (YR 1,000)**

Project	Aim	Local Cost	Foreign Exchange	Total Cost	Donors
Poultry production	Infrastructure	0	13284	13284	Netherlands
Animal husbandry	Infrastructure	84677	28900	113577	None
Development of Wadi Al Jauf	Infrastructure	24000	63200	87200	Germany
Small diversion dams	Infrastructure	10400	41600	52000	None
Maintenance of terraces	Infrastructure	4800	4800	9600	None
Meteorological stations	Infrastructure	1600	0	1600	None
Ma'arib Dam	Infrastructure	30000	270000	300000	Abu Dhabi
Ministry of Agriculture	Infrastructure	30000	18000	48000	UNDP
Integrated rural development	Infrastructure	146920	142553	289473	WB, IFAD, Abu Dhabi, Switzerland
Integrated rural development	Infrastructure	31572	47359	78931	Netherlands
Integrated rural development	Infrastructure	16751	16000	32751	Islamic Bank
Integrated rural development	Infrastructure	28777	50000	78777	Islamic Bank
Wadi Zebeid	Infrastructure	5125	5000	10125	None
Wadi Rimaa	Infrastructure	84200	97400	181600	WB, Kuwait
Wadi Mawr	Infrastructure	124572	223942	348514	WB, Kuwait, Germany, EEC, IFAD
Wadi Siham	Infrastructure	5860	11290	17150	None
Fisheries development	Infrastructure	26275	88725	115000	WB, Denmark
Fisheries corporation	Infrastructure	20000	14053	34053	None
Fishing net factory	Infrastructure	2500	7500	10000	None
Agricultural research&forestry	Research	19179	19803	38982	UK
Agricultural research	Research	67550	98600	166150	WB, IFAD, Italy
Fodder improvement	Research	10125	9315	19440	UNDP
Groundwater studies	Research	2000	6715	8715	None
Water resource survey	Research	3000	9000	12000	None
Agricultural research	Research	1120	1681	2801	None
Seed multiplication	Services	9878	41150	51028	EEC/FAO
Coffee seeds development	Services	15647	0	15647	None
Potato Multiplication	Services	9202	1927	11129	Netherlands
Honey production	Services	36700	22927	59627	AOAD
Plant protection	Services	23189	8940	32129	Germany, USA
Desert locust control	Services	5871	4451	10322	FAO
Agricultural engineering	Services	15583	11183	26766	UK
Reduction of harvest losses	Services	1000	4230	5230	UNDP
Soil conservation&soil developm	Services	16397	13603	30000	Germany
Land classification	Services	6320	9142	15462	UNDP
Veterinary services	Services	44473	44473	88946	UK
Department of Irrigation	Services	2880	3200	6080	AFESD
Sewage water for irrigation	Services		2720	2720	None
Water basin development	Services	14400	24000	38400	USSR
Agricultural planning	Services	22361	1513	23874	USA
Development of regions	Services	10000		10000	None
Agricultural marketing	Services	4824	10000	14824	None
Integrated rural development	Services	14908	4749	19657	Germany
Integrated rural development	Services	14344	6140	20484	None
Untegrated rural development	Services	15880	9454	25334	Italy(feasibility)
Integrated rural development	Services	7548	10000	17548	AOAD(feasibility)
Northern wadis	Services	3000	3000	6000	Japan
Aquaculture	Services	2500	7500	10000	None
Agricultural development	TechTransfer	8321	0	8321	None
Agricultural extension	TechTransfer	15158	1500	16658	None
Poultry production-training	TechTransfer	13361	23180	36541	USA
Modern irrigation techniques	TechTransfer	1600	1600	3200	UNDP
Agricultural extension	TechTransfer	12804	15000	27804	Netherlands, UNDP
Survival pilot farm	TechTransfer	9298	13947	23245	None
	TOTAL	1138450	1588249	2726699	

Source: Compiled from "Agricultural Sector Assessment, USAID, 1984".

- strengthening of institutional capacity through institution building, including agricultural services, education and training, extension and research institutions;
- support to private enterprises;
- effective utilization of water, the scarce resource;
- expansion and diversification of agriculture including development of cash crops for export and import-substituting staples through intensive farming and using modern technologies.

Government Investments in Agriculture

Government investments in agriculture in both North and South Yemen were channelled through development plans. Agriculture's share in development plans ranged from 6.5%-15.1% (average 11.7%) for North Yemen, and 10.1%-22.9% (average 15.2%) for South Yemen during the last two decades (Table 19).

Allocations for the agricultural sector in the second five-year plan (1982-1986) in the north were about 2.7 billion Yemeni rials, of which about 58% were foreign exchange supported by local as well as donor contributions. About 67% of the total allocations were for rural development, mainly to improve the infrastructure, and about 33% for institution building to improve agricultural services (20%), research (9%), and technology transfer (4%) (Table 20).

The government's sector budget for the year 1988 allocated to agriculture was 2.4% and 28.2% of the total budget in the north and the south, respectively. The main reason for the small allocation for agriculture in the north was its greater dependence on donors' contribution (Table 21).

Table 21: Sector Budget for the Year 1988
(1,000)

Sector	Amount		Percentage	
	North (YR)	South (YD)	North	South
Agriculture	79,500	476	2.4	28.2
Industry	-	-	-	-
Agro-industry	-	-	-	-
Health	464,400	635	14.2	37.6
Mining	28,600	-	0.9	-
Energy	-	-	-	-
Applied sciences	-	-	-	-
Education	2,691,700	579	82.5	34.2
TOTAL	3,264,200	1,690	100.0	100.0

Source: CPO, 1989 (for North Yemen); CSO, 1988 (for South Yemen).

Import and Export Policies

Food consumption patterns in the country show that about two-thirds of calories consumed per capita per day come from cereals — 45.2% from wheat (38.6% for the north and 52.3% for the south), 24.9% from sorghum (48.0% for the north), 12.6% from millet (0.7% for the north and 25.4% for the south), 9.1% from rice (2.8% for the north and 15.8% for the south), 2.6% from barley (5.1% for the north), and 5.1% from maize (4.8% for the north and 5.4% for the south). Cereals also provide about 64% of the protein and 27% of daily fat requirements. The remaining requirements for calories, protein, and fat are obtained from other plant and animal products. The calories and protein intake has increased by 1.4% and 1.6% per year, respectively, during the period from 1975-1988 (Table 22).

The high rate of population growth, the low rate of growth of sorghum and millet production, the changing habits of the population to consume more wheat, and the improvement of per-capita income have increased the demand for basic staple food, i.e., cereals, especially wheat, vegetable oils, sugar, and animal products. Therefore, self-sufficiency has deteriorated during the last two decades, especially for wheat, vegetable oils, and animal products. However, it has improved for fruits and vegetables (Table 23).

The import bill of agricultural products was about US \$493 million, and US \$199 million for 1989 for North and South Yemen, respectively, of which food products formed about 87% for the north and 82% for the south, cereals made up about 46% of the food imports for the north and about 41% for the south (Table 24).

The imports and exports of principal agricultural commodities for North and South Yemen for the years 1985, 1987, and 1988 are shown in Tables 25 and 26. While essential import handling was in the hands of the private sector in the north, it was restricted to state authorities in the south. However, after unification the country policies are to give the major role to private sector for import of agricultural commodities.

Food prices are controlled in the country by ensuring the availability of the basic food commodities — wheat and flour, rice, sugar, and vegetable oil — aided by the government which provides storage silos and runs central bakeries with outlets in the cities, runs consumer cooperatives, publishes and distributes periodic food price guidelines, and differentiates taxation on food items.

Table 22: Food Balance Intake: Calories, Protein and Fats

SOURCE		Calories per cap./dav			Protein (grams) per cap./dav			Fats (grams) per cap./day		
		1975	1980	1988	1975	1980	1988	1975	1980	1988
Vegetable products	N	1859	1979	2105	52.6	53.5	50.9	21.5	27.1	26.8
	S	1690	1910	2078	36.5	42.0	48.3	30.4	34.3	22.0
Cereals	N	1448	1444	1523	42.1	41.9	44.4	14.6	13.5	11.5
	S	1195	1319	1594	31.8	36.7	44.1	7.2	8.3	9.0
Wheat	N	317	544	843	9.6	16.4	25.6	1.7	3.4	4.5
	S	468	707	973	14.2	21.5	29.5	2.5	3.8	5.2
Rice	N	12	31	79	0.2	0.6	1.5	0.0	0.1	0.1
	S	240	151	260	4.6	2.9	5.0	0.5	0.3	0.5
Barley	N	102	67	55	3.4	2.2	1.8	0.6	0.4	0.3
	S	-	-	-	-	-	-	-	-	-
Maize	N	75	75	64	1.9	2.0	1.7	1.0	1.1	0.9
	S	68	92	62	1.8	2.4	1.6	1.0	1.3	0.9
Millet	N	0	0	31	0.0	0.0	0.9	0.0	0.0	0.3
	S	390	361	294	10.4	9.6	7.9	3.2	3.0	2.4
Sorghum	N	944	726	450	27.0	20.7	12.8	11.3	8.7	5.4
	S	-	-	-	-	-	-	-	-	-
Potatoes	N	24	38	29	0.4	0.6	0.5	0.1	0.1	0.1
	S	2	11	11	0.0	0.2	0.2	-	-	-
Sweeteners	N	127	168	273	-	-	-	-	-	-
	S	143	227	255	-	-	-	-	-	-
Pulses	N	115	115	54	7.4	7.4	3.5	0.7	0.7	0.3
	S	15	9	9	1.0	0.6	0.6	0.1	0.1	0.1

Source: FAO AGROSTAT Files, 1991.

Note: N = Northern Governorates; S = Southern Governorates

Table 22: Food Balance Intake: Calories, Protein and Fats (continued).

SOURCE		Calories per cap./day			Protein (grams) per cap./day			Fats (grams) per cap./day		
		1975	1980	1988	1975	1980	1988	1975	1980	1988
Vegetable oils	N	44	94	117	-	-	-	5.0	10.7	13.2
	S	178	184	91	-	-	-	20.1	20.8	10.3
Vegetables	N	19	27	20	1.2	1.7	0.9	0.2	0.2	0.2
	S	16	23	23	1.0	1.3	1.2	0.2	0.2	0.2
Fruits	N	70	65	71	0.7	0.6	0.9	0.3	0.4	0.4
	S	101	73	56	1.2	0.9	0.7	0.5	0.4	0.3
Animal products	N	163	220	217	10.0	13.8	15.6	11.5	14.5	14.0
	S	176	226	242	12.3	18.9	21.8	11.6	11.4	11.0
Meat	N	64	82	97	4.2	6.1	7.7	5.1	6.2	7.1
	S	53	60	61	3.6	4.2	4.4	4.2	4.6	4.7
Animal Fat	N	25	33	31	-	-	-	2.8	3.7	3.4
	S	24	16	15	-	-	-	2.7	1.8	1.6
Milk	N	57	82	68	3.8	5.0	5.4	2.9	3.4	2.4
	S	71	102	118	4.3	7.7	9.6	3.7	3.4	3.1
Eggs	N	2	6	10	0.2	0.5	0.7	0.1	0.4	0.7
	S	3	6	4	0.2	0.4	0.3	0.2	0.4	0.3
Fish	N	7	10	7	1.0	1.4	1.0	0.3	0.4	0.2
	S	19	34	40	3.4	5.9	6.9	0.5	1.0	1.1
TOTAL	N	2023	2199	2322	62.6	67.3	66.5	33.1	41.6	40.8
	S	1867	2135	2320	48.8	60.9	70.2	42.0	45.7	32.9

Source: FAO AGROSTAT Files, 1991.

Note: N = Northern Governorates; S = Southern Governorates

Table 23: Self-sufficiency in Main Commodity Groups, 1970 - 1988.

Commodity Group		1970				1980				1988			
		P	E	I	% S.S.	P	E	I	% S.S.	P	E	I	% S.S.
		(1000 MT)				(1000 MT)				(1000 MT)			
Cereals	N	766	0	101	88	788	29	377	69	808	83	780	54
	S	79	28	199	32	126	0	223	36	113	0	453	20
Wheat	N	26	0	95	21	63	2	345	16	132	2	706	16
	S	13	18	143	9	25	0	184	12	15	0	364	4
Millet	N	0	0	0	0	0	0	0	0	32	0	0	100
	S	58	0	0	100	83	0	0	100	85	-	-	100
Sorghum	N	610	0	0	100	632	0	0	100	542	0	0	100
	S	-	-	-	-	-	-	-	-	-	-	-	-
Pulses	N	50	0	0	100	80	0	1	99	46	0	1	98
	S	0	0	3	0	0	0	2	0	0	0	2	0
Potatoes	N	20	1	0	105	127	0	0	100	119	2	0	102
	S	0	0	0	0	5	0	5	50	8	0	5	62
Vegetable Oils	N	1	0	3	25	4	0	20	17	4	0	81	5
	S	3	0	2	60	5	0	13	28	4	0	16	20
Sugar	N	0	0	55	0	0	1	115	0	0	0	247	0
	S	0	0	42	0	0	0	52	0	0	0	69	0
Vegetables	N	50	0	0	100	254	0	16	94	238	6	1	102
	S	15	1	9	65	52	0	23	69	62	0	24	72

Source: Calculated from "AGROSTAT Files, FAO".

Note: N = Northern Governorates; S = Southern Governorates; P = Production; E = Export; I = Import; SS = Self-sufficiency

Table 23: Self-sufficiency in Main Commodity Groups, 1970 - 1988 (continued).

Commodity Group		1970				1980				1988			
		P	E	I	% S.S.	P	E	I	% S.S.	P	E	I	% S.S.
		(1000 MT)				(1000 MT)				(1000 MT)			
Fruits	N	36	0	5	88	137	3	149	48	502	0	7	99
	S	71	2	12	88	100	1	19	85	108	0	14	89
Animal Fats	N	4	0	1	80	6	0	5	55	7	0	4	64
	S	1	0	10	10	1	0	1	50	1	0	0	100
Meat	N	49	0	1	98	56	0	39	59	134	0	22	86
	S	10	0	3	77	14	0	7	67	16	0	11	59
bovine meat	N	12	0	1	92	9	0	4	69	13	0	1	93
	S	2	0	0	100	2	0	0	100	3	0	1	75
sheep meat	N	35	0	0	100	41	0	2	95	45	0	3	94
	S	6	0	2	75	9	0	3	75	10	0	4	71
poultry	N	1	0	0	100	5	0	32	14	76	0	16	83
	S	1	0	0	100	2	0	3	40	2	0	7	22
Milk	N	151	0	8	95	181	0	134	57	202	0	230	47
	S	56	1	29	67	53	3	101	35	58	0	181	24
Eggs	N	3	0	0	100	6	0	6	50	14	0	10	58
	S	1	0	0	100	2	0	1	67	2	0	1	67
Fish	N	7	4	0	233	17	0	9	65	22	0	4	85
	S	20	17	10	154	37	12	0	148	91	6	1	106

Source: Calculated from "AGROSTAT Files, FAO".

Note: N = Northern Governorates; S = Southern Governorates; P = Production; E = Export; I = Import; SS = Self-sufficiency.

Table 24: Agricultural, Food Products, and Main Commodity Groups Trade, 1970-1989 (Millions US\$)

Product		1970		1980		1989	
		Import	Export	Import	Export	Import	Export
Total agricultural products	N	17	2	518	19	493	38
	S	53	1	234	16	199	10
Total food products	N	17	2	475	9	428	32
and animals	S	45	6	207	3	164	4
Cereals	N	8	0	112	4	199	3
	S	19	3	75	0	67	0
Fats & oils	N	0	0	14	0	17	0
	S	1	0	3	0	23	0
Live animals	N	0	0	1	0	4	0
	S	3	0	10	0	6	0
Meat	N	0	0	5	0.4	7	0
	S	0.2	0	8	0.2	9	0
Fruits & vegetables	N	0.6	0	12	2	19	18
	S	3	0.4	26	0.6	17	0.2
Sugar	N	4	0	79	2	73	0.3
	S	5	0.4	40	1	17	3
Feed stuff	N	0	0	8	0	10	0.8
	S	0	0.1	0.1	0	1	0
Dairy products	N	1	0	7	0.5	56	0
and eggs	S	6	0.2	24	0.3	31	0
Agricultural requisites	N	0.1	0	26	0	32	0
	S	1	0	7	0	3	0

Source: FAO AGROSTAT FILES, 1991.

Note: N = Northern Governments; S = Southern Governments.

**Table 25: Imports of Principal Agricultural Commodities
for 1985, 1987, and 1988 (Millions US\$)**

Commodity	1985		1987		1988	
	N	S	N	S	N	S
Wheat	65.62	0.05	69.63	0.02	65.81	0.04
Flour	36.56	0.01	30.86	0.0	28.82	0.01
Rice	20.82	0.02	10.04	0.01	12.59	0.02
Sorghum	5.74	0.0	0.01	0.0	0.04	0.0
Other cereals	-	0.0	-	0.0	-	0.0
Sesame	-	0.01	0.24	0.0	-	0.0
Oils	-	0.01		0.01		0.02
Sugar	34.49		47.80		70.36	
Potatoes	-	0.0		0.0		0.0
Vegetables	0.06	0.02	4.10	0.01	5.85	0.0
Legumes	1.96	-	1.05		13.29	
Fruits	-	0.01	0.38	0.01	10.23	0.01
Dates	3.26	-	1.58	0.0	4.67	0.0
Feed stuff	0.52	-	28.49	-	51.08	
Red meat	47.88	0.15	36.11	0.0	38.40	0.0
White meat	6.14	0.08	17.15	0.01	15.67	0.01

Note: N = Northern Governorates; S = Southern Governorates.

**Table 26: Exports of Principle Agricultural Commodities
for 1985, 1987, and 1988 (Millions US\$)**

Commodity	1985		1987		1988	
	N	S	N	S	N	S
Tobacco	0.44	1.13	6.00	1.37	6.72	1.55
Coffee	1.65	-	12.91		27.5	
Cereals	2.55	-	5.58		3.17	
Cotton	-	1.21	-	2.62	-	2.89
Sesame	-	-	1.47		1.10	
Potatoes	0.16	-	0.27		0.38	
Tomatoes	1.02	-	0.09		0.46	
Grapes	2.20	-	3.02		1.37	
Raisins	0.04	-	1.06		1.51	
Honey	-	2.08		9.24		6.34
Animal skin	1.67	-	7.45		7.62	

Note: N = Northern Governorates; S = Southern Governorates.

AGRICULTURAL TECHNOLOGY MANAGEMENT SYSTEM

Technology Generation and Transfer Policies

Pricing and Input Policies

The government subsidizes the production of principal and newly introduced crops, i.e., wheat, sorghum, barley, maize, cotton, and legumes by providing producer subsidies for production inputs, i.e., seeds, fertilizers, pesticides, machinery, petroleum fuels, and cash loans. However, the government is also subsidizing main food commodities for consumers, i.e., bread and flour, rice, sugar, and vegetable oil. The government's pricing policies for major agricultural commodities follow three patterns: above world prices to promote cotton production in the north, below world prices in the south, and free market prices in the north (Table 27).

The new policies of the united country are more in favor of subsidizing consumers for bread and flour, rice, sugar, and vegetable oil, and subsidizing producers to produce more cotton, wheat, sorghum, and maize.

Seed Policies

Production of improved breeder seeds is the responsibility of the Agricultural Research and Extension Authority (AREA). AREA is also responsible for improved seed maintenance. However, various development projects participate in the production of improved seeds through testing and multiplication. The Seed Multiplication Project in the north of Yemen multiplies improved seed of wheat, barley, maize, sorghum, and millet and distributes these seeds to farmers at incentive prices through the Agricultural Cooperative Credit Bank. The improved potatoes in the north of Yemen are provided to farmers through the Seed Potato Production project. In the south of Yemen, the National Seed Multiplication Centre multiplies the approved and improved seeds and distributes to farmers. The area covered by improved seeds is between 1.0% and 15.8% for wheat, maize, sorghum, millet, barley, and potatoes in North Yemen, and between 10.4% and 100% for cotton, potatoes, wheat, maize, and sorghum in South Yemen (Table 28).

Improved vegetable seed production is mainly done on onions. Other vegetable seeds are imported or multiplied by the private sector. It must be noted that seed policies regulating the distribution and use of seeds are still lacking. However, the MAWR recently established a National Variety Release Committee mandated to approve varieties for release to farmers.

Transport, Storage, and Processing Policies

The development plans have dealt with transport, storage, and processing issues by allocating financial resources for development projects under the agriculture, industry, and transport and communication sectors. However, the government has supported private-sector initiatives to contribute to develop the sectors.

Table 27: Product Price Policies and Producer Subsidies

Item	Commodity	
	North Yemen	South Yemen
1. Product Price Policies a) Government intervention policies - above world prices - below world prices - free market prices b) Consumer subsidies - subsidized - non-subsidized	cotton - wheat; barley; sorghum; maize; groundnuts; legumes bread and flour; rice; sugar, vegetable oil red meat	Wheat; barley; sorghum; maize bread and flour; rice; sugar, vegetable oil red meat
2. Producer Subsidies a) Subsidies on inputs - seeds - fertilizers - pesticides - machinery - petroleum fuels b) Cash loan and loans by input - cash loan - seeds - fertilizers - pesticides	wheat; barley; sorghum; maize; cotton cotton wheat wheat; barley; sorghum; maize; cotton; groundnuts; legumes	wheat; barley; sorghum; maize; cotton; groundnuts; legumes wheat; barley; sorghum; maize; cotton; groundnuts; legumes wheat; barley; sorghum; maize; cotton; groundnuts; legumes - wheat; cotton wheat; cotton wheat; cotton wheat; cotton

Research and Extension Policies

The government supports research and extension by continuously improving their resource base. The second five-year plan allocated 9.1% for research and 4.2% for technology transfer of the total allocation for the agricultural sector. These allocations were used for institution building to develop the human and physical resources and to carry out program

activities. Support to develop research and technology transfer was given from many multilateral and bilateral technical assistance agencies (Table 20). Agricultural research in the north was organized as a semi-autonomous institution by the Presidential Law No. 32, for the year 1983. In South Yemen, research was then organized with extension in one department within the Ministry of Agriculture. Upon the merging of the two into one country, the former Department of Research and Extension in the south, and the General Department of Extension and Training (GDET) in the north merged with the north's Agricultural Research Authority and became the new AREA.

AREA is mandated to carry out applied research leading to the improved technologies needed to achieve agricultural development goals and objectives. The diversity of agroclimatic zones in the country forced AREA to establish a network of stations and centers at regional level. Regional institutions are decentralized in priority setting but coordinated by national coordinators.

Intrainstitutional coordination in AREA between research and extension is achieved at three levels:

- local level through monthly workshops;
- regional level through the Research and Extension Technical Committee which meets twice a year;
- national level through the National Research and Extension Coordinating Committee which meets once a year.

Extension activities at farm level are financed by the RDAs and RDPs. Extension leaders, subject matter specialists (SMSs) at RDAs, and RDPs meet once a month through the local coordination workshops. SMSs are members of the Research and Extension Committees.

Table 28: Production of Improved Seeds

1 Crop	2 Area Sown (ha)		3 Production of Improved Seeds (mt)		4 Estimated Seed Rate per ha (kg)		5 Potential for Area Planted (ha)		6 Total Area in Production 1988 (ha)		7 (5/6) %	
	N	S	N	S	N	S	N	S	N	S	N	S
	Sorghum	n.a.	21	5	35	15	17	333	2,083	584.3	20.0	0.1
Millet	n.a.	-	110	-	8	-	13,787	-	93.6	-	14.7	-
Maize	n.a.	17	201	30	30	17	6,693	1,765	42.4	2.9	15.8	61.9
Wheat	n.a.	367	1,452	662	120	149	12,096	4,443	76.9	5.4	15.7	82.6
Barley	n.a.	-	15	-	80	-	188	-	43.8	-	0.4	-
Potatoes	n.a.	333	2,500	3,040	3,000	2,000	853	1,520	9.2	1.0	9.1	100.0
Cotton (long)	n.a.	88	-	58	-	8	-	1,875	-	1.8	-	100.0
Cotton (med.)	n.a.	29	-	58	-	8	-	7,250	-	1.3	-	100.0

Source: Agricultural Statistics Book, 1989 (for North Yemen);
See Multiplication Centre (for South Yemen).

Note: N = North Yemen; S = South Yemen.

Analysis of Structure and Functions of the ATMS

Methodology

The methodology calls for the identification of main institutions and groups involved in the ATMS in Yemen, especially identification of their roles in affecting structure and performance of agriculture in the country, in affecting the critical functions the ATMS is expected to perform, and in the mechanisms by which the system carries out these functions. The functional analysis provides a framework in which improvements can be systematically discussed, since a function may be performed inadequately because there are too few or too many institutions and groups involved or because the mechanisms applied require improvement. The main instruments for analysis is a "linear responsibility chart." This is used to identify institution tasks and responsibilities for execution. However, this study was faced by dynamic changes in institutions as well as in groups involved in the ATMS due to the unification of the country. Therefore, the data collected and used should be updated by AREA management to allow the database to be utilized more efficiently to improve AREA management.

Thirteen key functions are identified which an ATMS must perform, or at least influence. If the system carries out all 13 functions effectively, it is likely to be "successful." These key functions and the analysis that must be undertaken are:

1. *Defining macroeconomic strategy:* Analysis of the institutions involved in making basic macroeconomic policies relating to rates of exchange, relative prices, and size of government institutions which set the overall framework in which the agricultural sector operates. These policies have an impact on agricultural innovations.
2. *Defining intersectoral allocation of resources:* Determination of the share of the government's budget devoted to the agriculture sector, its components, and the way in which the proportion is fixed.
3. *Developing human resources for the agricultural sector:* Determination of whether ATMS institutions are efficient in developing and managing their human resources.
4. *Generating domestic political support for agricultural research:* Determination of whether the ATMS institutions actively seek to generate support or detract from support for agricultural research through interaction or opposition.
5. *Generating external support for agricultural research:* Identification of institutions which generate external support for agricultural research, and the mechanisms they use.

6. *Setting goals for the agricultural sector:* Clarification of how goals are set for the agricultural sector. The establishment of realistic goals and the creation of appropriate mechanisms by which they are set are important for the success of the sector.
7. *Allocating resources within the agricultural sector:* Analysis of the mechanisms through which each institution influences decisions concerning allocation of resources devoted to research, extension, credit, input supply, and marketing.
8. *Determining agricultural research strategies at macro level:* Determination of the role and effectiveness of research institutions in setting research strategies. This involves the identification of development objectives, the expressions of those objectives as research problems, and the choice of appropriate research strategies to solve those problems.
9. *Generating and assessing technologies:* Identification of all institutions which generate and assess technologies, such as national research institutions, universities and private sector, and external institutions.
10. *Transfer of technologies:* Analysis of institutions and mechanisms involved in the transfer of technologies and of the linkages between research and extension.
11. *Providing support services to technologies adoption:* Identification of principal institutions that provide a range of support services for adoption of technologies.
12. *Evaluating the impact of technology-development efforts:* Identification of institutions involved in assessing the impact of agricultural research on agricultural development.
13. *Ensuring the marketing and use of the product:* Analysis of the roles of institutions involved in market regulations and interventions.

For each institution and group participant in the ATMS, the responsibility and mechanisms for participation in each of the above 13 key functions are described. The levels of *responsibility* of each institution, with respect to each function, may be described as: decides (makes, or participates in, the final decision); finances; coordinates; executes; participates; advises; informs; or requests. The *mechanisms* each institution uses to participate in each function may include formal lines of authority, procedures for regular consultation, lobbying by interest groups, or simply an informal exchange of information. Some institutions or groups may have no mechanisms at all for participating in many of the key functions.

Conceptually, the 13 key functions of the ATMS are arranged at the top of a matrix as columns, all institutions and groups involved in performing a given function are identified

and the extent of their involvement. By going across a row, all the functions that a participant performs in the system can be shown. The matrix provides a structural map of the system, which can highlight duplication, competition, or potential for cooperation among participants of the system. It also demonstrates the absence of certain institutions or groups from any influence on functions in which they should be involved.

The information collected by the national study team was computed in a database format at ISNAR by using the REFLEX program.

Analysis

Different institutions and groups of the Yemeni ATMS were identified and listed alphabetically with their acronyms in Table 29. Each has been classified by principal purpose and subsector: donor (external); technology generating; policy environment; support services; technology transfer; and technology using. The latter are in Table 30 with the institutional roles within each key function which were identified under each subsector of institutions. The particular mechanisms through which each institution functions and each group relates to each function are described in Tables 31 to 43.

Policy context of technology generation: Policy plays a critical role in shaping the structure of agricultural production, the efficient use of natural resources, and the context for technology development.

With respect to *macro-policy formation* (Table 31), national research institutions and faculties of agriculture participate in the macro-policy formation through participation in committees, writing reports, or through research boards; or they execute macro-policy decisions through development of research plans. Donors participate in macro-policy formation through an advisory role in their preference to finance specific subsectors. The producers participate in the formation of macro-policy by lobbying, reporting, and implementing.

Inter-sectoral resource allocation refers to decision making, executing, and participating as functions of various government institutions, e.g., ministries and cabinet. Donors, however, influence resource allocation through their advisory role and financing specific projects (Table 32).

Many institutions are involved in *human resource* development in the country. Donors fund training programs; research institutions and faculties of agriculture in the country execute, coordinate, or decide training programs; external research institutions assist Yemen in training the cadre needed for agricultural research; policy and services institutions develop and decide training plans (Table 33).

In *generating political support* to research, donors inform decisionmakers by recommending the needed support to research; research institutions participate through their contacts to improve the political support to research; and various services institutions participate in meetings which help to generate political support to research (Table 34).

Through various channels, research institutions are seeking *external support*, which includes financing research and supplying research with the necessities, i.e., required germplasm and breeds (Table 35).

In *influencing goals*, donors advise through preparation of reviews; research institutions participate by preparing reports; technology users participate through developing production policies, lobbying, and other means; policy institutions participate in board and cabinet meetings; and services institutions participate through board meetings (Table 36).

Donors and policymakers play a major role in *resource allocation within the agricultural sector*. Donors advise through preparation of reviews and finance specific projects; and policymakers participate in the decision process of budgeting development projects (Table 37).

In *setting research strategy*, research institutions participate in identifying priorities; policy institutions participate and decide priorities; services and technology-using institutions participate in identifying agricultural problems; and donors advise through their evaluations of projects (Table 38).

Technology generation and transfer: Donors finance technology generation; national research institutions execute research programs; external research institutions support national research efforts by providing germplasm; policy institutions finance research activities; and services and technology-using institutions request research directly or through extension to solve agricultural problems (Table 39).

Regarding *technology transfer*, donors finance several projects to transfer improved technologies, while research institutions participate in joint trials with extension and in training extension workers — especially subject-matter specialists in the south — services institutions participate by providing support and execute research recommendations; technology transfer institutions execute research recommendations and carry out demonstration trials; and technology-using institutions and groups execute recommendations (Table 40).

Support services to agriculture are decided by policy institutions. Donors finance support of agricultural production through specific projects; services institutions provide seeds and other inputs, finance support services, advise on support services, or coordinate inputs support; and technology-transfer and technology-using institutes participate in providing inputs (Table 41).

In *marketing and commercial intervention*, policy institutions advise or decide pricing policies, subsidies on staple food and production and inputs; the technology-using institutions participate or execute wholesale and marketing (Table 42).

In the *evaluation of impact*, donors participate in resource and project evaluation. Technology-generating institutions participate through holding workshops, meetings or impact studies. Policy, services, and technology-using institutions participate in evaluation activities (Table 43).

Table 29: A List of Institutions and Groups Involved in the ATMS in Yemen

Acronym	Institution/Group
ACSAD	Arab Center for the Studies of Arid Zones and Dry Lands
ADC	Agricultural Documentation Centre
AES	Agricultural Engineers Society
AEU	Agricultural Extension Unit in the Governorate
AFESD	Arab Fund for Economic and Social Development
AGFUND	Arab Gulf Programme for United Nations Development Organizations
AOAD	Arab Organization for Agricultural Development
ARA	Agricultural Research Authority
AREC	Agricultural Research and Extension Council
AREP	Agricultural Research and Extension Project
AVRDC	Asian Vegetable Research and Development Center
CACP	Cooperative and Agricultural Credit Bank
CI	Cooperative Institute,MAAR
CIMMYT	Centro Internacional de Mejoramiento de Maiz Trigo
CIP	Centro Internacional de la Papa
CoopFarm	Cooperative Farms
CoopFish	Cooperative Fishermen
CPO	Central Planning Organization
CSO	Central Statistics Organization
DAF	Department of Agriculture and Fishery,MP
DAG	Directorate of Agriculture in the Governorate
DAHVS	Department of Animal Husbandry and Veterinary Service,MAAR
DAM	Department of Agricultural Mechanization,MAAR
DC	Department of Cooperatives,MAAR
DI	Department of Irrigation,MAAR
DMA	Deputy Minister of Agriculture
DP	Department of Planning,MAAR
DRE	Department of Research and Extension
DSF	Department of State Farms,MAAR
EEC	European Economic Commission
ESCAW	Economic and Social Commission for Western Asia
ETC	Extension Training Centre,MAAR
FAAU	Faculty of Agriculture , Aden University
FAF	Fish Canning Factories
FAO	Food and Agriculture Organization
Farmers	Private Sector Farmers
FEAU	Faculty of Economics,Aden University
Fishermen	Private Sector Fishermen
GDSKHS	General Directorate of Scientific Research,Aden Univ
GTZ	German Agency for Technical Cooperation
IAEA	International Atomic Energy Agency
IBPGR	International Board for Plant Genetic Resources
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDA	International Development Association/World Bank
IDB	Islamic Development Bank
IFAD	International Fund for Agricultural Development
Italy	Directorate General of Cooperation for Development
Japan	Japan International Cooperation Agency
KARC	El-Kod Agricultural Research Centre
KFAED	Kuwait Fund for Arab Economic Development
Livestock	Private Livestock Owners

**Table 29: A List of Institutions and Groups Involved in the ATMS in Yemen
(continued)**

Acronym	Institution/Group
LRDC	Livestock Research and Development Centre
MAAR	Ministry of Agriculture and Agrarian Reform
MAF	Ministry of Agriculture and Fisheries
MCE	Ministry of Commerce and Economy
MCSAR	Ministry of Civil Service and Administrative Reform
MDRTS	Multidisciplinary Research Teams
MECO	Military Economic Cooperation
MF	Ministry of Finance
MFW	Ministry of Fisheries Wealth
MMF	Ministry of Municipality and Housing
MP	Ministry of Planning
MSRRC	Marine Science Research and Resources Centre, MFW
NDGIC	Netherlands Directorate General for International Cooperation
NFMC	National Fish Marketing Corporation
NSMC	National Seed Multiplication Centre, MAAR
ODA	Overseas Development Administration, United Kingdom
PASC	Public Agricultural Services Corporation
PCFV	Public Corporation for Fruits and Vegetables, MAAR
PCP	Public Corporation for Poultry, MAAR
PCUMS	Prices Central Unit, Ministry of State for Minister Cabinet
PHC	Post-Harvest Centre, MAAR
PM	Prime Ministry
PPI	Private Poultry Industry
PPS	Plant Production Section, MAAR
PS	Private Sector
RDA'S	Rural Development Agencies
RETC	Research and Extension Technical Committee of DRE
SARC	Seiyun Agricultural Research Centre
SF	State Farms
SMP	Seed Multiplication Project
SU	Sana'a University
TISP	Traditional Irrigation Systems Project, MAAR
UNDP	United Nations Development Programme
USSR	Union of the Soviets Socialist Republics
WBADP	Wadi Bihan Agricultural Development Project, MAAR
WFP	UN World Food Programme
WFP	World Food Program

Table 30: Functional Analysis: Roles of Institutions and Groups

Region	Institution	Subsector	MPF	ISA	HRI	GPS	ESR	IG	RAWAS	SRS	GT	TT	SSA	HCI	EIATMS
Both	AFESD	Donor	None	None	Finance	None	None	None	Finance	None	Finance	None	Finance	None	Participat
South	AGFUND	Donor	None	None	Finance	None	None	None	Finance	None	None	None	None	None	None
Both	ADAD	Donor	Advise	None	Finance	None	None	Participat	None	None	None	None	Advise	None	None
South	AREP	Donor	Participat	None	Finance	Coordinate	Request	None	None	Participat	Participat	Execute	None	None	None
North	EEC	Donor	None	None	None	None	None	None	None	None	None	None	Finance	None	None
South	ESCWA	Donor	Advise	None	Finance	Inform	Participat	None	None	None	None	None	None	None	None
Both	FAO	Donor	Advise	None	Coordinate	Inform	Participat	Advise	Advise	Advise	Advise	Advise	Advise	None	Participat
North	GTZ	Donor	None	None	Finance	None	Finance	None	None	None	Finance	Finance	Finance	None	None
Both	IDA	Donor	Inform	Advise	Finance	Inform	Finance	Advise	Advise	Advise	Finance	Finance	Finance	Advise	Advise
South	IDB	Donor	Inform	Advise	Finance	Inform	Finance	None	Advise	None	Finance	Finance	Finance	Finance	Advise
Both	IFAD	Donor	Advise	Advise	None	Inform	Finance	Advise	Advise	Advise	Finance	Finance	Finance	None	Advise
North	Italy	Donor	None	None	None	None	Finance	None	None	None	Finance	None	Finance	None	None
North	Japan	Donor	None	None	None	None	Finance	None	None	None	None	None	Finance	None	None
South	KFAED	Donor	Advise	None	Finance	Finance	None	None	Advise	None	None	Finance	Finance	None	None
North	MF	Donor	Finance	Finance	Finance	None	Coordinate	Finance	Finance	None	Finance	Finance	Finance	Finance	None
North	MDGIC	Donor	None	None	None	None	Finance	None	None	None	Finance	Finance	Finance	Finance	None
North	ODA	Donor	None	None	Finance	None	Finance	None	None	None	Finance	Finance	Finance	None	None
Both	UNDP	Donor	Inform	Advise	Finance	None	Finance	None	Advise	None	Finance	Finance	Finance	None	Participat
North	USAID	Donor	Inform	None	Finance	None	Finance	Advise	None	None	None	None	Finance	None	Participat
South	USSR	Donor	Advise	Finance	Finance	Advise	None	Advise	Advise	None	None	Participat	Finance	None	Participat
South	WFP	Donor	Advise	Finance	None	Advise	None	None	None	None	None	None	Finance	None	None
Both	ACSAD	Generating	None	None	Execute	None	Inform	None	None	None	Execute	None	None	None	None
North	ARA	Generating	Execute	None	Decide	Inform	Inform	Execute	Request	Decide	Execute	Execute	Participat	None	Decide
South	AVRDC	Generating	None	None	Execute	None	Participat	None	None	None	Execute	None	None	None	None
Both	CIMMYT	Generating	None	None	Execute	None	Participat	None	None	None	Execute	None	None	None	None
South	CIP	Generating	None	None	Execute	None	Participat	None	None	None	Execute	None	None	None	None
South	DRE	Generating	Participat	None	Coordinate	Participat	Request	Participat	Participat	Execute	Execute	Execute	Advise	Advise	Participat
South	FAAU	Generating	Participat	None	Execute	None	Request	Participat	None	None	Execute	Participat	None	None	None
South	FEAU	Generating	Participat	None	Execute	None	Request	None	None	None	None	None	None	None	None
South	IAEA	Generating	None	None	Finance	None	Finance	None	None	None	Finance	None	None	None	None
Both	IBPGR	Generating	None	None	Execute	None	Execute	None	None	None	None	None	None	None	None
Both	ICARDA	Generating	None	None	Execute	None	Execute	None	None	Advise	Execute	None	Advise	None	None
Both	ICRISAT	Generating	None	None	Execute	None	Execute	None	None	Advise	Execute	None	None	None	None
South	KARC	Generating	Participat	None	Participat	None	Request	Participat	None	Execute	Execute	Participat	Advise	None	Participat
South	LRDC	Generating	None	None	None	None	None	None	None	None	Execute	Participat	None	None	None
South	MDRTS	Generating	Participat	None	Advise	Participat	None	None	None	Participat	Execute	Participat	None	None	None

Table 30 : Functional Analysis: Roles of Institutions and Groups (continued)

South	MSRRC	Generating	None	None	Participat	None	None	None	None	None	Execute	None	None	None	None
South	PHC	Generating	None	Participat	None	None	None								
South	RETC	Generating	None	None	Advise	Participat	None	None	None	Participat	Participat	Participat	None	None	None
South	SARC	Generating	None	None	Participat	Participat	Request	Participat	None	Execute	Execute	Participat	Advise	None	Participat
North	SJ	Generating	None	None	Execute	Inform	None	None	None	None	None	Participat	Participat	None	None
South	AES	Policy	Inform	None	None	Participat	None								
South	AREC	Policy	None												
North	CM	Policy	Decide	Decide	Decide	None	None	Decide	Decide	None	None	None	Decide	None	Participat
North	CPD	Policy	Participat	Execute	Decide	Inform	Request	Coordinate	Participat	Participat	Participat	Participat	Participat	None	None
South	CSO	Policy	Participat	None	None	None	None	Participat	None	None	None	None	None	None	Participat
South	DMA	Policy	Participat	None	Decide	Participat	Request	Participat	Participat	Participat	None	None	Advise	Advise	Participat
South	DP	Policy	Participat	None	Decide	Participat	Request	Participat	Participat	Participat	None	None	Advise	Advise	Participat
South	GDSRHS	Policy	Participat	None	Coordinate	None	Request	None							
South	MAAR	Policy	Advise	Participat	Coordinate	Participat	Request	Participat	Participat	Decide	Finance	Finance	Request	Advise	Execute
North	MAF	Policy	Coordinate	None	Coordinate	Request	Request	Participat	Participat	Participat	Coordinate	Execute	Decide	Participat	Participat
North	MCE	Policy	None	Participat	Decide	None	None								
North	MCSAR	Policy	None	None	Participat	None									
South	MFW	Policy	Advise	Participat	Advise	Participat	None	Advise	None						
North	MMH	Policy	None	Participat	None										
South	MP	Policy	Advise	Participat	Advise	Participat	Request	Participat	Participat	Decide	Finance	Finance	Finance	Finance	Decide
South	PCUMS	Policy	Participat	None	None	None	None	Participat	None	None	None	None	Participat	Advise	Decide
South	PM	Policy	Decide	Decide	Decide	Decide	Request	Decide	Decide	Decide	None	Decide	Decide	Advise	Decide
North	SCARD	Policy	Participat	None											
South	ADC	Services	Inform	None	Inform	Inform	Inform	None	None	None	Inform	Inform	Inform	None	None
North	CACB	Services	Execute	None	Execute	None	None	None							
South	CI	Services	Advise	None	Participat	None	None	None	None	None	None	Participat	None	None	None
South	DAF	Services	Participat	None	Participat	Inform	Participat	Participat	Participat	Participat	Participat	None	None	Participat	None
South	DAG	Services	Participat	None	Participat	Participat	None	None	None	Participat	None	Participat	Participat	Participat	Participat
South	DAHVS	Services	Participat	None	Coordinate	Participat	Request	Participat	Participat	Participat	None	Participat	Advise	Advise	Participat
South	DAM	Services	Participat	None	Coordinate	Participat	Request	Participat	Participat	Participat	None	Participat	Advise	Advise	Participat
South	DC	Services	Participat	None	Coordinate	Participat	Request	Participat	Participat	Participat	None	Participat	Advise	Advise	Participat
South	DI	Services	Participat	None	Coordinate	Participat	Request	Participat	Participat	Participat	None	Participat	Advise	Advise	Participat
North	LCCD	Services	Request	None											
South	NFMC	Services	None	Execute	None										
South	PASC	Services	Participat	None	None	None	None	Participat	None	None	None	Participat	Coordinate	Execute	None
South	PPS	Services	Participat	None	Participat	Participat	None	None	None	None	Request	Participat	Request	None	None
North	SMP	Services	None	None	Finance	None	Inform	Inform	None	None	Request	Advise	Execute	Execute	Advise
South	TISP	Services	Inform	None	Finance	None	None	None	None	None	None	Execute	None	None	None
South	LBADP	Services	Execute	None	Finance	None	None	None	None	None	None	Execute	Finance	None	None
South	AEU	Transfer	Inform	None	Participat	Participat	Participat	None	None	None	Participat	Participat	Execute	Participat	None
South	ETC	Transfer	None	None	Execute	None	None	None	None	None	None	Participat	None	None	None
North	RDA'S	Transfer	Execute	None	None	None	None	Execute	Request	None	None	Execute	Participat	None	Participat
South	CoopFarm	Using	None	Participat	None	Execute	Participat	Participat	None						

Table 30: Functional Analysis: Roles of Institutions and Groups (continued)

South	CoopFish	Using	None	None	None	None	None	None	None	None	None	None	None	None	None	None	Participat	None
South	DSF	Using	Participat	None	Coordinate	Participat	Request	Participat	Participat	Participat	None	Execute	Advise	Advise	Participat	None	Participat	None
South	FAF	Using	None	None	None	None	None	None	None	None	None	None	None	None	Request	None	Request	None
South	Farmers	Using	None	None	None	None	None	None	None	Participat	Request	Execute	None	None	Participat	None	Participat	None
South	Fishermen	Using	None	None	None	None	None	None	None	None	None	None	None	None	Participat	None	Participat	None
South	Livestock	Using	None	None	None	None	None	None	None	None	None	None	None	None	Participat	None	Participat	None
North	MECO	Using	None	None	None	None	None	None	None	None	Request	Execute	None	None	Decide	None	Decide	None
South	NSMC	Using	Participat	None	Request	Participat	None	Participat	None	Participat	None	None	None	None	Execute	None	Execute	None
South	PCFV	Using	Participat	None	None	None	None	Participat	None	None	None	Participat	Coordinate	Execute	None	None	Participat	None
South	PCP	Using	Participat	None	None	None	None	Participat	None	None	None	None	None	None	Execute	None	Execute	None
South	PPI	Using	None	None	None	None	None	None	None	None	None	None	None	None	Execute	None	Execute	None
North	PS	Using	Request	None	None	Request	None	Infrom	Infrom	Infrom	None	None	None	None	None	None	Execute	Participat
South	SF	Using	Execute	None	None	None	None	Participat	None	None	None	Execute	None	Execute	None	Execute	Participat	None

MPF=Macropolicy formation;ISA= Intersectoral allocation;HRI= Human resource issues;GPS= Generating political support;ESR= External support to research;
 IG= Influencing goals;RAMAS= Resource allocation within the agricultural sector;SRS= Setting research strategy;GT= Generation of technology;
 TT= Technology transfer;SSA= Support service to agriculture;MCI= Marketing and commercial intervention;EIATMS= Evaluation of impact on ATMS
 Note: North= North Yemen; South= South Yemen; Both= North+South

Table 31: Functional Analysis: Macro-policy Formation

Region	Institution	Subsector	Role	Mechanism to Influence
Both	AOAD	Donor	Advise	Studies
South	AREP	Donor	Participate	Reports
South	ESCWA	Donor	Advise	Reports
Both	FAO	Donor	Advise	Reports
Both	IDA	Donor	Inform	Reports
South	IDB	Donor	Inform	Reports
Both	IFAD	Donor	Advise	Reports
South	KFAED	Donor	Advise	Reports
North	MF	Donor	Finance	Allocation
Both	UNDP	Donor	Inform	Reports
North	USAID	Donor	Inform	Reports
South	USSR	Donor	Advise	Committees
South	WFP	Donor	Advise	Reports
North	ARA	Generating	Execute	Res plans
South	DRE	Generating	Participate	MAAR Board
South	FAAU	Generating	Participate	Reports
South	FEAU	Generating	Participate	Committees
South	KARC	Generating	Participate	Reports
South	MDRTS	Generating	Participate	Res Priorities
South	AES	Policy	Inform	Memberships
North	CM	Policy	Decide	Dev plan
North	CPO	Policy	Participate	Dev plan
South	CSO	Policy	Participate	Cabinet
South	DMA	Policy	Participate	MAAR Board
South	DP	Policy	Participate	MAAR Board
South	GDSRHS	Policy	Participate	Committees
South	MAAR	Policy	Advise	Cabinet
North	MAF	Policy	Coordinate	Ag dev plan
South	MFW	Policy	Advise	Cabinet
South	MP	Policy	Advise	Cabinet
South	PCUMS	Policy	Participate	Pricing policies
South	PH	Policy	Decide	Cabinet
North	SCARD	Policy	Participate	Ag dev plan
South	ADC	Services	Inform	Publications
North	CACB	Services	Execute	Credit plans
South	CI	Services	Advise	Studies
South	DAF	Services	Participate	Develp budget
South	DAG	Services	Participate	MAAR Board
South	DAHVS	Services	Participate	MAAR Board
South	DAM	Services	Participate	MAAR Board
South	DC	Services	Participate	MAAR Board
South	DI	Services	Participate	MAAR Board
North	LCCD	Services	Request	Bodies
South	PASC	Services	Participate	Reports
South	PPS	Services	Participate	MAAR Board
South	TISP	Services	Inform	Reports
South	WBADP	Services	Execute	Implementing
South	AEU	Transfer	Inform	Reflection
North	RDA'S	Transfer	Execute	Rural dev plan
South	DSF	Using	Participate	MAAR Board
South	NSMC	Using	Participate	Reports
South	PCFV	Using	Participate	Reports
South	PCP	Using	Participate	Reports
North	PS	Using	Request	Lobbying
South	SF	Using	Execute	Implementing

Table 32: Functional Analysis: Inter-sectoral Allocation

Region	Institution	Subsector	Role	Mechanism to Influence
Both	IDA	Donor	Advise	Reports
South	IDB	Donor	Advise	Reports
Both	IFAD	Donor	Advise	Reports
North	MF	Donor	Finance	Allocation
Both	UNDP	Donor	Advise	Reports
South	USSR	Donor	Finance	Funding
South	WFP	Donor	Finance	Funding
North	CM	Policy	Decide	National Budget
North	CPO	Policy	Execute	Allocation
South	MAAR	Policy	Participate	Cabinet
South	MFW	Policy	Participate	Cabinet
South	MP	Policy	Participate	Cabinet
South	PM	Policy	Decide	Budget approval

Table 33: Functional Analysis: Human Resource Issues

Region	Institution	Subsector	Role	Mechanism to Influence
Both	AFISD	Donor	Finance	Training
South	AGFUND	Donor	Finance	Training
Both	AQAD	Donor	Finance	Projects
South	AREP	Donor	Finance	Training
South	ESCWA	Donor	Finance	Training
Both	FAO	Donor	Coordinate	Facilitate
North	GTZ	Donor	Finance	Training
Both	IDA	Donor	Finance	Training
South	IDB	Donor	Finance	Training
South	KFAED	Donor	Finance	Training
North	MF	Donor	Finance	Funding
North	ODA	Donor	Finance	Training
Both	UNDP	Donor	Finance	Training
North	USAID	Donor	Finance	Training
South	USSR	Donor	Finance	Training
Both	ACSAD	Generating	Execute	Training
North	ARA	Generating	Decide	Res needs
South	AVRDC	Generating	Execute	Training
Both	CIMMYT	Generating	Execute	Training
South	CIP	Generating	Execute	Training
South	DRE	Generating	Coordinate	Training plans
South	FAAU	Generating	Execute	Training
South	FEAU	Generating	Execute	Training
South	IAEA	Generating	Finance	Training
Both	IBPGR	Generating	Execute	Training
Both	ICARDA	Generating	Execute	Training
Both	ICRISAT	Generating	Execute	Training
South	KARC	Generating	Participate	Training
South	MORTS	Generating	Advise	Training needs
South	MSRRC	Generating	Participate	Submit plans
South	RETC	Generating	Advise	Plans approval
South	SARC	Generating	Participate	Submit plans
North	SU	Generating	Execute	Training
North	CM	Policy	Decide	Plans
North	CPO	Policy	Decide	Monitoring
South	DMA	Policy	Decide	Training
South	DP	Policy	Decide	Training
South	GDSRHS	Policy	Coordinate	Training
South	MAAR	Policy	Coordinate	Training plan
North	MAF	Policy	Coordinate	Facilitate
North	MCSAR	Policy	Participate	Assignment
South	MFW	Policy	Advise	Annual plan
South	MP	Policy	Advise	Annual plan
South	PM	Policy	Decide	Annual plan
South	ADC	Services	Inform	Communication
South	CI	Services	Participate	Training
South	DAF	Services	Participate	Training plan
South	DAG	Services	Participate	Trainees nomination
South	DAHVS	Services	Coordinate	Training plans
South	DAM	Services	Coordinate	Training plans
South	DC	Services	Coordinate	training plans
South	DI	Services	Coordinate	Training plans

Table 33: Functional Analysis: Human Resource Issues (continued)

Region	Institution	Subsector	Role	Mechanism to Influence
South	PPS	Services	Participate	Training
North	SMP	Services	Finance	Training
South	TISP	Services	Finance	Training
South	WBADP	Services	Finance	Training
South	AEU	Transfer	Participate	Training
South	ETC	Transfer	Execute	Training
South	DSF	Using	Coordinate	Training plans
South	NSHC	Using	Request	Training

Table 34: Functional Analysis: Generating Political Support

Region	Institution	Sector	Role	Mechanism to Influence
South	AREP	Donor	Coordinate	Tech reports
South	ESCWA	Donor	Inform	Reports
Both	FAO	Donor	Inform	Recommend
Both	IDA	Donor	Inform	Recommend
South	IDB	Donor	Inform	Recommend
Both	IFAD	Donor	Inform	Recommend
South	KFAED	Donor	Finance	Projects
South	USSR	Donor	Advise	Annual aid
South	WFP	Donor	Advise	Annual aid
North	ARA	Generating	Inform	Reports
South	DRE	Generating	Participate	MAAR Board
South	MORTS	Generating	Participate	Contacts
South	RETC	Generating	Participate	Contact
South	SARC	Generating	Participate	Reports
North	SU	Generating	Inform	Recommend
South	AES	Policy	Participate	Ann meeting
North	CPO	Policy	Inform	Ecommend
South	DMA	Policy	Participate	MAAR Board
South	DP	Policy	Participate	MAAR Board
South	MAAR	Policy	Participate	Cabinet
North	MAF	Policy	Request	Meetings
South	MFW	Policy	Participate	Cabinet
South	MP	Policy	Participate	Cabinet
South	PM	Policy	Decide	Budget approval
South	ADC	Services	Inform	Tech reports
South	DAF	Services	Inform	Missions findings
South	DAG	Services	Participate	MAAR Board
South	DAHVS	Services	Participate	MAAR Board
South	DAM	Services	Participate	MAAR Board
South	DC	Services	Participate	MAAR Board
South	DI	Services	Participate	MAAR Board
South	PPS	Services	Participate	MAAR Board
South	AEU	Transfer	Participate	Through local community
South	DSF	Using	Participate	MAAR Board
South	NSMC	Using	Participate	Reports
North	PS	Using	Request	Lobbying

Table 35: Functional Analysis: External Support to Research

Region	Institution	Subsector	Role	Mechanism to Influence
South	AREP	Donor	Request	Proposals
South	ESCWA	Donor	Participate	Funding
Both	FAO	Donor	Participate	Donors contact
North	GTZ	Donor	Finance	Funding
Both	IDA	Donor	Finance	Funding
South	IDB	Donor	Finance	Funding
Both	IFAD	Donor	Finance	Funding
North	Italy	Donor	Finance	Funding
North	Japan	Donor	Finance	Funding
North	MF	Donor	Coordinate	with Central Bank
North	NDGIC	Donor	Finance	Funding
North	ODA	Donor	Finance	Funding
Both	UNDP	Donor	Finance	Funding
North	USAID	Donor	Finance	Funding
Both	ACSAD	Generating	Inform	Recommend
North	ARA	Generating	Inform	Min Agric
South	AVRDC	Generating	Participate	Germlasm
Both	CIMMYT	Generating	Participate	Germlasm
South	CIP	Generating	Participate	Germlasm
South	DRE	Generating	Request	Contact
South	FAAU	Generating	Request	Contact
South	FEAU	Generating	Request	Contact
South	IAEA	Generating	Finance	Funding
Both	IBPGR	Generating	Execute	Germlasm
Both	ICARDA	Generating	Execute	Germlasm
Both	ICRISAT	Generating	Execute	Germlasm
South	KARC	Generating	Request	Proposals
South	SARC	Generating	Request	Contact
North	CPO	Policy	Request	Donors contact
South	DMA	Policy	Request	Contact
South	DP	Policy	Request	Contact
South	GDSRHS	Policy	Request	Contact
South	MAAR	Policy	Request	Contact
North	MAF	Policy	Request	Through CPO
South	MP	Policy	Request	Contact
South	PM	Policy	Request	Contact
South	ADC	Services	Inform	Publications
South	DAF	Services	Participate	Contact
South	DAHVS	Services	Request	Contact
South	DAM	Services	Request	Contact
South	DC	Services	Request	Contact
South	DI	Services	Request	Contact
North	SMP	Services	Inform	Reports
South	AEU	Transfer	Participate	Problem ident
South	DSF	Using	Request	Contact

Table 36: Functional Analysis: Influencing Goals

Region	Institution	Subsector	Role	Mechanism to Influence
Both	ADAD	Donor	Participate	Reviews
Both	FAO	Donor	Advise	Reviewing
Both	IDA	Donor	Advise	Reviewing
Both	IFAD	Donor	Advise	Reviewing
North	MF	Donor	Finance	Funding
North	USAID	Donor	Advise	Reviewing
South	USSR	Donor	Advise	Reviewing
North	ARA	Generating	Execute	Dev plans
South	DRE	Generating	Participate	MAAR Board
South	FAAU	Generating	Participate	Reports
South	KARC	Generating	Participate	Reports
South	SARC	Generating	Participate	Studies
North	CM	Policy	Decide	Overall plan
North	CPO	Policy	Coordinate	Overall plan
South	CSO	Policy	Participate	Data collect
South	DMA	Policy	Participate	MAAR Board
South	DP	Policy	Participate	MAAR Board
South	MAAR	Policy	Participate	Cabinet
North	MAF	Policy	Participate	Ag dev plan
South	MP	Policy	Participate	Cabinet
South	PCLMS	Policy	Participate	Pricing policies
South	PM	Policy	Decide	Approve policies
South	DAF	Services	Participate	Projects approval
South	DAHVS	Services	Participate	MAAR Board
South	DAM	Services	Participate	MAAR Board
South	DC	Services	Participate	MAAR Board
South	DI	Services	Participate	MAAR Board
South	PASC	Services	Participate	Input import
North	SMP	Services	Inform	Report
North	RDA'S	Transfer	Execute	5-year plan
South	DSF	Using	Participate	MAAR Board
South	NSMC	Using	Participate	Seed programs
South	PCFV	Using	Participate	Marketing
South	PCP	Using	Participate	Poultry needs
North	PS	Using	Inform	Lobbying
South	SF	Using	Participate	Production policies

Table 37: Functional Analysis: Resource Allocation within the Agricultural Sector

Region	Institution	Subsector	Role	Mechanism to Influence
Both	AFESD	Donor	Finance	Funding
South	AGFUND	Donor	Finance	Project funding
Both	FAO	Donor	Advise	External funding
Both	IDA	Donor	Advise	Reviews
South	IDB	Donor	Advise	Reviews
Both	IFAD	Donor	Advise	Reviews
South	KFAED	Donor	Advise	Reviews
North	MF	Donor	Finance	Funding
Both	UNDP	Donor	Advise	Reviews
South	USSR	Donor	Advise	Reviews
North	ARA	Generating	Request	Budget submission
South	DRE	Generating	Participate	Budget plan
North	CM	Policy	Decide	Approval
North	CPO	Policy	Participate	Impose limitations
South	DMA	Policy	Participate	Budget plan
South	DP	Policy	Participate	Budget plan
South	MAAR	Policy	Participate	Cabinet
North	MAF	Policy	Participate	Impose limitations
South	MP	Policy	Participate	Cabinet
South	PM	Policy	Decide	Budget approval
South	DAF	Services	Participate	Proj budgets
South	DAHVS	Services	Participate	Budget plan
South	DAM	Services	Participate	Budget plan
South	DC	Services	Participate	Budget plan
South	DI	Services	Participate	Budget plan
North	RDA'S	Transfer	Request	Submit budgets
South	DSF	Using	Participate	Budget plan
North	PS	Using	Infrom	Policy makers

Table 38: Functional Analysis: Setting Research Strategy

Region	Institution	Subsector	Role	Mechanism to Influence
South	AREP	Donor	Participate	Proposals
Both	FAO	Donor	Advise	Evaluation
Both	IDA	Donor	Advise	Evaluation
Both	IFAD	Donor	Advise	Evaluation
North	ARA	Generating	Decide	Task forces
South	DRE	Generating	Execute	Res projects
Both	ICARDA	Generating	Advise	Meetings
Both	ICRISAT	Generating	Advise	Meetings
South	KARC	Generating	Execute	Committee
South	MDRTS	Generating	Participate	Priorities
South	RETC	Generating	Participate	Priorities
South	SARC	Generating	Execute	Res projects
North	CPO	Policy	Participate	Impose limitations
South	DMA	Policy	Participate	MAAR Board
South	DP	Policy	Participate	MAAR Board
South	MAAR	Policy	Decide	Advisory council
North	MAF	Policy	Participate	Identification
South	MP	Policy	Decide	Approv res priorities
South	PM	Policy	Decide	Development plan
South	DAF	Services	Participate	Res projects
South	DAG	Services	Participate	Farmer problems
South	DAHVS	Services	Participate	MAAR Board
South	DAM	Services	Participate	MAAR Board
South	DC	Services	Participate	MAAR Board
South	DI	Services	Participate	MAAR Board
North	SMP	Services	Request	Seeds improv
South	AEU	Transfer	Participate	Farmers problems
South	CoopFarm	Using	Participate	Farmers problems
South	DSF	Using	Participate	MAAR Board
South	Farmers	Using	Participate	Problems
South	NSMC	Using	Participate	Committees
North	PS	Using	Infrom	Priorities

Table 39: Functional Analysis: Generation of Technology

Region	Institution	Subsector	Role	Mechanism to Influence
Both	AFESD	Donor	Finance	Funding
South	AREP	Donor	Participate	Funding
Both	FAO	Donor	Advise	Resource needs
North	GTZ	Donor	Finance	Funding
Both	IDA	Donor	Finance	Funding
South	IDB	Donor	Finance	Funding
Both	IFAD	Donor	Finance	Funding
North	Italy	Donor	Finance	Funding
North	NSF	Donor	Finance	Funding
North	NDGIC	Donor	Finance	Funding
North	ODA	Donor	Finance	Funding
Both	UNDP	Donor	Finance	Funding
Both	ACSAD	Generating	Execute	Germlasm
North	ARA	Generating	Execute	Activities
South	AVRDC	Generating	Execute	Germlasm
Both	CIMMYT	Generating	Execute	Germlasm
South	CIP	Generating	Execute	Germlasm
South	DRE	Generating	Execute	Funding
South	FAAU	Generating	Execute	Research
South	IAEA	Generating	Finance	Funding
Both	ICARDA	Generating	Execute	Germlasm
Both	ICRISAT	Generating	Execute	Germlasm
South	KARC	Generating	Execute	Research
South	LRDC	Generating	Execute	Research
South	MDRTS	Generating	Execute	Research
South	MSRRC	Generating	Execute	Research
South	RETC	Generating	Participate	Res projects
South	SARC	Generating	Execute	Research
North	CPO	Policy	Participate	Impose limitation
South	MAAR	Policy	Finance	Funding
North	MAF	Policy	Coordinate	Intervention
South	MP	Policy	Finance	Funding
South	ADC	Services	Inform	Publications
South	PPS	Services	Request	Solving problems
North	SMP	Services	Advise	Solve problems
South	AEU	Transfer	Participate	Verif trials
South	Farmers	Using	Request	Extension
South	Livestock	Using	Request	Extension

Table 40: Functional Analysis: Transfer of technology

Region	Institution	Subsector	Role	Mechanism to Influence
South	AREP	Donor	Execute	Funding
Both	FAO	Donor	Advise	Tech assistance
North	GTZ	Donor	Finance	Funding
Both	IDA	Donor	Finance	Funding
South	IDB	Donor	Finance	Funding
Both	IFAD	Donor	Finance	Funding
South	KFAED	Donor	Finance	Funding
North	MF	Donor	Finance	Funding
North	NDGIC	Donor	Finance	Funding
North	OOA	Donor	Finance	Funding
Both	UNDP	Donor	Finance	Funding
South	USSR	Donor	Participate	Recommendations
North	ARA	Generating	Execute	Tech support
South	DRE	Generating	Execute	Extension
South	FAAU	Generating	Participate	Training
South	KARC	Generating	Participate	Training SMS
South	LRDC	Generating	Participate	Training
South	MORTS	Generating	Participate	Training SMS
South	PHC	Generating	Participate	Trials
South	RETC	Generating	Participate	Extn activities
South	SARC	Generating	Participate	Training SMS
North	SU	Generating	Participate	Training
North	CPO	Policy	Participate	Impose limitations
South	MAAR	Policy	Finance	Funding
North	MAF	Policy	Execute	Various means
South	MP	Policy	Finance	Funding
South	PM	Policy	Decide	Production plan
South	ADC	Services	Inform	Publications
South	CI	Services	Participate	Training
South	DAG	Services	Participate	Support
South	DAHVS	Services	Participate	Support
South	DAM	Services	Participate	Support
South	GC	Services	Participate	Support
South	DI	Services	Participate	Support
South	PASC	Services	Participate	Seeds import
South	PPS	Services	Participate	Recommendations
North	SMP	Services	Execute	Seed mult
South	TISP	Services	Execute	Recommendations
South	WBADP	Services	Execute	Recommendations
South	AEU	Transfer	Execute	Extension
South	ETC	Transfer	Participate	Training
North	PDA'S	Transfer	Execute	Demonstrations
South	CoopFarm	Using	Execute	Recommendations
South	DSF	Using	Execute	Extension
South	Farmers	Using	Execute	Recommendations
South	Livestock	Using	Execute	Recommendations
South	NSMC	Using	Participate	seed multiplication
South	PCFV	Using	Participate	Marketing
South	SF	Using	Execute	Recommendations

Table 41: Functional Analysis: Support Service to Agriculture

Region	Institution	Subsector	Role	Mechanism to Influence
Both	AFESD	Donor	Finance	Funding
Both	AOAD	Donor	Advise	Reports
North	EEC	Donor	Finance	Funding
Both	FAO	Donor	Advise	Tech assis
North	GTZ	Donor	Finance	Funding
Both	IDA	Donor	Finance	Funding
South	IDB	Donor	Finance	Funding
Both	IFAD	Donor	Finance	Funding
North	Italy	Donor	Finance	Funding
North	Japan	Donor	Finance	Funding
South	KFAED	Donor	Finance	Funding
North	MF	Donor	Finance	Funding
North	NOGIC	Donor	Finance	Funding
North	ODA	Donor	Finance	Funding
Both	UNDP	Donor	Finance	Funding
North	USAID	Donor	Finance	Funding
South	USSR	Donor	Finance	Funding
South	WFP	Donor	Finance	Funding
North	ARA	Generating	Participate	Tech packages
South	DRE	Generating	Advise	MAAR Board
Both	ICARDA	Generating	Advise	Seed production
South	KARC	Generating	Advise	Recommendations
South	SARC	Generating	Advise	Recommendations
North	SU	Generating	Participate	Training
North	CM	Policy	Decide	Priorities
North	CPO	Policy	Participate	Funds control
South	DMA	Policy	Advise	MAAR Board
South	DP	Policy	Advise	MAAR Board
South	MAAR	Policy	Request	Requirements plan
North	MAF	Policy	Decide	Ag services
North	MCE	Policy	Participate	Impose limitations
South	MP	Policy	Finance	Funding
South	PCUMS	Policy	Participate	Pricing
South	PM	Policy	Decide	Approve budget
South	ADC	Services	Inform	Publications
North	CACB	Services	Execute	Funding
South	DAF	Services	Participate	Import plan
South	DAG	Services	Participate	Requirements determinatio
South	DANVS	Services	Advise	MAAR Board
South	DAM	Services	Advise	MAAR Board
South	DC	Services	Advise	MAAR Board
South	DI	Services	Advise	MAAR Board
South	PASC	Services	Coordinate	Inputs import
South	PPS	Services	Request	Requirements
North	SMP	Services	Execute	Provide seeds
South	WBADP	Services	Finance	Funding
South	AEU	Transfer	Participate	Trans Tech
North	RDA'S	Transfer	Participate	Provide facilities
South	CoopFarm	Using	Participate	Inputs
South	DSF	Using	Advise	MAAR Board
South	NSMC	Using	Participate	Improved seeds
South	PCFV	Using	Coordinate	Inputs import

Table 42: Functional Analysis: Marketing and Commercial Intervention

Region	Institution	Subsector	Role	Mechanism to Influence
Both	IDA	Donor	Advise	Funding
North	MF	Donor	Finance	Funding
North	NDGIC	Donor	Finance	Funding
South	DRE	Generating	Advise	MAAR Board
South	DMA	Policy	Advise	MAAR Board
South	DP	Policy	Advise	MAAR Board
South	MAAR	Policy	Advise	Policy issues
North	MAF	Policy	Participate	Organization
North	MCE	Policy	Decide	Pricing
South	MFW	Policy	Advise	Policy issues
North	MMH	Policy	Participate	Organization
South	MP	Policy	Finance	Projects
South	PCUHS	Policy	Advise	Pricing
South	PM	Policy	Advise	Pricing policy
South	DAG	Services	Participate	Procedures
South	DAHVS	Services	Advise	MAAR Board
South	DAM	Services	Advise	MAAR Board
South	DC	Services	Advise	MAAR Board
South	DI	Services	Advise	MAAR Board
South	NFMC	Services	Execute	Marketing
South	PASC	Services	Execute	Whole sale
North	SMP	Services	Advise	Seed needs
South	CoopFarm	Using	Participate	Channels
South	CoopFish	Using	Participate	Channels
South	DSF	Using	Advise	MAAR Board
South	FAF	Using	Request	Export
South	Farmers	Using	Participate	Marketing
South	Fishermen	Using	Participate	Marketing
South	Livestock	Using	Decide	Marketing
North	MECO	Using	Execute	Trading
South	PCFV	Using	Execute	Whole sale
South	PCP	Using	Execute	Whole sale
North	PS	Using	Execute	Marketing
South	SF	Using	Execute	Marketing

Table 43: Functional Analysis: Evaluation of Impact on ATM System

Region	Institution	Subsector	Role	Mechanism to Influence
Both	AFESD	Donor	Participate	Proj eval
Both	FAO	Donor	Participate	Reviews
Both	IDA	Donor	Advise	Reviews
Both	IFAD	Donor	Advise	Reviews
Both	UNDP	Donor	Participate	Reviews
North	USAID	Donor	Participate	Reviews
South	USSR	Donor	Participate	Reviews
North	ARA	Generating	Decide	Workshops
South	DRE	Generating	Participate	Evaluation
South	KARC	Generating	Participate	Impact
South	SARC	Generating	Participate	Impact
North	CH	Policy	Participate	Ann meeting
South	CSO	Policy	Participate	Evaluation
South	DMA	Policy	Participate	Evaluation
South	DP	Policy	Participate	Evaluation
South	MAAR	Policy	Execute	Evaluation
North	MAF	Policy	Participate	Reviews
South	MP	Policy	Decide	Policies
South	PCUHS	Policy	Decide	Pricing policies
South	PH	Policy	Decide	Policies
South	DAG	Services	Participate	Evaluation
South	DAHVS	Services	Participate	Evaluation
South	DAM	Services	Participate	Evaluation
South	DC	Services	Participate	Evaluation
South	DI	Services	Participate	Evaluation
North	SMP	Services	Participate	Reviews
North	RDA'S	Transfer	Participate	Workshops
South	DSF	Using	Participate	Evaluation
North	PS	Using	Participate	Reviews

AGRICULTURAL RESEARCH

Historical Background

In chronological order, agricultural research in Yemen goes back to the fifties, when El-Kod Research Centre was established in South Yemen.

After independence of South Yemen on 30 November 1967, agricultural research has gone through two phases during the last two decades:

Phase I: The seventies, 1970-1980

a. *UNDP/FAO Research and Training Project, 1969-1971*

The objective of the project was to strengthen the research centre by providing technical assistance, equipment, and training to expand research areas to cover more field and horticultural crops. The duration of the project was for two years. The UNDP contribution in the project was about half a million US dollars and the government contribution was 137,500 Yemeni dinars.

b. *UNDP/FAO Research and Training Project, 1972-1976*

The aim of the project was to strengthen applied research needed to improve crop production and introduce high yielding field and horticultural crop varieties. The project has assisted in (i) establishment of the Seiyun Research Centre in Wadi Hadramout, (ii) developing national coordinated research programs on medium-staple cotton, tomatoes, potatoes, and wheat, and (iii) establishment of plant protection and seed multiplication services. The UNDP/FAO contribution was about 1.5 million US dollars and the government contribution was 595,530 Yemeni dinars.

c. *UNDP/FAO Crop Production Improvement Project, 1977-1981*

The project aimed to (i) support technology transfer through the adoption of research recommendations and developing pilot demonstration farms under spate and well irrigation and (ii) introduce mechanization for commercial production. The UNDP/FAO contribution was about four million US dollars, and the government contribution was 1,483,000 Yemeni dinars. This project has assisted in establishing the Department of Research and Extension (DRE), initiating on-farm mechanization trials, improving demonstration farms and improving infrastructure at El-Kod and Seiyun Research Centres, and training of research staff.

Phase II: The eighties, 1980-1990

a. *UNDP/FAO Extension and Farming System Research Project, 1982-1984*

The objectives of the project were to strengthen the technology transfer from research to producers, to conduct farming system research, and to strengthen extension at DRE. It was the first project under the responsibility of DRE. The project has achieved its objectives through implementation of several farming system studies, and

assessment of needs to strengthen the local training center. The UNDP/FAO contribution was about 1.6 million US dollars, and the government contribution was 655,300 Yemeni dinars.

b. The IDA/FAO Agricultural Research and Extension Project, 1985-1990

The objectives of the project were to reorganize El-Kod and Seiyun Research Centres, to develop national research priorities, specifically to formulate multidisciplinary research teams (MDRTs) at El-Kod and Seiyun Centres, to develop the five-year medium-term research program, 1985/86-1989/90, to integrate research-extension system by establishing R&E Coordination Units, to reorganize extension in Lahej, Abyan, and Hadramout in a unified structure under the management of the Agriculture Department in each of these governorates, to strengthen the Communication Unit in the Ministry and to link it to DRE, to strengthen DRE to play its role as a national coordinator of research and extension under chairmanship of the Director General of DRE.

The project budget was 5 million US dollars, the contribution of IDA, and 600,000 Yemeni dinars, the contribution of the government.

The project has achieved its objectives. The DRE was strengthened to play its role in coordination of research and extension, the two centers were restructured, the medium-term program was developed and implemented, the extension service was restructured and provided with facilities and training, and the coordination between research and extension was improved.

In North Yemen, as a component of agricultural production projects, agricultural research was introduced in 1970 when the FAO/UNDP initiated three agricultural production projects in rainfed and irrigated areas. However, 1973 is considered the beginning of organizing agricultural research in North Yemen with the start of FAO/UNDP's Agricultural Research Station and Training Project. This major research effort was supplemented by research carried out by various rural development projects. In addition, two more projects to strengthen agricultural research in the north were implemented. Accordingly, major efforts to develop agricultural research in the north during the last two decades could be categorized in three phases as follows:

Phase I: The UNDP/FAO Agricultural Research Station and Training Project, Taiz and Ibb (1973-1978) was implemented with the objective to lay down the foundation of agricultural research organization through the procurement of agricultural land for experimentation, the setting up of needed laboratories for soil, water, and plant protection, recruitment of scientists to carry out research of direct interest to farmers, and establishing an extension training program to train junior extensionists for the benefit of the Southern Rural Development Project.

Phase II: The UNDP/IDA Agricultural Research Station Project (1979-1982) was initiated by UNDP with the International Development Association (IDA) of the World Bank as an executing agency, which, in turn, subcontracted the project to FAO to provide specialists, UN volunteers, and purchase equipment.

Phase III: IFAD/Italy/IDA/FAO Agricultural Research Authority Project (1983-1988) was implemented to assist the newly formed Agricultural Research Authority in planning, programming, coordination, and evaluation of agricultural research and to develop the scientific cadre through intensive postgraduate and short-term training programs.

The above three phases were supplemented by research components of various bilateral rural development projects, e.g., ODA, USAID, GTZ, the Netherlands, and China. The ODA and the Netherlands' bilateral projects have assisted in developing livestock and forestry research programs.

To consolidate research efforts in North Yemen, the Agricultural Research Authority (ARA) was established in December 1983 by the Presidential Law no. 32, as a semi-autonomous institution under the supervision of the Minister of Agriculture, with its headquarters in the city of Dhamar. Its mandate includes planning, coordinating, and implementing agricultural research activities targeted to develop agricultural production in the country.

In the eighties, ARA had three regional research stations located in the Tihama coastal region in Surdud with a substation in Zabid, in the southern uplands region in Taiz with a substation in Ibb, and in the central highlands region in Dhamar where the ARA headquarters is with a substation in Rada'a. Two more regional stations were planned in the late eighties for the northern and the eastern region.

The unification of North and South Yemen into one country, in May 1990, has led to the merging of the DRE in Aden, GDET in Sana'a, and the ARA in Dhamar into one semi-autonomous institution, the "Agricultural Research and Extension Authority" (AREA), with its headquarters in Dhamar. AREA has replaced ARA in the organization and structure of research by the annexation of research centers in the south to AREA, the cancellation of DRE in the south, and the application of the Presidential Law no. 32 for 1983, which established ARA as the newly formed AREA. A newly proposed presidential law to organize AREA has been prepared and submitted for discussions and approval.

September 15, 1955, the day in which El-Kod Research Centre was established, became the Agricultural Research Day in the unified Yemen.

Agricultural research is limited at the Faculty of Agriculture of the University of Sana'a (FAUS). The faculty was established in 1984; its buildings and farms just recently have been structured and equipped. However, the Faculty of Agriculture of the University of Aden was established as a higher agricultural institute in 1972, and was annexed as the Faculty of Agriculture of the University of Aden (FAUA) upon its establishment in 1975. In the latter, little research is carried out by academic staff, because their time is more devoted to teaching and the lack of financial resources allocated to research. Both Faculties of Agriculture have only an education program to award B.Sc.s in agriculture. Graduate research programs are planned to be implemented in the near future.

Agricultural extension activities are mainly implemented through rural development and bilateral projects in North Yemen, while in South Yemen they are implemented through extension units in the governorates. AREA is recently coordinating extension programs

through the regional Technical Committees in which participants from research stations and extension units meet to discuss and approve annual programs and reports.

Structure and Organization

The way in which a national agricultural research system is structured and organized critically affects the efficiency and effectiveness of research. The structure and organization shape the way the system operates, as well as its capacity to diagnose problems; assess world knowledge of improved technologies; mobilize resources to conduct research; and perform other assigned functions to achieve designated objectives.

Despite the fact that agricultural research is very recent in Yemen, it has gone through some structural and organizational changes since its establishment about two decades ago. In North Yemen, agricultural research has passed through two main stages: the research station establishment and fragmented research efforts within agricultural development projects (stage 1) and the establishment of ARA as a semi-autonomous organization (stage 2). In South Yemen, however, changes have three main stages: establishing the two main centers (stage 1), setting up the DRE as a department within the MAAR (stage 2), and merging the DRE and GDET with the ARA in the AREA as a semi-autonomous organization (stage 3).

At the present stage, which started in 1990, only one national agricultural research institution, AREA, and the university carry out agricultural research in the country. Some agricultural research is carried out by rural development projects, but in collaboration with AREA. Fisheries research is carried out by MSRC.

The Agricultural Research Authority (ARA, Before Merging in AREA)

As mentioned earlier, ARA was established by the Presidential Law no. 32 in its original form in 1983. It is a semi-autonomous government institution under the direct supervision of the Minister of Agriculture. Its mandate is to carry out agricultural research to improve agricultural production of plants and animals in North Yemen. Its headquarters is in Dhamar.

ARA's responsibilities, which are spelled out in the presidential law, mainly cover the following:

1. conducting agricultural research to develop agricultural production of plants and animals, supervising and evaluating overall agricultural research activities, and implementing research results in various regions in the country;
2. defining research priorities of producing and using products in different agroecological regions in response to the needs of the national economy;
3. studying constraints of agricultural production of plants and animals to develop suitable solutions to these constraints including introduction of improved varieties and breeds and modern production inputs, and to suggest suitable farming systems;

4. collecting scientific, technical, and economic information relevant to agricultural research, distributing this information to agricultural extension workers, and preparing and training agricultural research cadres;
5. communicating with regional and international institutions working in agricultural research to benefit from their experiences and resources and to exchange information with them.

The organizational structure of ARA mainly consisted of four central directorates in the headquarters at Dhamar and three regional research stations: Tihama at Surdud, the Southern Upland at Taiz, and the Central Highland at Dhamar. The Technical Directorate has five research sections: crops, mechanization, livestock, land and water, and plant protection. A Soil Survey and Land Classification project (SSLC) is at the headquarters (Figure 4). The headquarters at Dhamar has the main central laboratories of the soil and water, plant protection, seed testing and germination, and feed nutrition analysis.

ARA is managed by a board of directors and a director general.

The responsibilities of the board of directors were spelled out in the Presidential Law No. 32 as follows:

1. *Proposing agricultural research policy at the country level;*
2. *developing and supervising implementation plans for the agricultural research policy;*
3. *reviewing and approving the research program priorities proposed by the Director General of ARA;*
4. *Approving ARA's financial contracts;*
5. *recruiting, promoting, and expiring services of expatriates;*
6. *deciding policies needed for implementing work activities and preparing administrative and financial procedures;*
7. *approving proposed estimated annual budget, prepared by the director general, and the final annual account;*
8. *holding monthly meetings to implement the above responsibilities.*

The board of directors is chaired by the Minister of Agriculture, and has on its membership, the director general of ARA, the director general of agricultural affairs of the Ministry of Agriculture, the Dean of the Faculty of Agriculture of Sana'a University, and a representative of the Central Planning Organization (CPO).

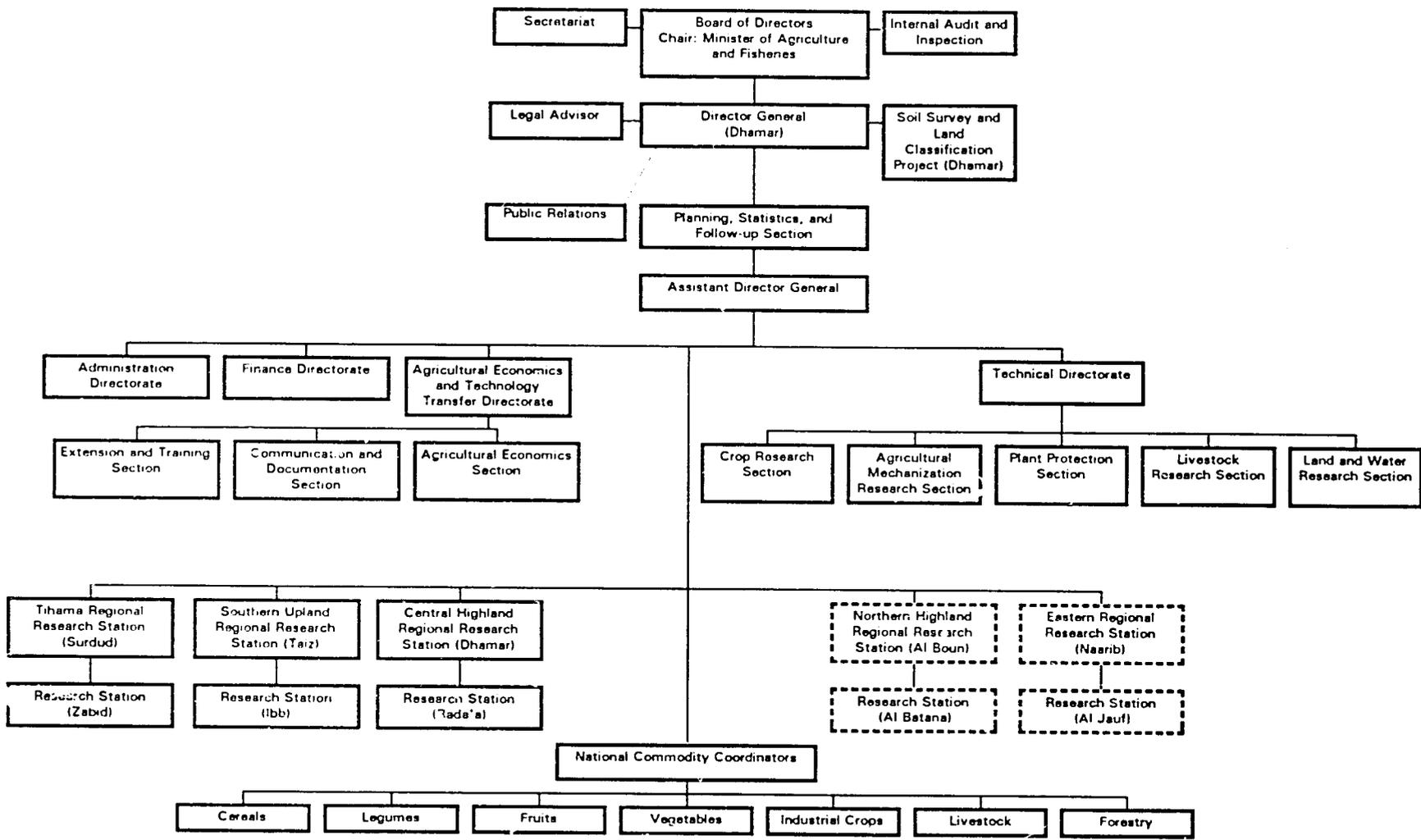


Figure 4: Organizational Structure of the Agricultural Research Authority (ARA) in North Yemen in February 1990 (before merging in AREA in May 1990)

ARA has a Research Coordination Committee (RCC), comprising of the director general of ARA (chairperson), the director of the Technical Directorate, the director of the Administration Directorate, and the three directors of the regional stations — Tihama, Southern Upland, and Central Highland. The RCC meets monthly to monitor implementation of the research program. The RCC is also guided by the National Agricultural Research Council (NARC), which is also chaired by the director general with membership of members of RCC and the national regional research coordinators and representatives from the agricultural extension. The NARC meets twice a year to review programs of coordinators and directors of regional stations.

There are seven national commodity coordinators; for cereals, legumes, fruits, vegetables, industrial crops, livestock, and forestry. The national commodity coordinators are appointed to perform interregional and interproject coordination within the country and to deal directly with related international centers' programs.

The regional stations are managed independently of each other and directly linked to the headquarters of ARA.

Each technical section within headquarters is directed by a senior scientist. The director general is assisted by an assistant director general. A section for planning, statistics and follow-up is attached directly to the director general's office. In addition, a public relations unit and a legal advisor are attached to the director general's office.

At ARA headquarters, there is the Soil Survey and Land Classification Project. This project has a management consisting of a national project director from the ARA staff, FAO staff — team leader and support staff —, and staff for the five units of soil survey, land suitability evaluation, laboratory, cartography, and soil database.

The Department of Research and Extension (DRE, Before Merging in AREA)

The DRE was established in 1980 as a department of the MAAR. It had four sections; for research, extension, communications, and administration and finance. It also had an Agricultural Documentation Centre (Figure 5).

The DRE had the overall responsibility for coordinating, monitoring, and evaluating research and extension on crops, as well as livestock in South Yemen. It functioned under the Deputy Minister of Agriculture. At the policy level, DRE activities were guided by the Agricultural Research and Extension Council; while at operational level, it was assisted by the Research and Extension Technical Committee (RETC).

The research is carried out by the two main research centers at El-Kod and Seiyun for coastal and mid-altitude regions, respectively. Research also is carried out at a sub-center at Mukeiras for the high-altitude region. Livestock research is carried out at a small center at Mujahid (Figure 5).

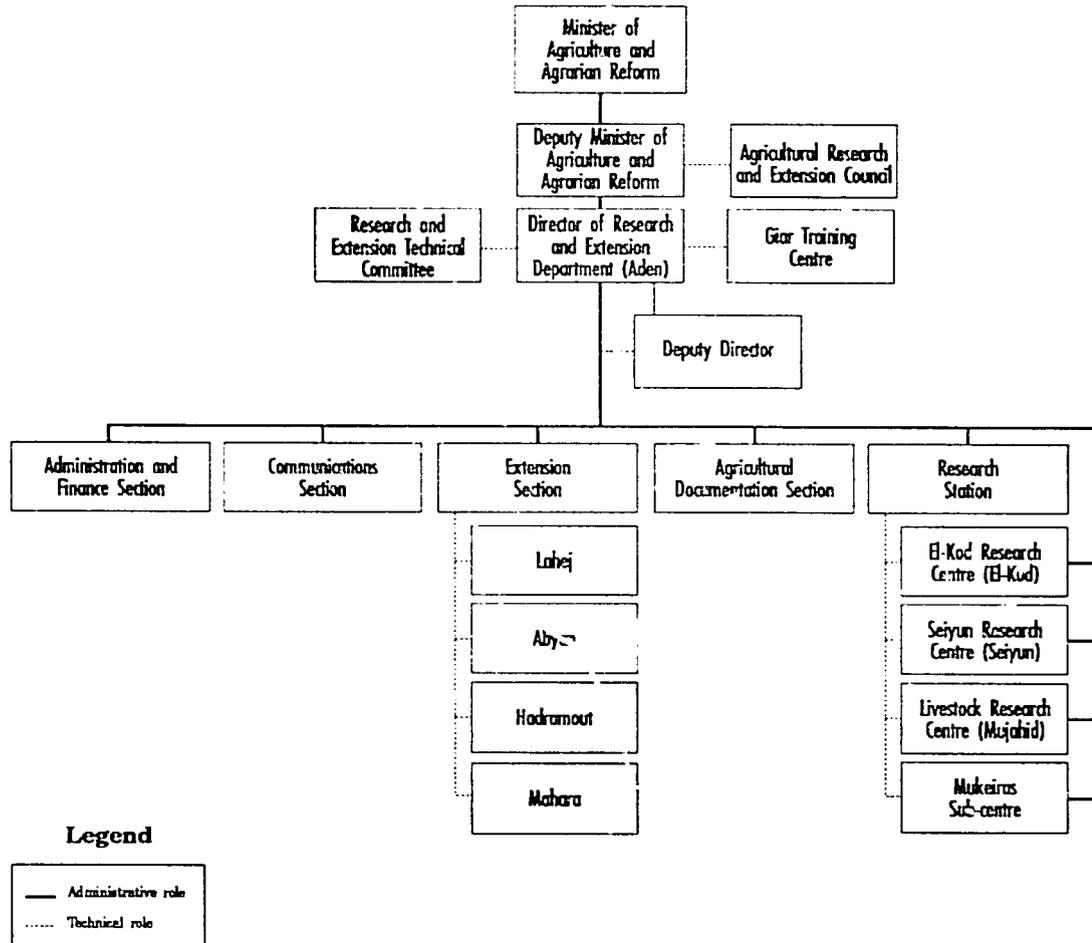


Figure 5: Organizational Structure of the Department of Research and Extension (DRE) in South Yemen (before merging in AREA in 1990)

Each of the two main centers, El-Kod and Seiyun, is composed of six disciplinary research sections: agronomy, horticulture and food technology, soil and irrigation, plant protection, farming systems and economics, and forestry and range management. The research program is implemented through five commodity multidisciplinary research teams (MDRTS), namely vegetables, cereals, industrial crops, fruits, and legumes and forages (Figure 6).

Agricultural Research and Extension Authority (AREA)

As mentioned earlier, the unification of North and South Yemen into one country in 1990 led to the merge of the DRE in Aden in the south and the ARA in Dhamar and GDET in Sana'a in the north into one national semi-autonomous organization, the Agricultural Research and Extension Authority (AREA) with its headquarters in Dhamar.

The new structure of AREA consists of the following (Figure 7):

a. AREA Headquarters in Dhamar

- Director General, Deputy Director General, three Assistants Deputy Director General for Research, Extension, and Finance and Administration who each lead one of the three Directorates of Research, Extension, and Finance and Administration, respectively.
 - The Directorate of Research has three Departments of Plant Research, Livestock Research, and Agricultural Economics and Systems. These departments have the national research laboratories. Each department has sections which are shown in Figure 7.
 - Directorate of Extension and Information with two departments of extension and training, and information and documentation. Each department also has sections shown in Figure 7.
 - Directorate of Finance and Administration with its departments and sections (Figure 7).
- Follow-up and monitoring department.

b. Regional research centres and stations

- Tihama Coastal Lands
 - El-Kod Research Centre, El-Kod;
 - Tihama Regional Research Station, Surdud;
- Southern Uplands Regional Research Station, Taiz;
- Central Highlands Regional Research Station, Dhamar;
- Northern Highlands Regional Research Station, Al-Boun;
- Eastern Region
 - Seiyun Research Centre, Seiyun;
 - Eastern Regional Research Station, Mareb;
- Mujahed Livestock Research Station, Lahej.

AREA is a national semi-autonomous institution supervised by the Minister of Agriculture and Water Resources. It is mandated to carry out applied research and scientific studies to develop agricultural production, to supervise and coordinate agricultural research and extension activities, and to evaluate and certify research results in the country. To achieve these objectives, AREA has the following responsibilities:

- setting agricultural research and extension policies, plans, and programs;
- studying constraints to agricultural production in various agroecological zones and developing solutions to these constraints to develop agricultural production;
- defining research priorities in various agroecological zones in response to government policies and national economy needs;
- conducting research aiming to develop agricultural production with priorities to research which has impact on agricultural production;
- technical guiding of agricultural extension units of RDAs and RDPs, and agricultural offices in various agroecological zones;
- working to transfer research results to production areas through extension;
- producing with extension various extension publications;
- documenting research results and literature;
- training researchers and extensionists;
- communicating with Arab, regional, and international research organizations with the objective to transfer improved technologies and to exchange information.

AREA is governed by a board of directors chaired by the Minister of Agriculture and Water Resources. The board has a deputy chairperson who is appointed by a presidential decree to manage day to day work of AREA. The board also has in its membership representatives of plant and livestock production and irrigation and water resources sectors of MAWR, Ministry of Planning and Development (MPD), Ministry of Higher Education and Scientific Research (MHESR), Ministry of Finance (MOF), and two Deans of the Faculties of Agriculture at the Universities of Sana'a and Aden.

The main responsibilities of the board of directors of AREA were spelled out in a new proposed presidential law as follows:

1. setting agricultural research and extension policy for the country;
2. reviewing and approving agricultural research and extension priorities and setting policies required to implement these priorities;
3. deciding administrative and financial regulations for AREA;
4. discussing and approving estimated annual budget and the final annual account;
5. approving training plans for AREA personnel;
6. approving recruitment of researchers and external experts;
7. holding meetings at least once every two months.

All research centers and stations are administratively, financially, and technically under the control of AREA. However, agricultural extension offices which are administratively and financially under the control of MAWR, RDAs, and RDPs are technically controlled by AREA.

The National Agricultural Research and Extension Coordinating Committee (NARECC) — chaired by the Minister of Agriculture and Water Resources with membership of AREA board of directors and representatives of various research and services institutions — meets annually to coordinate research and extension activities at the country level.

The University System

There are two faculties of agriculture. One is located in Aden within the University of Aden, and the other is in Sana'a within the University of Sana'a. Both faculties have programs to award B.Sc. degrees in agriculture.

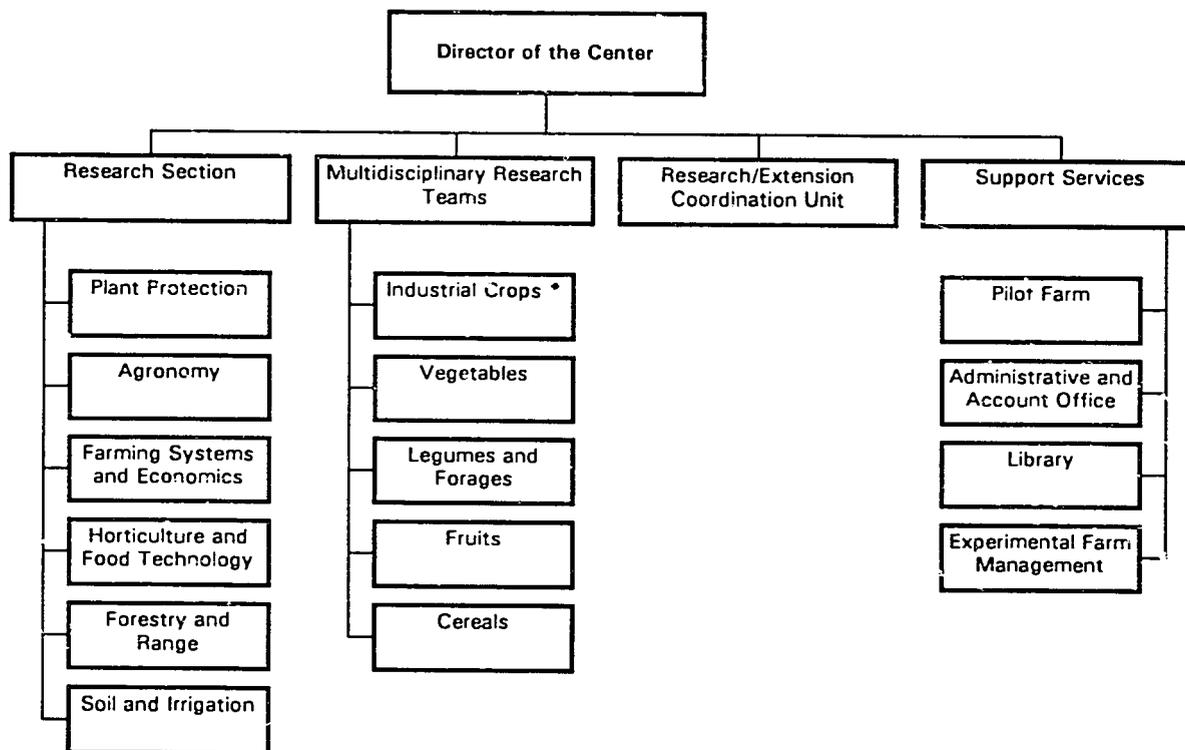
In 1988, the Faculty of Agriculture of the University of Sana'a had 14 Ph.D. holders in the academic staff — nationals and expatriates. The number of students was 450, with a target of 800 after completing the construction of the faculty campus. Under an USAID assistance project, the faculty trained manpower developed curricula, constructed, and equipped its new campus in 1991. Because of the teaching load, the academic staff have little time to carry out research. The Dean of the Faculty is a member of the board of directors of AREA.

The Faculty of Agriculture of the University of Aden has a small research program, which is carried out to strengthen teaching capacity and contribute in solving agricultural problems in South Yemen. The Dean of the Faculty was a member of the Agricultural Research and Extension Council of the former DRE, and is now a member of the board of directors of AREA.

Each faculty has laboratories and experimental farms, where academic staff carry out their laboratory and field research.

Other Organizations

1. Animal health research is mandated to the directorate of Veterinary Services. With assistance from ODA, a National Veterinary Services Development Program was established to improve livestock health in the country.
2. Fisheries research in the country is limited. It is mandated to the MSRC, which was set up to study the national fisheries resources.
3. Bilateral and multilateral agricultural development projects contribute to research efforts in the country through their financing and carrying out research activities required to achieve development objectives of projects. For example, ODA assisted in forestry research, GTZ in plant protection, USAID in deciduous fruit



* Only at El-Kod

Figure 6: Organizational Structure of the El-Kod and Seiyun Research Centers

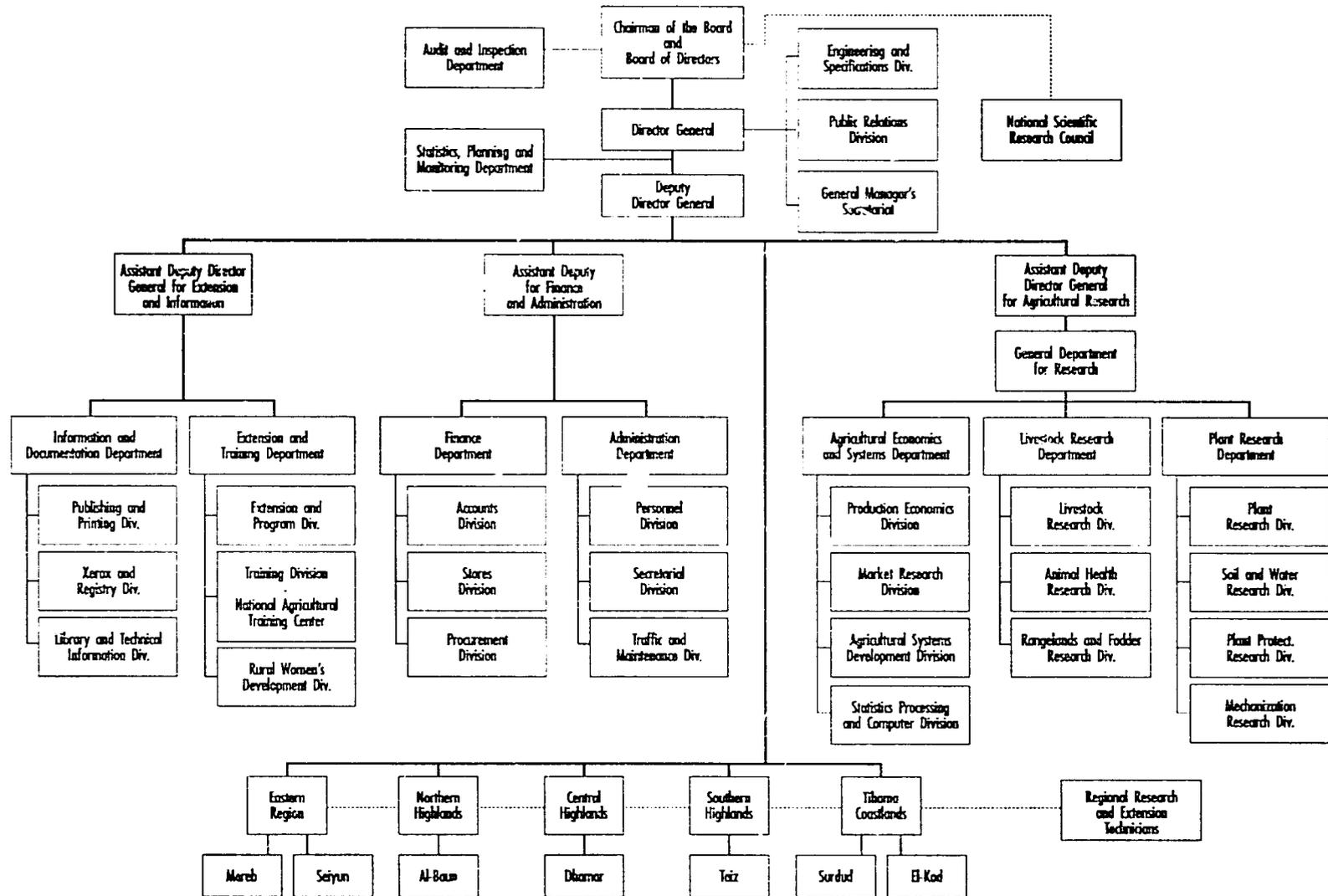


Figure 7: Organizational Structure of the Agricultural Research and Extension Authority (AREA)

trees, the Netherlands in livestock and range, and UNDP in the sorghum and supplementary irrigation research.

4. Private-sector research is limited and is carried out in collaboration with public research, e.g., research on introduction of hybrid seeds, pesticides, agricultural machinery, and fertilizers.

Agricultural Research Linkages

Organizing communication channels is one of the basic duties of research institutions. They communicate with a wide range of research partners within and among research institutions in the country, outside the country, and with their major clients in the country — policymakers and technology-using and transfer systems. These linkages have various characteristics depending on the type of linkage and whether it is with partners in the sources of knowledge or with various clients.

In addition to the various characteristics, channels, and types of linkages, partners in the linkage process generally vary greatly in their competence and commitment to collaboration. Therefore, the nature of linkages varies from simple to quite complex, and from country to country. Studies of linkages at ISNAR have demonstrated that there must be shared objectives, resources, and pressure from policymakers for linkages to work well. For efficient and effective research, linkages of importance have been identified with service institutions of the Ministry of Agriculture and Water Resources (MAWR), especially extension, farmers and farmers' associations, rural and agricultural development authorities and projects, bilateral and multilateral donors, and with sources of knowledge such as university research and regional and international organizations. Mechanisms must be established and resources allocated to make the linkages effective. In the late eighties, the agricultural research in the country made important efforts to develop formal and informal mechanisms to improve linkages.

Linkages at the national level: AREA links with MAWR, MPD, MOF, MHESR, and universities mainly through its board of directors, where the Minister of MARW is the chairperson of the board, and representatives of MAWR, MPD, MOF, MHESR and universities are members of the board of directors (Table 44).

Agricultural extension in the country is organized at the national, provincial, district, and village levels; as well as at agroecological zone levels, where rural development authorities and projects are developing zones across provincial boundaries.

In the south, there is an extension unit in each directorate of agriculture in the governorates of Lahej, Abyan, Shabwa, Hadramout, and Mahara. Research is linked with extension through a technical advisory linkage with extension units and with subject-matter specialists. Specifically, research and extension are linked through joint planning and implementation of on-farm research to validate and formulate technical recommendations, release the improved technologies, and assess technology adoption. In addition, research provides training to extension workers.

In the north, research and extension linkages are tied to the rural development authorities and projects. Therefore, extension in the Tihama agroecological zone is one of the several objectives of the Tihama Development Authority (TDA), whereas in the Taiz and Ibb governorates, extension is undertaken by the Southern Upland Rural Development Project (SURDP). Likewise, in the central highland agroecological zone, extension is one of the main activities of the Central Highland Rural Development Project (CHRDP). Extension is also the responsibility of the Northern Region Development Project (NRDP) and the Eastern Region Development Project (ERDP). In fact, there are no linkages between these regional development projects. Each of them differs from the others in setup and in approach to agricultural extension work. ARA, however, with its agroecological regional research stations in Tihama, the southern uplands, and in the central highlands, links its research activities to the needs of the country and to the agroecological zones. Linkages between research and extension in each of these regions are formed through joint planning of research activities at regional level, joint implementation of verification trials, visits of extension workers and farmers to research stations, regular formal and informal meetings, and training of extension workers.

As a result of the formulation of AREA, coordination with extension is taking place at three levels: national, regional, and local (Table 44):

- a. *National level:* Coordination at national level is achieved through the NARECC, chaired by the Minister of MAWR with membership of AREA board of directors, directors of research centers and stations, and directors of RDPs, RDAs, and agricultural services offices in the MAWR. NARECC meets once a year;
- b. *Regional level:* Coordination between research and extension is achieved through the Regional Research and Extension Technical Committees at agroecological zone levels. These committees meet twice a year to discuss and plan work of both research and extension units;
- c. *Local level:* Coordination is carried out through the Research and Extension Coordination Unit which holds monthly workshops at research stations or centers. The monthly workshops are joint meetings of researchers and subject-matter specialists (SMS). Four major issues are discussed in the monthly workshops: agricultural calendar in the region, compilation of research recommendations on crops, case studies raised by SMS, and training on common issues between researchers and SMS.

Table 44: Linkages of AREA with Other Organizations in the Country

Organization	Linkages
1. AREA Board of Directors	
<ul style="list-style-type: none"> ● MAWR 	<ul style="list-style-type: none"> ● The Minister is the chairperson of the Board of Directors. ● Two Deputies Minister for Plant and Livestock Production and Irrigation Water Resources Sectors are members of the Board of Directors.
<ul style="list-style-type: none"> ● MPD, MOF, MHESR 	<ul style="list-style-type: none"> ● Representatives are members of the Board of Directors.
<ul style="list-style-type: none"> ● Faculties of Agriculture, Sana'a and Aden Universities 	<ul style="list-style-type: none"> ● The two Deans are members of the Board of Directors.
2. Extension	
a. At National Level through NARECC:	
<ul style="list-style-type: none"> ● AREA Board of Directors 	<ul style="list-style-type: none"> ● The chairperson and members of the AREA Board of Directors are members of NARECC.
<ul style="list-style-type: none"> ● RDPs and RDAs 	<ul style="list-style-type: none"> ● Representatives of rural development projects and authorities are member of NARECC.
<ul style="list-style-type: none"> ● Directors of Agricultural and Water Resources offices in Governorates 	<ul style="list-style-type: none"> ● Directors of Agricultural offices in Governorates are members of NARECC.
<ul style="list-style-type: none"> ● Directors of General Directorates of MAWR 	<ul style="list-style-type: none"> ● Directors of MAWRs services Directorates are members of NARECC.
<ul style="list-style-type: none"> ● Directors of AREA stations and centers 	<ul style="list-style-type: none"> ● Directors of research stations and centers are members of NARECC.
b. at Regional Level	<ul style="list-style-type: none"> ● Through the Research and Extension Technical Committees.
c. at Local Level	<ul style="list-style-type: none"> ● Through Research and Extension Coordination Units.

Agricultural researchers in the AREA and the academic staff of the Faculty of Agriculture of the University of Sana'a (FAUS) were requested to indicate how their research does and should benefit potential beneficiaries, they listed extension, small farmers, and rural residents on top as crucial to their research (Table 45).

Table 45: Research Beneficiaries (n=100)

	Will or Does Benefit (1)	Should Benefit (2)	Difference (2)-(1)
Extension	4.27	4.46	0.19
Small Farmers	4.11	4.16	0.05
Rural Residents	4.07	4.11	0.04
Farming Systems Research Groups	3.90	4.18	0.28
Agri-business	3.90	4.09	0.19
Scientists in Own Discipline	3.73	3.80	0.07
Other Scientific Disciplines	3.35	3.32	- 0.03
Local State Government	3.27	3.52	0.05
General Public	3.23	3.32	0.09
Other	3.09	3.00	- 0.09
Foreign Groups, Institutions or Governments	2.96	3.10	0.04

Note: Agricultural researchers were requested to indicate how their research does or should benefit a series of potential beneficiaries. A scale of 1 to 5 was provided, with 1=not at all, and 5=a great deal. Benefit scores were calculated as means.

Linkages with international and bilateral technical assistance: Yemen has received great attention from multilateral and bilateral donors to improve its agricultural output through enhancement of agricultural research in the country. North Yemen received more assistance than South Yemen from bilateral donors before the unification. At present Yemen as a whole is receiving the same interest from donors as before. Therefore, AREA was assisted, for example, by the FAO and the Netherlands in livestock and range research, by UNDP in sorghum and millet, oilseed crops, supplementary irrigation networks, and the soil survey and land classification project; and by ODA in forestry research and postharvest technology. AREA was indirectly assisted by GTZ in plant protection research; and by USAID in fruit research. Other externally funded projects to support national generation and transfer of agricultural technology are in the pipelines.

Linkages with sources of knowledge: Agricultural research is an integral part of a complex world of agricultural research ranging from academic and basic research at a global level; to strategic, applied, and adaptive research; to final testing of new technologies on farmers' fields. These activities generate a vast pool of information from which national research can and should draw to avoid wasteful duplication of effort. In turn, information generated in national research should be an integral part of this pool of knowledge. But this depends on the existence of mechanisms for information exchange that make such interchange possible. Therefore, it is important for research institutions to maintain strong linkages with other research activities, in particular to maintain linkages

with other national sources of knowledge (i.e., university research) and external sources of knowledge (i.e., regional and international research organizations and external national research organizations).

1. *AREA linkages with university research:* Despite the fact that limited research is carried out by the faculties of agriculture in the country, they should be linked to the needs of agricultural development. This could be ensured through the board of directors of AREA since the two deans of the faculties are members of this board. A postgraduate program on the faculties should be begun when resources are available to train scientists at AREA.
2. *AREA linkages with regional and international organizations:* It has been shown that research institutions in the country have linkages with many regional and international research organizations e.g., ICARDA, CIMMYT, ICRISAT, AVRDC, IBPGR, ACSAD (Table 35). Linkages cover genetic resources and information exchange, in-service training for AREA staff, joint trials, and other activities. An agreement of collaboration between the Government of Yemen and ICARDA was signed in December 1988 with the objective of exchanging scientists, technologies, germplasm, and breeding materials relevant to the cooperative research program of ICARDA-mandated commodities, i.e., wheat, barley, fababeans, lentils, and chickpeas. AREA collaborates with ACSAD in exchange of genetic resources and information, in-service training, and soil classification.
3. *Linkages with external national organizations:* AREA is participating in some intercountry research networks which are supported financially by donors — mainly UNDP. It participates in research networks on sorghum and millet with Egypt, Somalia, Sudan, and Syria; the development of oilseed crops with Somalia and Sudan; and supplementary irrigation and improved water management with various Arab countries in the Mashraq and Maghreb subregions. The country participates in the networks on aquaculture through the fisheries department, and on eradication of rinderpest through the veterinary services. These networks provide to the country, specifically to Aden, in-service training opportunities, equipment, meetings with members of the networks in which joint planning of research activities is performed, and support to implement research activities approved by the network.

Recommendations on Structure and Organization

At present, AREA is the national agricultural research institution and its mandate covers the whole country. It is a semi-autonomous national research organization governed by an apex body "The Board of Directors", chaired by the Minister of Agriculture and Water Resources, with membership of the director general of AREA, two deputy ministers of MAWR, representatives of MPD, MOF, and MHESR, and the two deans of the faculties of agriculture.

The two faculties of agriculture are also involved in agricultural research. Particular emphasis will have to be placed on structural organization that will ensure determining research policy and strategy, setting broad research priorities and rationalizing resource allocation, as well as better coordination and implementation of multidisciplinary research activities to address priority areas in agricultural development plans.

1. Functions of the Board of Directors of AREA.

In the newly proposed presidential law for organizing AREA, it is proposed that the major functions of the board of directors should be amended to include:

- determination of national agricultural research policy and strategy by developing clear statement of research objectives;
- setting broad research priorities and rationalizing resource allocations;
- securing political support for agricultural research;
- participating in the development of articulated development policy;
- securing financial and human resources;
- organizing the implementation of strategy, program, and budget plans;
- approving five-year program and budget plans.

The above proposed functions give a greater role to the board of directors to work as a policy body rather than a management one. However, for the board to function properly, a set of guidelines of procedures, arrangements, and policies should be developed.

2. An internal management committee for AREA is proposed to be established to replace the National Agricultural Research Council and the Research Coordination Committee.

This proposal is aimed to reduce time spent by researchers for travel, administration, and other second-priority activities. The major functions of this internal management committee would be:

- developing guidelines for research proposals, within the research strategy, operations, and budget plans, with details for a provisional budget and allocation of funds;
- approving the annual program and budget;
- coordinating research activities;
- organizing implementation of research programs;
- improving the documentation of current research activities and reporting system needed for efficient monitoring and evaluation;
- guiding AREA management.

3. Organizing for the implementation of the research strategy, formulating and implementing the research program, formulating an annual program, forming multidisciplinary research programs, and organizing resource management will be discussed later in the relevant section.

4. Efforts should be increased to continuously improve the institutional mechanisms for linkages between AREA and extension at various levels for joint planning and follow-up of research trials, especially on-farm trials; for identification of farmers' problems; and for joint on-farm validation/verification trials. Resources should be allocated to plan and carry out joint activities to foster the technology-adaptation and -transfer processes.
5. AREA and universities in the country should identify mechanisms for collaboration and coordination of research activities.
6. AREA should guide and coordinate donors' technical assistance to research activities through the implementation of the approved research policy and strategies.
7. Linkages between AREA and regional and international organizations should be strengthened. AREA should benefit more from its participation in the regional intercountry research networks.
8. Improved linkages between AREA and farmers require development of efficient government policies on pricing, seeds, marketing, and storage.

Research Resource Management

Introduction

The management of human, financial, and physical (materials) resources is one of the most important jobs of research managers. Managing these resources well is vital to maintaining the productivity of the agricultural research system and hence to ensuring continuity of support from policymakers. Thus, when scientists of the Yemeni agricultural research system were requested to select the most serious limitations to research, the most serious limitation was identified as financial resources, which received a total of 184 points, the second and third were physical and human (technical support) resources, respectively (Table 46). The same scientists were requested to identify the adequacy and importance of resources on a five point-scale, analysis of responses has shown that the majority of resource factors were less than adequate while some of the factors were more adequate than others, such as: job security, availability of experimental land, management's reputation for scientific achievement, and personal freedom to determine research problems. The least adequate resources were financial support for self and family, suitable living conditions, operating supplies and materials, equipment and tools to use in research, office and laboratory facilities, scientific literature, and other human-resource factors (Table 47). Therefore, the resource management challenge in agricultural research in the country is particularly clear with regard to human, physical, and financial resources.

**Table 46: Limitations to Research
(n=100)**

Criteria	1st Most serious	2nd Most Serious	3rd Most Serious	Total Points
Financial resources	129	46	9	184
Physical resources	108	38	8	154
Technical support	36	26	10	72
Clear direction	12	52	8	72
Reward structure	18	24	26	68
Administrative support/advice	30	26	6	62
Define research problems	21	24	12	57
Personal interest/motivation	12	16	8	36

Note: Agricultural researchers were requested to select the three most serious limitations to their research. Total points were calculated by multiplying the number of respondents who selected the various criteria by a factor of 3 for the most serious, 2 for the 2nd most serious, and 1 for the 3rd most serious.

Table 47: Resource Adequacy and Importance (n=100)

	Adequacy (1)	Importance (2)	Difference (3)
1. Personal			
Financial support for self and family	3.67	1.39	2.28
Suitable living conditions	3.85	1.57	2.28
Job security	2.83	1.70	1.13
Personal average	3.45	1.55	1.90
2. Administrative			
Operating supplies and materials	3.65	1.47	2.18
Transportation	3.59	1.62	1.97
Availability of experimental land	2.81	1.68	1.13
Equipment & tools to use in research	3.70	1.36	2.34
Office & laboratory facilities	3.67	1.43	2.24
Availability of labor	3.45	1.66	1.79
Quality of labor	3.89	1.48	2.41
Scientific literature/library	3.80	1.43	2.37
Availability of trained technical help	3.75	1.63	2.12
Quality of trained technical help	3.66	1.54	2.12
Availability of advice from experienced researchers	3.41	1.71	1.70
Administrative average	3.58	1.55	2.03
3. Professional			
Personal freedom to determine research problems	3.00	1.69	1.31
Contact with other scientists	3.78	1.55	2.23
Opportunity for advanced education	3.68	1.42	2.26
Opportunity to gain scientific recognition	3.59	1.49	2.10
Opportunity for professional advancement	3.54	1.43	2.11
Opportunity for promotion based on merit	3.64	1.46	2.18
Opportunity for training people who work under your direction	3.33	1.62	1.71
Opportunity for practical implementation of outputs	3.50	1.63	1.87
Opportunity to publish research findings	3.44	1.44	2.00
Professional average	3.50	1.53	1.97
4. Organizational			
Scientific training of management	3.33	1.53	1.80
Management's reputation for scientific achievement	3.01	1.60	1.41
Organization's reputation for scientific achievement	3.19	1.56	1.63
Organizational average	3.17	1.56	1.61

Note: Agricultural researchers were requested to identify the adequacy and importance of a number of resources on 5-point scale, where 1=very adequate, very important, and 5=very inadequate, very unimportant. Scores were calculated as means.

Human Resources

Qualification and distribution: In 1989, AREA had 207 professional staff (23 with a Ph.D. degree, 67 with an M.Sc. degree, 83 with a B.Sc.-degree, and 34 expatriates mainly associated with externally funded projects); about 50% of the national research staff are Ph.D. and M.Sc. holders, of which about two-third are at El-Kod and Seiyun Research Centers (Table 48a). However, staffing of AREA in 1992 included 235 university graduated staff (27 with a Ph.D.-degree, 82 with an M.Sc.-degree, and 126 with a B.Sc.-degree (Table 48b).

The AREA professional staff are assisted by 167 technical staff (2 university graduates, 77 diploma holders, and 88 nondiploma holders), 109 administrative staff (university graduates, 31 diploma holders, and 70 nondiploma holders), and 677 other permanent employees, including field laborers (Table 48).

The distribution of research experience among AREA's staff shows that more than half have three to ten years experience, about 11% have 2 years or less experience, and the remaining have more than 10 years experience (Table 49).

About 40% of the research technicians have 6-10 years research experience, about 20% have 3-5 years experience, about 27% have more than 11 years experience, and the remaining of about 13% have less than two years of research experience (Table 50).

Analysis of the age distribution of scientists from AREA and FAUS showed that 43% were born between 1950 and 1955, 25% between 1945 and 1950, 25% between 1955 and 1960, and 7% between 1940 and 1945 (Table 51).

The total number of scientists at AREA with a Ph.D. and a M.Sc. degree has grown by about tenfold during the period 1980-1989 (Table 52). However, the number of research technicians during the same period has grown only by about 1.4 times (Table 53).

The distribution of AREA scientists by research subsector indicates that about 57% of scientists work in crop research — about 27% in vegetable research, 25% in cereals, 21% in fruits, 15% in industrial crops, and 6% in forages as well as in legumes — 31% in noncommodity research (soil and water, plant protection, agricultural economics, and agricultural engineering), 6% in livestock, and 5% in forestry (Tables 54; 55).

The distribution of AREA scientists by commodity, by thematic research, and by qualifications is shown in Table 56. More than half of the qualified Ph.D. and M.Sc.holders work in cereals, fruits, vegetables, and soil and water research.

Annual work activities: Scientists were requested to allocate their work time between activities, locations, types of research, and research subsectors. The data collected were inputted and analyzed at ISNAR by using the Reflex program. The results of the analysis are shown in Tables 57 to 60.

Table 48a: Staffing of AREA, 1989

Location	Research Staff				Technical Support Staff			Administrative Staff			Other Employees	Total
	Ph.D.	M.Sc.	B.Sc.	Expatriate	University graduate	Diploma	Non-Diploma	University Graduate	Diploma	Non-Diploma		
AREA Headquarters	6	8	7	7	0	8	3	3	10	4	45	101
Tihama Regional Station	1	2	9	0	0	6	4	1	2	4	96	125
Southern Upland regional Station	1	8	6	2	1	5	12	2	7	2	97	143
Central Highland regional Station	2	1	3	0	0	5	0	0	1	2	29	48
El-Kod Research Centre	13	33	32	0	1	19	57	2	6	37	370	570
Seiyun Research Centre	0	13	16	2	0	33	7	0	5	19	37	132
Subtotal	23	65	78	11	2	76	83	8	31	68	674	1119
Soil Survey & Land Classification Project	0	2	5	5	0	1	5	0	0	2	3	23
External Funded Projects				18								18
Total	23	67	83	34	2	77	88	8	31	70	677	1160

Table 48b: Staffing of AREA, February 1992

Location	Qualification					Total
	Ph.D.	M.Sc.	B.Sc.	Secondary	Less	
Administration and Fin.	-	-	5	39	38	82
Research (General Directorate)	7	8	11	11	2	39
Extension (General Directorate)	1	5	13	2	3	24
El-Kod Research Centre	10	38	33	66	22	169
Seiyun Research Centre	-	13	19	41	42	115
Southern Upland Regional Station	2	7	7	7	17	40
Central Highland Regional Station	2	3	14	5	25	49
Northern Highland Regional Station	1	2	5	3	5	16
Eastern Regional Station	2	-	-	4	2	8
Tihama Regional Station	1	5	12	15	-	33
Mujahed Livestock Station	1	1	7	3	2	14
Total	27	82	126	196	158	589

Table 49: Qualifications and Experience Profiles of Research Staff, 1989

Location	Qualification			Research Experience (years)				
	Ph.D.	M.Sc.	B.Sc.	0-2	3-5	6-10	11-15	< 15
AREA Headquarters	6	9	9	6	12	2	2	2
Tihama Regional Station	1	2	9	3	5	3	1	0
Southern Upland Regional Station	1	9	5	2	5	5	1	2
Central Highland Regional Station	2	1	8	2	8	0	1	0
El-Kod Research Centre	15	33	32	4	15	26	20	13
Seiyun Research Centre	0	13	16	2	3	11	10	3
Total	23	67	79	19	48	47	35	20
Overall percentage	13.6	39.6	46.8	11.3	28.4	27.8	20.7	11.8

Table 50: Qualifications and Experience Profiles of Research Technicians, 1989

Location	Qualifications		Research Experience (years)				
	Diploma	Non-Diploma	0-2	3-5	6-10	11-15	+ 15
AREA Headquarters	10	10	3	3	13	1	0
Tihama Regional Station	6	4	3	3	4	0	0
Southern Upland Regional Station	6	10	1	2	5	4	4
Central Highland Regional Station	5	0	2	3	0	0	0
El-Kod Research Centre	10	36	8	9	9	9	11
Seiyun Research Centre	33	7	1	7	23	6	3
Total	70	67	18	27	54	20	18
Overall percentage	51.1	48.9	13.1	19.7	39.4	14.6	13.1

Table 51: Distribution of Scientists According to their Birth Year (number responded=75)

Birth Year	AREA (North) (Ph.D. + M.Sc.)	AREA (South) (Ph.D. + M.Sc.)	FAUS (Ph.D.)	Total	% of Total
1940-45	2	2	1	5	7
1945-50	5	10	4	19	25
1950-55	12	18	2	32	43
1955-60	12	7	0	19	25
Total	31	37	7	75	100

Table 52: Number of Ph.D. and M.Sc. Scientists at AREA in 1980, 1985, and 1989

Location	1980		1985		1989	
	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.
AREA Headquarters	1	1	6	5	6	10
Tihama Regional Station	0	0	1	0	1	2
Southern Upland Regional Station	1	0	1	3	1	8
Central Highland Regional Station	0	1	1	1	2	2
El-Kod Research Centre	0	1	2	11	11	32
Seiyun Research Centre	0	4	0	6	0	13
Total	2	7	11	26	21	67

Table 53: Number of Research Technicians at AREA in 1980, 1985, and 1989

Location	1980		1985		1989	
	Diploma	Non-Diploma	Diploma	Non-Diploma	Diploma	Non-Diploma
AREA Headquarters	5	11	9	13	10	10
Tihama Regional Station	0	0	3	1	6	4
Southern Upland Regional Station	12	12	10	10	5	12
Central Highland Regional Station	0	0	0	0	5	0
El-Kod Research Centre	1	25	1	12	11	33
Seiyun Research Centre	25	5	28	7	33	7
Total	43	53	51	43	70	66

Table 54: Distribution of AREA Scientists by Research Subsectors for 1989

Institution	Crops	Forestry	Livestock	Non commodity	Unallocated	Total
AREA Headquarters	5	1	2	15	-	23
Tihama Regional Station	7	-	-	6	-	13
Southern Upland Regional Station	8	1	2	5	-	16
Central Highland Regional Station	8	-	-	3	-	11
El-Kod Research Centre	70	5	3	-	-	78
Seiyun Research Station	10	1	-	18	-	29
SSLC	-	-	-	12	-	12
External Funded Projects	1	2	4	-	3	10
Total	109	10	11	59	3	192

Table 55: Distribution of AREA Scientists by Commodity and Thematic Research for 1989

Program	AREA Hq	Tikama Regional Station	Southern Upland Regional Station	Central Highland Regional Station	El-Kod Research Centre	Seiyun Research Centre	SSLC	External Funded projects (Expatriates)	Total
Cereals	1	2	4	5	10	5			27
Industrial Crops		2			15				17
Legumes				2	4				6
Forages	2	1			4				7
Fruits	1	1	3	1	14	2		1	23
Vegetables	1	1	1		23	3			29
Forestry	1		1		5	1		2	10
Large Ruminants									0
Small Ruminants	1		2					2	5
Range	1				3			2	6
Plant Protection	4	3	2	1		9			19
Agricultural Economics	5					3			8
Agricultural Engineering	1					2			3
Soil & Water	5	3	3	2		4	12		29
Others								3	3
Total	23	13	16	11	78	29	12	10	192

Table 56: Distribution of AREA Scientists by Commodity and by Qualifications for 1989

Program	AREA HQ			Tihama Regional Station			Southern Upland Regional Station			Central Highlands Regional Station			El-Kod Research Centre			Seiyun Research Centre			SSLC			Expatriates			Total		
	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B
Cereals		1		1		1		2	2	1	1	3	2	3	5		3	2							4	10	13
Industrial Crops					1	1							4	4	7										4	5	8
Legumes												2	1	2	1										1	2	3
Forages			2			1							1	1	2										1	1	5
Fruits	1					1		3				1	3	6	5			2				1			5	9	9
Vegetables		1				1		1					2	13	8			3							2	15	12
Forestry			1							1				2	3			1					1	1		3	7
Large Ruminants																											
Small Ruminants	1							1	1													2			1	3	1
Range			1											2	1							2				4	2
Plant Protection	2	1	1			3		1	1	1							5	4							3	7	9
Agricultural Economics		2	3														1	2								3	5
Agricultural Engineering			1														2									2	1
Soil & Water	2	3			1	2	1	1	1			2					2	2	5	2	5				8	9	12
Other																						3				3	
Total	6	8	9	1	2	10	1	9	6	2	1	8	13	33	32	0	13	16	5	2	5	4	5	1	32	73	87

Note: P = Ph.D.; M = M.Sc.; B = B.Sc.

An average of about two-thirds of scientists' time is allocated for research, and the remaining one-third is distributed to administration (10%), teaching (9%), support (about 7%), extension (about 4%), conferences (about 3%), and production (less than 1%). While scientists at AREA devoted more time for research, the academic staff of FAUS only devoted about 21% of their time to research. It is expected that most of their time will be allocated for teaching (about 61%) (Table 57).

Scientists spend about half of their time in the offices and their main stations, about one-third in the field, and the remaining time in substations and travel. The academic staff of FAUS, however, spent most of their time in the main offices of their college (Table 58).

About three-quarters of scientists' time is allocated to applied and strategic research; the remaining is for basic and strategic types of research (Table 59).

Scientists allocate between about 66% to 85% of their time to crops research, the remaining is allocated for livestock, fisheries, natural resources, and policy research subsectors (Table 60).

Table 57: Time Allocation of Scientists between Work Activities (%)
(n=100)

Institution	Degree of Responded Scientists	No. Responded	Research	Admin.	Teaching	Exten.	Supp.	Conf.	Prod.
AREA + FAUS	P + M + B	98	66.4	10.3	9.0	3.8	7.4	2.5	0.7
AREA	P + M + B	91	69.9	9.9	4.9	4.0	7.9	2.6	0.8
AREA (North)	P + M	31	63.0	13.6	7.7	6.1	6.9	2.1	0.5
AREA (South)	P + M + B	60	72.5	7.8	3.4	4.2	8.3	2.8	0.9
FAUS	P	7	20.7	15.0	61.4	1.7	0.7	0.4	0

Note: P=Ph.D.; M=M.Sc.; B=B.Sc.

Table 58: Time Allocation of Scientists between Work Locations (%)
(n=100)

Institution	Degree of Responded Scientists	No. Responded	Main Station Office	Substation	Field	Travel
AREA + FAUS	P + M + B	77	53.2	9.0	33.3	4.5
AREA	P + M + B	73	51.0	9.5	35.0	4.5
AREA (North)	P + M	19	62.0	22.0	7.9	8.1
AREA (South)	P + M + B	54	47.2	5.2	44.4	3.2
FAUS	P	4	93.5	0	1.2	5.2

Note: P=Ph.D.; M=M.Sc.; B=B.Sc.

Table 59: Time Allocation of Scientists between Research Types (%)
(n=100)

Institution	Degree of Responded Scientists	Number Responded	Basic	Strategic	Applied	Adaptive
AREA + FAUS	P + M + B	80	16.3	8.7	51.7	23.3
AREA	P + M + B	74	16.1	9.0	52.9	2.0
AREA (North)	P + M	23	12.6	3.3	56.9	27.2
AREA (South)	P + M + B	51	17.6	11.5	51.1	19.8
FAUS	P	6	19.3	5.0	36.7	39.0

Note: P=Ph.D.; M=M.Sc.; B=B.Sc.

Table 60: Time Allocation of Scientists between Research Subsectors (%)
(n=100)

Institution	Degree of Responded Scientists	No. Responded	Crops	Livestock	Forestry	Fisberius	Natural Resources	Policy
AREA + FAUS	P + M + B	78	79.1	2.9	7.4	1.2	6.1	3.3
AREA	P + M + B	74	79.1	1.8	7.9	1.2	6.5	3.5
AREA (North)	P + M	22	66.1	5.9	7.0	0.5	12.3	7.7
AREA (South)	P + M + B	52	84.7	0	8.2	1.4	4.0	1.7
FAUS	P	5	80.0	20.0	0	0	0	0

Note: P=Ph.D.; M=M.Sc.; B=B.Sc.

The AREA scientists, and FAUS academic staff have produced domestic and foreign documents, ranging from books and book chapters to news articles. About half of the domestic documents are produced as research reports and abstracts. The AREA scientists produce extension publications and conference reports and papers. The documents are published abroad and include journal articles and conference papers (Table 61).

Capabilities and constraints: Concerning professional advancement, the scientists were requested to select from a list the three most important criteria that actually did, and ideally should, influence their professional advancement. Results from these questions are shown in Table 62. Academic and technical qualifications were ranked, the most important criterion both actually and ideally, with experience also considered to be important both actually and ideally. Peer or supervisor evaluation was ranked on the eight place actually and in the fourth place ideally. In the third place, effort devoted to research was ranked as an important criterion both actually and ideally.

**Table 61: Documents Produced by AREA and FAUS up to 1989
(n=100)**

Item	Domestic Documents				Foreign Documents			
	AREA (North)	AREA (South)	FAUS	Total	AREA (North)	AREA (South)	FAUS	Total
Books & Book chapters	2	2	4	8	0	0	0	0
Journal Articles	4	19	1	24	3	7	0	10
Research Reports	18	162	7	187	7	4	0	11
Research Abstracts	9	46	0	55	1	1	0	2
Extension Publications	10	36	0	46	1	0	0	1
Conference Reports/Papers	14	9	1	24	3	15	0	18
Media Programs	3	3	1	7	2	0	0	2
News Articles	6	1	1	8	0	0	0	0
Other	25	16	0	41	0	13	0	13
Total	91	294	15	400	17	40	0	57

Note: AREA (North)= 31; AREA (South)= 62; FAUS= 7.

**Table 62: Criteria for Professional Advancement
(n=100)**

Criteria	Actual					Ideal				
	1st Most Important	2nd Most Important	3rd Most Important	Total Points	Rank	1st Most Important	2nd Most Important	3rd Most Important	Total Points	Rank
Academic/Technical Qualifications	150	40	7	197	1	171	16	7	194	1
Experience	72	42	7	121	2	69	68	4	141	2
Effort Devoted to Research	36	30	12	78	3	36	24	8	68	3
Research Results Reported	18	44	10	72	4	33	14	8	55	6
Organizational Policies or Attitudes	33	10	20	63	5	21	18	15	54	7
Impact/Use of Research Results	9	26	25	60	6	18	30	8	56	5
Professionalism (i.e., Motivation)	18	22	8	48	7	21	12	5	38	9
Peer or Supervisor Evaluation	6	18	21	45	8	21	20	17	57	4
Seminars/Conferences Attended or Organized	9	22	7	38	9	21	16	7	44	8
Other	3	2	1	6	10	3	8	0	11	10

Note: Agricultural researchers were requested to select the three most important criteria (actual and ideal) for professional advancement within their institutions. Total points were calculated by multiplying the number of respondents, who selected the various criteria by a factor of 3 for the 1st most important, 2 for the 2nd most important, and 1 for the 3rd most important.

The scientists were also requested to identify what they considered to be the most serious limitations to their career development (Table 63). The most important limitation was considered to be the academic and technical qualification criterion. Organizational policies or attitudes was also considered as an important limitation. Reporting research results was in the ninth place in ranking.

**Table 63: Limitations to Career Advancement
(n=100)**

Criteria	1st Most Serious	2nd Most Serious	3rd Most Serious	Total Points
Academic/Technical Qualifications	93	16	8	117
Organizational Policies or Attitudes	78	14	16	108
Experience	51	26	11	88
Impact/Use of Research Results	18	32	11	61
Effort Devoted to Research	27	20	13	60
Peer or Supervisor Evaluation	21	14	17	52
Seminars/Conferences Attended or Organized	12	28	9	49
Professionalism (i.e., Motivation)	21	20	5	46
Research Results Reported	12	26	4	42
Other	9	10	6	25

Note: Agricultural researchers were requested to select the three most serious limitations to their career advancement. Total points were calculated by multiplying the number of respondents who selected the various criteria by a factor of 3 for the 1st most serious, 2 for the 2nd most serious, and 1 for the 3rd most serious.

Conditions of service: Salaries of technical staff at AREA have been comparable with those of the academic staff of the same qualifications at universities in the country, and they are above salary scales in the civil service. However, when scientists requested to select resource adequacy and importance, the score for financial support for self and family, and for suitable living in conditions showed inadequacy of these criteria. In addition, scientists also indicated inadequacy of contact with other scientists, and opportunities for advanced education, for promotion based on merit for professional advancement, and to gain scientific recognition (Table 47).

Recently there have been increases in salaries of the academic staff which were not applied to the technical staff at AREA. It is expected this will have a negative implication on AREA because AREA's technical staff may tend to accept posts at universities where salaries are more attractive.

Training: While the two faculties of agriculture in the country provide supplies of trained scientists at B.Sc. level, postgraduate training for national scientists is provided

through universities abroad. The postgraduate training is mainly sponsored by donors and less by government and self funds (Table 64).

The AREA scientists were requested to give information on their postgraduate education fields and countries. The answers of 75 scientists are shown in Tables 65 and 56. Forty percent of the scientists were graduated in plant production and breeding, about 18% in plant protection, 17% in soil, and the remaining in other fields (Table 65). About 18% of the scientists were educated in the former-USSR higher education institutions, about 13% in the United Kingdom, 12% in the USA and Egypt each, and the remaining scientists in other countries (Table 66).

The AREA has developed a manpower requirement and training plan during the five-year development plan for North Yemen (1988-92). It was planned that by the year 1991, the AREA would have 32 Ph.D. holders, and 80 M.Sc. holders. In fact, it was a great challenge for AREA to achieve these figures. The training for 1991 for Ph.D. and M.Sc. degrees is shown in Table 67.

Table 64: Distribution of Education Sponsors

Sponsor	M.Sc.	Ph.D.	Total	% of All
Government	5	10	15	20
Donors	34	19	53	71
Self	6	1	7	9
Total	45	30	75	100

Note: Number responded = 75.

Table 65: Distribution of Scientists According to Education Fields

Education Field	AREA (North)		AREA (South)	FAUS	Total
	Ph.D.	M.Sc.	Ph.D. + M.Sc.	Ph.D.	
Agricultural Engineering		0	4	0	4
Animal Production		3	0	1	4
Basic Science and Support		0	1	0	1
Food Science and Nutrition		0	1	0	1
Natural Resource Management		2	3	0	5
Plant Breeding		7	1	1	9
Plant Production		6	14	1	21
Plant Protection		4	8	2	14
Socioeconomics		2	0	0	2
Soil		7	5	1	13
General		0	0	1	1
Total		31	37	7	75

**Table 66: Distribution of Education Countries Awarded Ph.D. and M.Sc. Degrees
(Number Responded=75)**

Education Country	M.Sc.	Ph.D.	Total
Austria	0	1	1
Belgium	2	0	2
Bulgaria	4	0	4
Czechoslovakia	0	1	1
Egypt	6	3	9
Germany (East)	3	0	3
Germany	0	1	1
Hungary	2	2	4
India	4	1	5
Korea (North)	1	0	1
Netherlands	1	0	1
Pakistan	2	0	2
Philippines	1	0	1
Romania	1	2	3
Syria	1	0	1
United Kingdom	6	4	10
USA	1	8	9
USSR	8	6	14
Yugoslavia	1	0	1
Others	1	1	2
Total	45	30	75

Table 67: Present and Expected Training, 1991

Location	Already Undertaking Postgraduate Training		Expected to Undertake Postgraduate Training	
	M.Sc.	Ph.D.	M.Sc.	Ph.D.
AREA Headquarters	-	6	-	5
Tihama Regional Station	3	1	2	-
Southern Upland Regional Station	4	-	1	1
Central Highland Regional Station	-	-	-	-
El-Kod Research Centre	2	4	3	1
Seiyun Research Centre	-	1	3	1
Total	9	12	9	8

Physical Resources

Stations, centers, and mandates: The consistency and quality of physical resources has a great influence on the quality of research output. Thus, the physical resources available to agricultural research in the country have grown up during the last decade in quantity and quality. The three regional research stations and the headquarters of AREA were newly constituted and equipped; two more regional research stations, in the northern and eastern agroecological zones, are under construction. At the same time the two research centers in the south have also constructed new laboratories, the postharvest and fibre testing. New substations were also established at Ibb, Zubid, Rada'a, and Mukeris. The location, zone, land area, mandate, laboratory equipment, maintenance of equipment, and library of the AREA Headquarters and its regional research stations and research centers are shown in Table 68.

The regional research stations and research centers network covers the agroecological zones in the country and the irrigated and rainfed systems (Figure 1).

Land: The total area available for field trials in the stations and centers network is about 280 ha including Zubid Research Station (17 ha) and Ibb Research Station (8 ha) and excluding Seiyun Research Centre (Table 68).

Buildings: New central laboratories and offices to accommodate the AREA headquarters were built in the late eighties at the Central Highland Regional Station in Dhamar. The AREA facilities should focus increased attention on maintenance of buildings as well as equipment.

Equipment: The AREA headquarters, the El-Kod Research Centre, and the Southern Upland Regional Research Station are well equipped, others are inadequately equipped in terms of field and laboratory facilities.

Central support: Research support services include central laboratories for soil and water, plant protection, statistics, data processing, socioeconomic service unit, a centralized agricultural library and documentation center, maintenance of scientific instruments, and seed banks. While AREA has developed adequate central support services in water and soil and plant protection, it still lacks other components of centralized support services.

Financial Resources

Sources of funding: Expenditures on agricultural research in North Yemen were public (about 70%) and external funds (about 30%). These were mainly public funds in South Yemen. The research institutions receive public funds from the ordinary annual and development budgets, and receive donor funds through technical assistance development projects.

**Table 68: AREA Headquarters, Regional Research Stations, and Research Centers:
Location, Zone, Land Area, Mandate, Laboratory, Maintenance, and Library**

Name	Location	Zone	Land Area (ha)	Mandate	Laboratory	Maintenance of Equipment	Library
AREA Headquarters	Dhamar	Overall	-	Overall management	-	-	Good
- Soil & Water Laboratory	Dhamar	Overall	-	Services & research	Good	Poor	-
- Cartography Laboratory	Dhamar	Overall	-	Services & research	Good	Poor	-
- Feed Analysis Laboratory	Dhamar	Overall	-	Services & research	Good	Poor	-
- Plant Protection Laboratory	Dhamar	Overall	-			Poor	-
- Food Technology Laboratory	Dhamar	Overall	-			Poor	-
Tihama Regional Research Station	Surdud	Coastal	60	Irrigated crops research; Livestock research	Poor	Absent	Poor
Southern Upland Regional Research Station	Taiz	Southern upland	16	Rainfed & irrigated crops research; Livestock research			Good
- Soil & Water Laboratory	Taiz	Southern upland	-	Services & research	Poor	Poor	
- Plant Protection Laboratory	Taiz	Southern upland	-	Services & research	Poor	Poor	
Central Highland Regional Research Station	Dhamar	Central highland	14	Irrigated & rainfed crops and livestock research	Absent	Poor	Poor
El-Kod Research Centre	El-Kod	Coastal	165	Crop & Forestry Research	Good	Poor	Poor
- Soil & Irrigation Laboratory	El-Kod		-	Services & research			
- Post-harvest Technology Laboratory	El-Kod		-	Post-harvest research			
- Fibre-testing Laboratory	El-Kod		-	Quality testing of cotton fibers			
- Plant Protection Laboratory	El-Kod		-	Pests & pesticides research			
Seiyun Research Centre	Seiyun	Medium montane region	165	Crops & forestry research	Poor	Absent	Poor
Northern Highland Regional Research Station	Al-Boun	Northern highland	2	Rainfed and irrigated crops research	Poor	Poor	Absent
Eastern Regional Research Station	Mareb	Eastern region	13	Irrigated crops research	Absent	Absent	Absent
Mujahed Livestock Research Station	Lahej	Coastal region	60	Livestock and forages	Absent	Poor	Absent

Flow of funds: The survey of research institutions has shown that the difference between budget received and budget approved was a serious problem, while delays in receiving approved funds from national sources, instability in total resources one year to the next, inadequate adjustment for inflation in annual budget, and revenue from institution production retained by treasury were a problem, and delays in receiving approved funds from external sources was not a problem.

Budget allocation to cost elements: The AREA budget received and its cost elements for 1989 is shown in Table 69. The capital investment formed about 8 to 55% of the budget for research institutions in North Yemen since these were under construction. In South Yemen, it formed from 0.4 - 5.5% of the total received budget. An overall average of 21.2% was for capital investment, 65.9% for salaries and related charges, and 12.9% for operational costs. The latter formed between 6.8%-18.5% of the total budgets of research institutions (Table 69).

Evolution of total expenditure: The available data of expenditures on agricultural research in the country shows that total expenditures on research formed 0.24 - 0.35% and 1.46%-2.16% of the total AgGDP in North and South Yemen, respectively (Table 70). However, the total expenditures, including capital investment, of AREA for 1990 was about 120 million Yemeni rials which formed about 0.74% of the Agricultural GDP (16,101 million Yemeni rials for 1990).

Table 69: Budget Allocation to Cost Elements in 1989 (US dollars)

Institution	Capital Investment		Salaries & Related Charges		Operating Costs		Total	
	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	%
AREA HQ *	410,256	17.7	1,476,559	63.8	427,805	18.5	2,314,620	100.0
Tihama Regional Station	769,231	54.6	511,590	36.3	128,923	9.1	1,409,744	100.0
Southern Upland Regional Station	62,667	8.1	626,974	80.6	88,102	11.3	777,743	100.0
Central Highland Regional Station	225,641	42.4	270,872	50.8	36,410	6.8	532,923	100.0
El-Kod Research Centre	6,470	0.4	1,390,059	88.6	172,803	11.0	1,569,332	100.0
Seiyun Research Centre	25,588	5.5	379,412	81.8	58,823	12.7	463,823	100.0
Total	1,499,853	21.2	4,655,466	65.9	912,866	12.9	7,068,185	100.0

* Including budget of SSLC.

Note: US \$1 = Yemeni rials 9.75 = Yemeni dinar 0.34.

Table 70: Evolution of Agricultural Research Expenditures from 1980 to 1988
 (Million Yemeni Rial for North Yemen; Million Yemeni Dinar for South Yemen)

	1980	1981	1982	1983	1984	1985	1986	1987	1988
North									
Government Expenditure	3.30	6.98	7.48	7.43	13.83	18.13	19.11	23.32	25.71
External Loans & Assistance	6.10	6.10	6.10	5.14	6.61	5.31	7.19	7.29	10.65
Total Expenditure	9.40	13.08	13.58	12.57	20.44	23.44	26.30	30.61	36.36
AGDP*	3,485	3,685	5,035	5,224	6,236	8,033	11,136	11,922	12,962
Total Expenditure (% of AgGDP)	0.27	0.35	0.27	0.24	0.33	0.29	0.24	0.26	0.28
South									
Government Expenditure	n.a.	n.a.	n.a.	n.a.	0.67	0.66	0.63	0.67	n.a.
External Assistance	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.013	0.029	n.a.
Total Expenditure					0.67	0.66	0.643	0.699	
AGDP**					3i	37	40	48	
Total Expenditure (% of AgGDP)					2.16	1.78	1.61	1.46	

* 1988 prices.

** 1981 prices.

Research expenditures by subsectors: The research expenditures by research institutions and subsectors are in Table 71. The estimated research expenditures of AREA for 1989 were about 7 million US dollars, of which 34.3% for crops, 29.5% for unallocated activities, 20.8% for noncommodity, 8.8% for forestry, and 6.7 for livestock (Figure 8). By excluding external funding, the crops research expenditure was about 45% (Figure 9). The expenditure of the AREA headquarters, the El-Kod Research Centre, and the externally funded projects formed 61.7% of the total expenditures (Table 71; Figure 8).

Research expenditure by commodity and theme: The research expenditures by research institution by commodity, and theme are in Table 72. Expenditures on cereals, fruits, and vegetables formed 28.7% of total research expenditures. Soil research costs were 12.6% of the total expenditures. Unallocated other research expenditures formed 29.5% of the total expenditures (Table 72).

Table 71: Distribution of Research Expenditures by Subsectors for 1989
(in US dollars)

Institution	Crops	Forestry	Livestock	Non commodity	Unallocated	Total	% of Total
AREA HQ	147,180	21,846	207,692	347,692	664,000	1,388,410	19.7
Tihama Regional Station	248,205	-	61,641	158,256	172,410	640,512	9.1
Southern Upland Regional Station	315,384	50,154	46,872	108,000	194,667	715,077	10.2
Central Highland Regional Station	268,717	-	-	51,282	38,462	358,461	5.1
El-Kod Research Centre	1,190,687	29,770	19,848	-	311,382	1,551,687	22.0
Seiyun Research Centre	115,461	29,412	-	279,830	-	464,703	6.5
SSLC	-	-	-	515,955	-	515,955	7.3
External Funded Projects	86,974	484,718	137,436	-	696,000	1,405,128	20.0
Total	2,412,608	615,900	473,489	1,461,015	2,076,921	7,039,933	100.0
% of Total	34.3	8.8	6.7	20.7	29.5	100.0	

US \$1 = Yemeni rial 9.75 = Yemeni dinar 0.34.

Evolution of research expenditure by subsector: Evolution of research expenditure in local currencies by subsectors is shown in Table 73 for North Yemen, and in Table 74 for El-Kod and Seiyun Research Centers in South Yemen.

The research expenditures in North Yemen increased more than four times from 1980 to 1989. During the same period, external sources contribution in these expenditures has increased by less than twofold with a decrease from 65% in 1980 to 26% in 1989 in relative terms. Crop-research expenditures ranged from about 10 to 24% (average 21%) of total research expenditure. Noncommodity research ranked in the third place after unallocated and crop research (Table 73). The research expenditures in South Yemen, however, were nearly stable during the period from 1984-89. Crop research formed about 80% of the total research expenditures during the same period (Table 74).

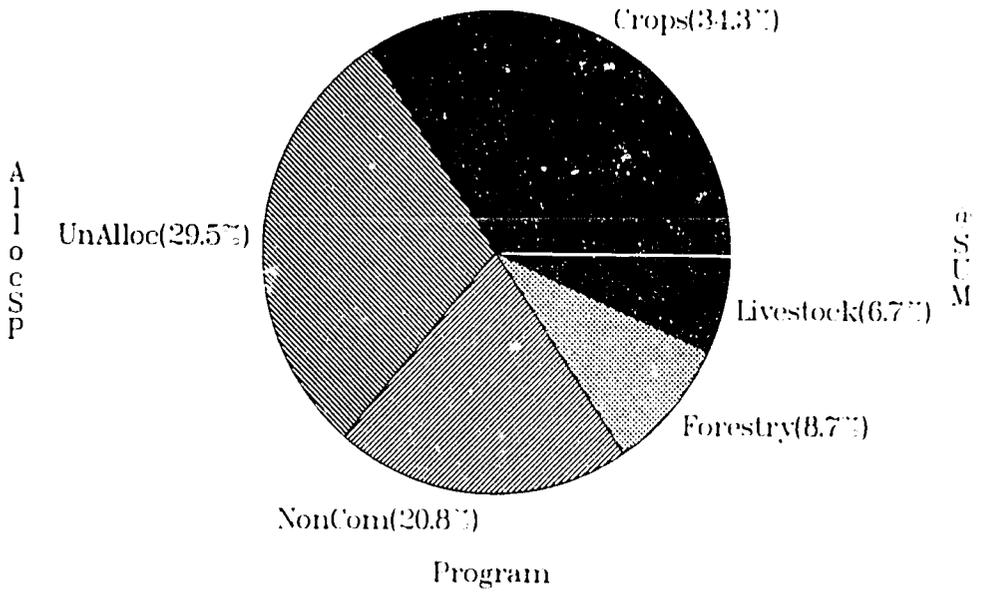


Figure 8: Distribution of Expenditures (Including External Funding)

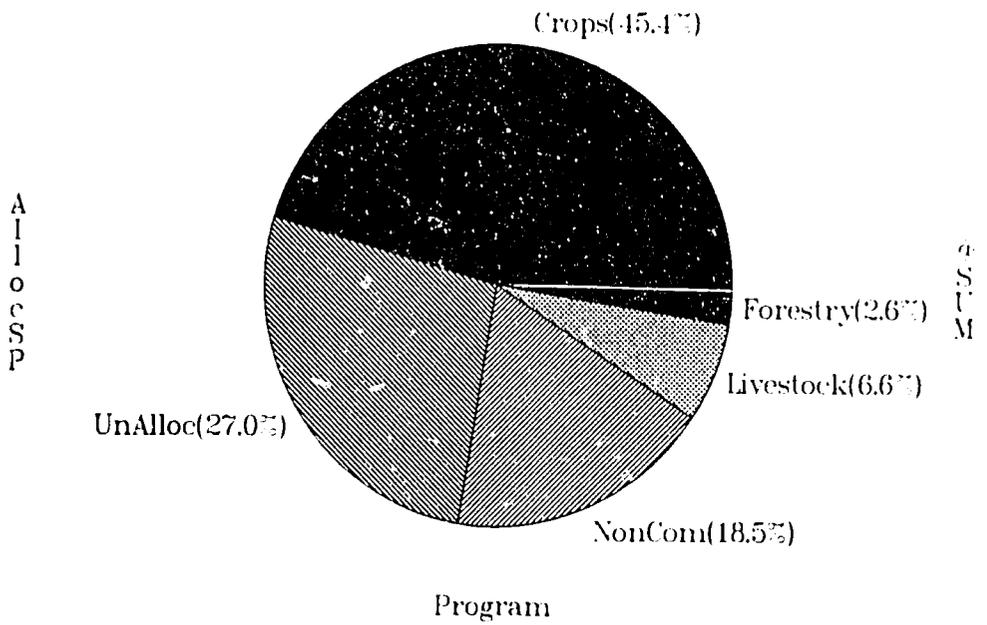


Figure 9: Distribution of Expenditures (Excluding External Funding)

**Table 72: Distribution of Research Expenditures by Commodity and Theme for 1989
(In US\$)**

Program	AREA HQ	Tihama Reg. Station	Southern Upland Reg. Station	Central Highland Reg. Station	El-Ked Res. Centre	Seiyun Res. Centre	SSLC	Externally Funded Projects	Total	% of Total
Cereals	24,821	94,462	173,333	155,897	148,835	77,731			675,079	9.6
Industrial Crops		65,846			148,835				214,681	3.1
Legumes				56,410	43,410				99,820	1.4
Forages	23,077	11,487			43,410				77,974	1.1
Fruits	62,051	26,769	82,051	24,205	372,091	31,092		86,974	685,233	9.7
Vegetables	37,231	49,641	60,000	32,205	434,106	46,638			659,821	9.4
Forestry	21,846		50,154		29,770	29,412		484,718	615,900	8.7
Large Ruminants		30,769							30,769	0.4
Small Ruminants	138,461	20,513	46,872					68,718	274,564	3.9
Range	69,231	10,359			19,848			68,718	168,156	2.4
Plant Protection	104,308	80,615	42,051	25,641		139,915			392,530	5.6
Agricultural Economics	69,538					46,638			116,176	1.7
Agricultural Engineering	34,769					31,092			65,861	0.9
Soil	139,077	77,641	65,949	25,641		62,185	515,935		886,448	12.6
Others	664,000	172,410	194,667	38,462	311,382			696,000	2,076,921	29.5
Total	1,388,410	640,512	715,077	358,461	1,551,687	464,703	515,935	1,405,128	7,039,933	100.0
% of Total	19.7	9.1	10.2	5.1	22.0	6.6	7.3	20.0	100.0	

Note: US\$ = Yemeni Rial 9.75 = Yemeni Dinar 0.34.

Table 73: Evolution of Agricultural Research Expenditure by Subsector for ARA in North Yemen (In thousands of Yemeni rial*)

Sector \ Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Crop Research		2,946	2,823	2,900	1,976	5,636	6,405	7,207	7,368	9,326
Livestock					1,751	2,185	1,770	2,840	2,773	3,308
Forestry						190	130	457	507	702
Noncommodity Research					2,228	2,438	3,346	3,443	6,025	7,566
Other/Unallocated	9,379	9,184	10,425	9,672	14,497	12,979	14,646	16,667	19,690	21,283
Total	9,397	12,130	13,284	12,572	20,452	23,428	26,297	30,614	36,363	42,185
% of Total from External Source	65	50	46	41	32	23	27	24	29	26
Number of National Scientists	17	17	24	29	36	45	53	61	61	69
Number of Expatriates	16	15	11	11	11	10	17	21	17	13

* US \$1 = Yemeni rial 9.75.

Table 74: Evolution of Agricultural Research Expenditure by Subsector for El-Kod and Seiyun Research Centres in South Yemen (In thousands of Yemeni dinar*)

Sector \ Year	1984	1985	1986	1987	1988	1989
Crop Research	539	528	547	525	537	553
Forestry	26	24	25	25	26	27
Fisheries	-	-	-	-	-	-
Noncommodity Research	102	105	106	101	104	106
Other/Unallocated						
Total	667	657	678	651	667	686
% of Total from External Source	0	0	0	2	4	7
Number of Scientists	n.a.	n.a.	n.a.	n.a.	n.a.	107

* US \$1 = Yemeni dinar 0.34.

**Table 75: Evolution of Research Expenditure by Commodity or Theme
for Al-Khail Research Centre in North Yemen
(In thousands of Yemeni rial *)**

Category/Year	1984	1985	1986	1987	1988	1989
Crop Research						
Cereals	2,856	3,277	2,830	3,557	3,538	4,373
Vegetables	1,147	1,957	1,859	2,404	2,472	2,246
Fruits	1,102	1,551	1,618	2,579	2,246	2,328
Industrial Crops	718	642	607	1,319	429	642
Fodder Crops	69	103	131	159	126	112
Legumes		399	374	335	486	550
Livestock Research						
Livestock	882	1,395	1,219	2,363	2,906	3,305
Range & Ecology	441	534	2,165	4,763	4,112	2,015
Forage/Feed	147	178	125	203	191	225
Forestry Research		190	657	7,461	4,554	4,654
Noncommodity Research						
Soil & Water	1,666	1,571	1,564	1,547	6,071	8,436
Plant Protection	2,053	1,400	1,554	1,239	1,542	2,213
Agricultural Economics	176	524	898	683	1,327	1,555
Agricultural Engineering	352	360	243	244	254	339
Genetic Resource						488

* US \$1 = Yemeni rial 9.75.

**Table 76: Evolution of Research Expenditure by Commodity or Theme
for El-Kod Research Centre in South Yemen
(In thousands of Yemeni dinar *)**

Category/Year	1984	1985	1986	1987	1988	1989
Crop Research						
Vegetables	137	121	142	136	160	148
Fruits	79	101	81	97	100	127
Industrial Crops	59	64	64	58	60	51
Cereals	59	60	61	50	40	51
Legumes & Forages	43	40	41	31	24	30
Forestry Research						
Range Management	7	7	7	6	7	7
Afforestation & Wildlife	10	10	10	10	10	10

* US \$1 = Yemeni dinar 0.34.

Evolution of research expenditure by commodity or theme: Evolution of research expenditure in local currencies by commodity and theme are shown in Table 75 for North Yemen, and in Table 76 for the El-Kod Research Centre in South Yemen.

In North Yemen, expenditure for commodity and thematic research has increased for cereals, vegetables, legumes, livestock and forestry research. It has also increased for soil and agricultural economics. However, expenditure for plant protection was nearly stable but decreased for industrial crops (Table 75). Expenditure at El-Kod Research Centre was nearly stable for various commodities, except for fruits which has increased, and for legumes which has decreased (Table 76).

Recommendations on Research Resource Management

1. Planning and development of human resources should be organized for AREA to review future program needs in terms of the various skills of researchers and research support staff.
2. Staffing, career, and training plans should be developed to assist AREA in maintaining dedicated and efficient staff, including the adjustment of salaries to be comparable with those of the academic staff of the same qualifications. Provision for degree and in-service technical and management training, sabbatical leave, and attending scientific meetings will also help in maintaining high-quality staff with improved ability to contact other scientists, opportunities to gain scientific recognition and progression advancement, and better opportunity for promotion based on merit. In-service training programs should be developed for support staff in various fields of work.
3. In making decisions about type and number of stations, support services, and equipment, a fundamental consideration is long-term sustainability of the country's resources. Therefore, the objective should be to maintain the present number — constructed or under construction — of research stations and centers and improve their efficiency and effectiveness to serve agroecological zones and production systems in the country by developing policies and procedures for maintenance and use of buildings, land, equipment, and farms.
4. The centralized research support services at AREA headquarters should be strengthened through the following:
 - a) Improving the germplasm bank. The country is experiencing rapid change in agriculture from old subsistence to commercial farming with the consequent loss of traditional cultivars and wild genetic resources. Therefore collection, conservation, evaluation, and documentation of genetic resources in the country should be a high-priority objective.
 - b) Developing the AREA main library to become a central agricultural library and documentation center for the country. The flood on information and choices of systems and machines are reasons to centralize and strengthen a central agricultural library and documentation center.

- c) Strengthening the central laboratories at AREA headquarters to serve researchers in implementing and interpreting the results of their experiments and studies and for public services. In addition to the present three central laboratories — soil and water, cartography, and feed analysis — which should improve their services, the feed analysis laboratory should be strengthened to cover food, pesticides, and fertilizers chemical analysis, and a new central laboratory for experimental design, statistics, and data processing should be established.
- d) Establishing a central workshop for maintenance of scientific instruments to assist researchers to keep their instruments suitable and reliable. Researchers and managers frequently experience difficulties in identifying the correct scientific instruments to conduct research. Often, when instruments are identified and purchased, frustration results when these instruments cannot be maintained. Thus, the AREA should consolidate and centralize maintenance of expensive and sophisticated scientific instruments.
- e) A maintenance strategy should be developed by AREA to maintain existing buildings, land, laboratory, field, office, and workshop equipment.
- f) Financial resources, especially for operations, should be enough to conduct on-station and on-farm research activities and to purchase supplies needed for research.
- g) Resources allocated to regional stations and centers, in terms of physical and human resources, should be strengthened to provide efficient and effective linkages with extension, farmers, and rural development projects.

Research Policies and Plans

Introduction

Agricultural development policies and goals in Yemen include:

- increasing agricultural production and productivity in a sustainable resource base to achieve a projected level of self-sufficiency in some strategic food and feed commodities, e.g., sorghum, millet, wheat, oilseeds, and animal products and to improve export of cash crops, e.g. vegetable and fruit crops including coffee;
- intensifying agriculture in rainfed and irrigated land through using water resources optimally;
- generating employment for the rural population.

These policies and goals have implications for the agricultural research policies and the research program of AREA and the university system. Broad responsibilities which should be given to AREA include:

- improving the varieties of various crops suitable for different agroecological regions in the country;
- improving animal production;
- improving production and productivity in a sustainable resource base;
- improving the use of forest, range, land, and water resources.

Agricultural researchers in the country were requested to indicate the importance of the objectives of agricultural research on a 5-point scale. The analysis of their selection of research objectives has shown that the highest-importance score was given to the objective of "increase agricultural productivity." Other objectives of importance were decrease production costs of farm products, develop knowledge or improved methodology, improve level of rural living, and provide input to other researchers (Table 77).

In implementing the above responsibilities and objectives, emphasis has been given to plant breeding for developing sorghum, millet, wheat, vegetables, oilseeds, fruits, coffee, and other crops, as well as for agronomic cultural practices and plant protection. Emphasis has also been given to animal resources and to soil and water research.

For example, as a result of research efforts, improved varieties and new cultural practices for wheat, sorghum, maize, cotton, onions, okra, tomatoes, cowpeas, potatoes, mango, papaya, banana and guava have been introduced. Improved chemical control methods of pests and diseases have been adopted by farmers growing wheat, maize, sorghum, cotton, potatoes, onions and tomatoes (see Table 83).

**Table 77: Importance of Research Objectives
(n = 100)**

Objectives	Importance Score
Increase Agricultural Productivity	4.88
Decrease Production Costs of Farm Products	4.29
Develop New Knowledge or Improved Methodology	4.11
Improve Level of Rural Living	4.10
Provide Input to Other Researchers	4.01
Reduce Import Expenditures	3.91
Improve Protection from Insects, Disease & Other Hazards	3.80
Promote Community Improvement	3.78
Expand Demand by Developing New Products or Enhancing Product Quality	3.78
Improve Support Services	3.78
Protect Consumer Health and Improve Nutrition	3.75
Improve Marketing Efficiency	3.29
Expand Export Receipts	2.73

Note: Agricultural researchers were requested to indicate the importance of objectives of agricultural research on a 5-point scale, where 1=of no importance, and 5=of highest importance. Scores were calculated as means.

Research Priorities and Five-year Plans

Efficient planning helps researchers and research managers maintain the quality and relevance of the research program to the institution's mandate and clients. The research institution is part of the government system which provides its financial resources; thus, program planning must be consistent with the goals and planning procedures of the government.

Accordingly, ARA in North Yemen and DRE in South Yemen were requested to submit their five-year research plan to improve research outputs' contributions to the development objectives of the third five-year development plan, 1987-1991 (implemented 1988-1992).

The first five-year research plan for ARA in North Yemen was prepared through the following steps:

Step 1: Three preliminary meetings took place from 21-26 June, 30 June - 2 July, and 6 -9 July 1986, with the participation of all ARA researchers, academic staff of FAUS, and representatives from rural and agricultural regional development authorities and projects, Ministry of Agriculture, extension, and seed multiplication project. The outcome of the meetings was a list of suggested research priorities for commodity and thematic research areas. Those areas covered preliminary proposed research priorities in sorghum, maize, millet and grain legumes, wheat and barley, vegetable crops, fruits and coffee, industrial crops, forage crops, agricultural mechanization, livestock, soil and water, plant protection, and agricultural economics. Other output include the identification of potential coordination linkages between research and extension and the formation of teams to develop project proposals for the third five-year plan 1987-1991.

Step 2: A national agricultural research workshop was held from 21-26 March 1987 and attended by policymakers, researchers, extension workers, academic staff from university, and representatives of various agricultural development and service institutions. The main objectives of the workshop were to present and discuss the formulated research project proposals for the five-year plan 1987-1991 prepared by national teams assigned in earlier meetings of step 1, to discuss and finalize the technical report of 1986, and to discuss research programs for the current year 1987.

Step 3: Finalization of a directory of national agricultural research projects.

A directory of national agricultural research projects for North Yemen for the third five-year development plan was published in 1988. The approved research projects are listed in Table 78. The projects covered various commodity, noncommodity research, agroecological zones, and farming systems. A total of two hundred national projects were approved. These projects were distributed into 11 programs as follows: fruits (39), vegetables (28), livestock including fisheries (26), plant protection (22), forestry (19), industrial crops (14), grain legumes (14), cereals (13), soil and water (12), agricultural economics (8), and agricultural mechanization (5) (Table 79).

About 14 disciplines were involved in these research projects. These and numbers of projects involved were: breeding, plant and animal (66), agronomy (40), plant protection (29), forestry (17), agricultural economics (14), soil (12), machinery (5), nutrition (3), postharvest (3), range (3), fishery (3), veterinary (2), animal husbandry (2), and statistics (1) (Table 80).

In South Yemen, the planning of medium-term research programs coincided with the preparation of the third five-year national development plan, 1986-90 which was rescheduled to 1988-92. The process of planning involved the following steps:

Step 1: Identification of priority crops and major areas of research, definition of research objectives, listing projected research activities and their durations, setting dates for the potential release of recommendations, and listing disciplines involved.

Step 2: Preparation of the medium-term plan, which will guide the preparation of annual research plans.

The above two steps were carried out by requesting various research sections in the two research centers to submit the plans of their proposals to the multidisciplinary research teams who will review and finalize the plans; of these commodity teams there are five at El-Kod Research Centre — fruits, vegetables, cereals, legumes and forages, and industrial crops — and four at Seiyun Research Centre — fruits, vegetables, cereals, and legumes and forages.

Table 78: A List of Agricultural Research Projects, North Yemen (1987-1991)

Title	Subprogram	Location	Duration	Farming system
-----	-----	-----	-----	-----
Cost/benefit of major crops	AgEconomics	TR,SU,CH,NH,ER	1987-91	
Studies on marketing systems	AgEconomics	SU,TP,CH,NH,ER	1987-91	
Technology packages impact studies	AgEconomics	AREA		
Inventory of ag resources in Yemen	AgEconomics	TR	1989-	
Agricultural projects impact	AgEconomics	AREA	1988-	
Farming system research	AgEconomics	TR	1989	
Farm management	AgEconomics	AREA	1987-91	
Survey of agroforestry systems	Agroforestry	Humid and dry areas	1989	Forestry
Agroforestry in coffee plantations	Agroforestry	CH	1988-92	Forestry
Alley cropping with annual crops	Agroforestry	CH	1989-93	Forestry
Acacia on terrace boundaries	Agroforestry	CH	1988-93	Forestry
Trees and wind breaks	Agroforestry	CH	1989-	Forestry
Breeding	Almond	CH,NH	1987-long ter	
Breeding	Apple	CH	1987-long ter	
Cultural practices	Apple	CH,SU	1987- mid ter	
Breeding	Apricot	CH	1987-long ter	
Cultural practices	Apricot	CH	1989-mid term	
Breeding	Banana	SU,TR	1986-90	I
Cultural practices	Banana	SU,TR	1986-90	I
Breeding	Barley	CH,NH	1987-91	R
Cultural practices	Barley	CH,NH	1987-91	R
Breeding	Bean	EU,TR	1987-91	I
Cultural practices	Bean	TR,SU	1987-91	I
Breeding	Bean	CH	1985-1990	
Breeding	Bean	Zabid,Surdud,Ibb	1987-90	
Breeding	Cabbage	Taiz,Dhamar	1987-89	
Seed production	Cabbage	Dhamar,Taiz	1988-91	
Cultural practices	Cabbage	Dhamar,Zabid	1987-90	
Breeding	Carrot	SU,CH	1987-89	
Seed production	Carrot	SU,CH	1988-91	
Performance of Yemeni cattle	Cattle	TR,CH,SU	1987-97	
Improving cattle feed	Cattle	CH,SU	1986-91	
Yemeni cattle reproductive behavior	Cattle	CH,SU,TR	1988-92	
Improving yemeni cattle	Cattle	CH,SU,TR	1988 -long te	
Breeding	Cauliflower	CH(Dhamar)	1987-89	
Seeds production	Cauliflower	Dhamar,Taiz	1988-91	
Cultural practices	Cauliflower	CH(Dhamar)	1987-90	
Breeding	Cherry	CH	1987-long ter	
Cultural practices	Cherry	CH	1989-mid term	
Breeding	Chickpea	AREA	1986-90	
Cultural practices	Chickpea	CH	1988-92	
Breeding	Citrus	SU,TR,ER	1987-92	I
Cultural practices	Citrus	SU,TR,ER	1988-92	I
Breeding	Coffee	SU	1988-long ter	I
Cultural practices	Coffee	SU	1988-long ter	I
Breeding	Cotton	TR(Surdud and Zabid)	1987-91	I
Cultural practices	Cotton	TR(Surdud and Zabid)	1987-89	I
Conrol of diseases and insects	Cotton	TR(Surdud)	1987-89	I
Breeding	Cowpea	SU	1985-1989	
Cultural practices	Cowpea	SU	1987-91	
Breeding	Cucumber	TR,ER,Rada'a	1987-91	I
Breeding	Date palm	TR	1987- long te	I
Cultural practices	Date palm	TR	1988-long ter	I
Survey of crop fungal diseases	Diseases	SU,CH,NH,ER,TR	1987-91	
Chemical control of important disea	Diseases	SU,TR,CH	1987-91	
Disease screening techniques	Diseases	SU,TR,CH	1987-91	

Diseases of major crops	Diseases	SU,TR,CH	1987-91	
Physiological studies	Diseases	SU,CH	1987-91	
Epidemiology of important pathogens	Diseases	SU,CH,TR	1987-91	
Host/pathogen interaction	Diseases	AREA research farms	1987-91	
Viral diseases survey	Diseases	SU,CH,NH,ER,TR	1987-91	
Bacterial diseases survey	Diseases	SU,CH,NH,ER,TR	1987-91	
Insect pests survey	Entomology	SU,CH,NH,ER,TR	1987-91	
Insect pests control	Entomology	AREA research farms	1987-91	
Screening	Entomology	SU,CH,NH,ER,TR	1987-91	
Biological studies on major insect	Entomology	Plant Protection Lab	1987-91	
Breeding	Faba bean	CH	1987-91	
Cultural practices	Faba bean	CH	1986-90	
Breeding	Fig	SU,CH	1987-long ter	
Fishery resources evaluation	Fishery	Hodeida,Salif,Luheya		Fisheries
Fishing techniques	Fishery	Khokha,Luheya,Salif	1990-	Fisheries
Economics of fisheries	Fishery	Coastal area	1989-91	Fisheries
Indian mackerel	Fishery	Coastal area	1987-	Fisheries
Evaluating forage varieties	Forages	SU,TR	1988-91	I
Cultural practices	Forages	SU,TR	1988-91	I
Afforestation suitability index	Forestry	CH	1989-91	Forestry
Natural woodland management	Forestry	TR,Subtropical regions		Forestry
Nursery silviculture studies	Forestry	Dhamar,Taiz,Zabid	1988-92	Forestry
Acacia spp.provenance evaluation	Forestry	TR,ER,CH	1988-92	Forestry
Adaptability to agroecological regi	Forestry	CH,SU	1988-93	Forestry
Tamarix:cultural practices and sele	Forestry	CH	1988-93	Forestry
Leading tree species and provenance	Forestry	CH,SU	1989-92	Forestry
Frost resistance	Forestry	CH	1988-93	Forestry
Sand dune fixation by irrigated tre	Forestry	TR,ER	1988-92	Forestry
Trees and shrubs for rangeland impr	Forestry	CH	1989-	Forestry
Wood preservation studies	Forestry	Countrywide	1988-92	Forestry
Economics of forest products	Forestry	Countrywide	1988-92	Forestry
Cultural practices	Garlic	Dhamar,Rada'a	1987-89	
Seed collection procedures	Germplasm	Throughout the country	1989-continuo	Forestry
Local stands of Acacia	Germplasm	Throughout the country	1988-92	Forestry
Performance of different goat breed	Goats	NH,SU	1987-91	
Improving goat feeds	Goats	SU	1988-92	
Improving goat breeds	Goats	SU	1987-97	
Breeding	Grape	CH,NH,SU	1987-91	
Cultural practices	Grape	CH,NH,SU	5 years	
Breeding	Groundnut	TR(Surdud and Zabid)	1987-91	I
Cultural practices	Groundnut	TR(Surdud and Zabid)	1986-88	I
Breeding	Guava	SU,TR	1988-92	I
Cultural practices	Guava	SU,TR	1988-90	I
Breeding	Hot pepper	Zabid	1987-90	
Cultural practices	Lentil	CH	1987-91	
Breeding	Maize	CH,SU,TR,ER	1987-91	I,R
Cultural practices	Maize	CH,SU,TR,ER	1987-91	I,R
Breeding	Mango	SU,TR	1987-92	I
Cultural practices	Mango	SU,TR	1988-92	I
Evaluation of farm mechanical requi	Mechanization	TR,CH,NH,ER,SU	1988-91	
Cooperative utilization of farm mac	Mechanization	TR,CH,SU,NH,ER	1988-91	
Land preparation machinery	Mechanization	Research stations	1988-91	
Crop management machineries	Mechanization	Research stations	1988-91	
Crop harvesting equipment	Mechanization	TR,ER,SU,CH,NH	1988-91	
Breeding	Melon	Zabid,Surdud,Rada'a,Mareb	1987-91	
Breeding	Millet	SU,TR,ER	1987-90	Low rainfall,spate-i
Nematode diseases survey	Nematodes	SU,CH,NH,ER,TR	1987-91	
Improving seed production	Okra	Zabid,Taiz	1987-91	
Breeding	Olive	CH,SU	1987-long ter	
Breeding	Onion	CH,SU	1987-91	I
Cultural practices	Onion	CH,SU	1987-91	I
Cultural practices	Onion	CH,SU	1987-91	I
Breeding	Other fruits	SU,TR	1986- long te	
Breeding	Papaya	SU,TR	1988-90	I

Cultural practices	Papaya	SU,TR	1988-long ter	I
Breeding	Pea	Dhamar,Rada'a	1987-90	
Cultural practices	Pea	CH	1987-90	
Breeding	Peach	CH,SU		
Cultural practices	Peach	CH,SU	1987-	
Breeding	Pear	CH	1987-long ter	
Cultural practices	Pear	CH,SU	1990-mid term	
Breeding	Pigeonpea	TR	1988-92	I
Cultural practices	Pigeonpea	TR	1988-92	I
Breeding	Plum	CH	1987-long ter	
Breeding	Pomegranate	CH,NH	1987-long ter	
Breeding	Potato	CH,NH	1987-91	I
Cultural practices	Potato	CH,NH	1988-91	I
Breeding rabbits	Rabbits	Taiz,Ibb,Sana'a,Tihama	1987-91	
Rangeland ecological studies	Range	Rangelands	1984-	Rangeland
Rangeland improvement studies	Range	CH,TR,ER	1984	Rangeland
Rangeland utilization	Range	CH,TR,ER	1984-	Rangeland
Survey of rodents and birds	Rodents/birds	SU,CH,NH,ER,TR	1987-91	
Control of rodents and birds	Rodents/birds	AREA research farms in SU	1987-91	
Biological studies	Rodents/birds	Plant Protection Lab	1987-91	
Breeding	Sesame	TR(Surdud and Zabid)	1987-91	I
Cultural practices	Sesame	TR(Surdud)	1987-89	I
Performance of sheep breeds	Sheep	AREA work areas	1986-91	
Sheep feed	Sheep	Dhamar,Taiz,Sana'a,Hodeid	1986-91	
Reproductive behaviour	Sheep	CH,TR	1987-91	
Improving different breeds	Sheep	CH,TR	1987-97	
Snails survey	Snails	SU,AREA laboratories and	1987-91	
Snails control	Snails	AREA research farms	1987-91	
Biological studies	Snails	AREA research farms in SU	1987-91	
Soil survey and classification	Soil	ER,TR,CH,NH	1987-91	R,I
Soil amangement and conservation	Soil	Selected areas	1987-91	R,I
Soil fertility investigations	Soil	AREA research farms	1987-91	
Plant micronutrient requirement	Soil	Different ecological zones	1987-89	
Microbiological activities	Soil	AREA research farms	1987-91	
Breeding	Sorghum	CH,SU,TR	1987-91	
Cultural practices	Sorghum	CH,SU,TR	1987-92	
Breeding	Soybean	TR(Surdud and Zabid)	1987-89	I
Cultural practices	Soybean	TR(Surdud and Zabid)	1986-88	I
Experimental design and statistical	Statistics	AREA		
Breeding	Strawberry	CH	1987-91	
Cultural practices	Strawberry	CH	1988-long ter	
Cereal insects and diseases	Support	AREA res farms	long term	I,R
Economics of cereals	Support	TR,SU,CH,ER,NH		
Managing insect pests and diseases	Support	AREA research farms		
Economics of legumes	Support	CH		
Nursery techniques	Support	Taiz	1988	
Insect pest and disease management	Support	AREA research farms	long term	
Post harvest technology	Support	Taiz,Dhamar,Tihama	1988-89	
Economic studies	Support	TR,SU,CH,NH,ER		
Nursery techniques	Support	SU,CH,TR	1988-long ter	
Insect pests and diseases	Support	AREA research farms	Long term	
Post harvest treatment	Support	SU,CH,TR	1987	
Economic studies	Support	NH,TR,SU,CH	1988-	
Mapping of major livestock diseases	Support	NH	1987-89	
Livestock internal parasites	Support	NH,SU,TR	1987-91	
Status of livestock housing	Support	CH	1987-89	
Live stock husbandry	Support	CH	1987-88	
Economics of livestock	Support	TR,CH	1987-89	
Post-harvest	Support	TR	1987-91	I
Pest management	Support	TR	1987-long ter	I
Economic studies	Support	TR	1987-91	I
Breeding	Tobacco	TR(Surdud and Zabid)	1986-90	I
Cultural practices	Tobacco	TR(Surdud and Zabid)	1987-89	I
Breeding	Tomato	TR	1987-91	I

Pesticide studies	Toxicology	AREA research farms	1987-91	
Breeding	Triticale	CH,NH,SU,ER,TR	1987-91	I,R
Cultural practices	Triticale	CH,NH,SU,ER,TR	1987-91	I,R
Breeding	Walnut	CH	1987-long ter	
Water quality survey	Water	CH,ER,TR,NH	1987-91	
Agroclimatological studies	Water	Meteorological stations	1987-91	
Crop water requirements	Water	TR,SU,CH,ER	1986-	
Irrigation scheduling	Water	TR,SU,CH,ER	1987-91	
Irrigation methods improvement	Water	TR,SU,CH,ER	1987-91	
Salinity/alkalinity studies	Water	TR,ER	1987-91	
Soil moisture conservation	Water	Spate/supplementary irrig	1987-91	
Breeding	Watermelon	TR,ER,SU,CH	1987-91	
Mosaic virus	Watermelon	Tihama,Marid	1987-91	
Survey of weeds of plant crops	Weeds	SU,CH,NH,ER,TR	1987-91	
Breeding	Wheat	CH,NH,SU,ER,TR	1987-91	I,R
Cultural practices	Wheat	CH,NH,SU,ER,TR	1987-91	I,R

CH= Central Highland; ER= Eastern Region; NH= Northern Highland; SU= Southern Upland; TR= Tihama Region
I= Irrigated; R= Rainfed

Source: Directory of National Agricultural Research Projects (1987-1991),ARA, 1988

Table 79: National Research Projects, North Yemen, by Programs/Subprograms, 1987-1991

Summary: @COUNT Field: PROGRAM

Rows: SUBPROGRAM Columns: PROGRAM

	AgEconomics	AgMechanization	Cereals	Forestry	Fruits	IndCrops	Legumes	Livestock	PlProtection	Soil/Water	Vegetables	ALL
AgEconomics	7	0	0	0	0	0	0	0	0	0	0	7
Agroforestry	0	0	0	5	0	0	0	0	0	0	0	5
Almond	0	0	0	0	1	0	0	0	0	0	0	1
Apple	0	0	0	0	2	0	0	0	0	0	0	2
Apricot	0	0	0	0	2	0	0	0	0	0	0	2
Banana	0	0	0	0	2	0	0	0	0	0	0	2
Barley	0	0	2	0	0	0	0	0	0	0	0	2
Bean	0	0	0	0	0	0	3	0	0	0	1	4
Cabbage	0	0	0	0	0	0	0	0	0	0	3	3
Carrot	0	0	0	0	0	0	0	0	0	0	2	2
Cattle	0	0	0	0	0	0	0	4	0	0	0	4
Cauliflower	0	0	0	0	0	0	0	0	0	0	3	3
Cherry	0	0	0	0	2	0	0	0	0	0	0	2
Chickpea	0	0	0	0	0	0	2	0	0	0	0	2
Citrus	0	0	0	0	2	0	0	0	0	0	0	2
Coffee	0	0	0	0	2	0	0	0	0	0	0	2
Cotton	0	0	0	0	0	3	0	0	0	0	0	3
Cowpea	0	0	0	0	0	0	2	0	0	0	0	2
Cucumber	0	0	0	0	0	0	0	0	0	0	1	1
Date palm	0	0	0	0	2	0	0	0	0	0	0	2
Diseases	0	0	0	0	0	0	0	0	9	0	0	9
Entomology	0	0	0	0	0	0	0	0	4	0	0	4
Faba bean	0	0	0	0	0	0	2	0	0	0	0	2
Fig	0	0	0	0	1	0	0	0	0	0	0	1
Fishery	0	0	0	0	0	0	0	4	0	0	0	4
Forages	0	0	0	0	0	0	0	2	0	0	0	2
Forestry	0	0	0	12	0	0	0	0	0	0	0	12
Garlic	0	0	0	0	0	0	0	0	0	0	1	1
Germplasm	0	0	0	2	0	0	0	0	0	0	0	2
Goats	0	0	0	0	0	0	0	3	0	0	0	3
Grape	0	0	0	0	2	0	0	0	0	0	0	2
Groundnut	0	0	0	0	0	2	0	0	0	0	0	2
Guava	0	0	0	0	2	0	0	0	0	0	0	2
Hot pepper	0	0	0	0	0	0	0	0	0	0	1	1
Lentil	0	0	0	0	0	0	1	0	0	0	0	1

Maize	0	0	2	0	0	0	0	0	0	0	0	2
Mango	0	0	0	0	2	0	0	0	0	0	0	2
Mechanizatio	0	5	0	0	0	0	0	0	0	0	0	2
Melon	0	0	0	0	0	0	0	0	0	0	0	5
Millet	0	0	1	0	0	0	0	0	0	0	0	1
Nematodes	0	0	0	0	0	0	0	0	1	0	0	1
Okra	0	0	0	0	0	0	0	0	0	0	1	1
Olive	0	0	0	0	1	0	0	0	0	0	0	1
Onion	0	0	0	0	0	0	0	0	0	0	0	1
Other fruits	0	0	0	0	1	0	0	0	0	0	3	3
Papaya	0	0	0	0	2	0	0	0	0	0	0	1
Pea	0	0	0	0	0	0	0	0	0	0	2	2
Peach	0	0	0	0	2	0	0	0	0	0	0	2
Pear	0	0	0	0	2	0	0	0	0	0	0	2
Pigeonpea	0	0	0	0	0	0	2	0	0	0	0	2
Plum	0	0	0	0	1	0	0	0	0	0	0	1
Pomegranate	0	0	0	0	1	0	0	0	0	0	0	1
Potato	0	0	0	0	0	0	0	0	0	0	2	2
Rabbits	0	0	0	0	0	0	0	1	0	0	0	1
Range	0	0	0	0	0	0	0	3	0	0	0	3
Rodents/bird	0	0	0	0	0	0	0	0	3	0	0	3
Sesame	0	0	0	0	0	2	0	0	0	0	0	2
Sheep	0	0	0	0	0	0	0	4	0	0	0	4
Snails	0	0	0	0	0	0	0	0	3	0	0	3
Soil	0	0	0	0	0	0	0	0	0	5	0	5
Sorghum	0	0	2	0	0	0	0	0	0	0	0	2
Soybean	0	0	0	0	0	2	0	0	0	0	0	2
Statistics	1	0	0	0	0	0	0	0	0	0	0	1
Strawberry	0	0	0	0	2	0	0	0	0	0	0	2
Support	0	0	2	0	4	3	2	5	0	0	4	20
Tobacco	0	0	0	0	0	2	0	0	0	0	0	2
Tomato	0	0	0	0	0	0	0	0	0	0	0	2
Toxicology	0	0	0	0	0	0	0	0	1	0	0	1
Triticale	0	0	2	0	0	0	0	0	0	0	0	1
Walnut	0	0	0	0	1	0	0	0	0	0	0	1
Water	0	0	0	0	0	0	0	0	0	7	0	7
Watermelon	0	0	0	0	0	0	0	0	0	0	2	2
Weeds	0	0	0	0	0	0	0	0	1	0	0	1
Wheat	0	0	2	0	0	0	0	0	0	0	0	2
ALL	8	5	13	19	39	14	14	26	22	12	28	200

Table 80: National Research Projects, North Yemen, by Subprograms/Disciplines, 1987-1991

Summary: @COUNT Field: Discipline

Rows: SUBPROGRAM Columns: Discipline

	AgEconomics	Agronomy	Breeding	Fishery	Forestry	Husbandry	Machinery	Nutrition	PlProtection	Postharvest	Range	Soil	Statistics	Veterinary	ALL
AgEconomics	7	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Agroforestry	0	0	0	0	5	0	0	0	0	0	0	0	0	0	5
Almond	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Apple	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Apricot	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Banana	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Barley	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Bean	0	1	3	0	0	0	0	0	0	0	0	0	0	0	4
Cabbage	0	1	2	0	0	0	0	0	0	0	0	0	0	0	4
Carrot	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3
Cattle	0	0	3	0	0	0	0	1	0	0	0	0	0	0	2
Cauliflower	0	1	2	0	0	0	0	0	0	0	0	0	0	0	4
Cherry	0	1	1	0	0	0	0	0	0	0	0	0	0	0	3
Chickpea	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Citrus	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Coffee	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Cotton	0	1	1	0	0	0	0	0	0	1	0	0	0	0	2
Cowpea	0	1	1	0	0	0	0	0	0	0	0	0	0	0	3
Cucumber	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Date palm	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1
Discases	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Entomology	0	0	0	0	0	0	0	0	9	0	0	0	0	0	9
Faba bean	0	1	1	0	0	0	0	0	0	0	0	0	0	0	4
Fig	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Fishery	1	0	0	3	0	0	0	0	0	0	0	0	0	0	1
Forages	0	1	1	0	0	0	0	0	0	0	0	0	0	0	4
Forestry	0	0	0	0	12	0	0	0	0	0	0	0	0	0	2
Garlic	0	1	0	0	0	0	0	0	0	0	0	0	0	0	12
Geraplasm	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1
Goats	0	0	2	0	0	0	0	1	0	0	0	0	0	0	2
Grape	0	1	1	0	0	0	0	0	0	0	0	0	0	0	3
Groundnut	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Guava	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Hot pepper	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Lentil	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1

Maize	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Mango	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Mechanization	0	0	0	0	0	0	5	0	0	0	0	0	0	0	5
Melon	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Millet	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Nematodes	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Okra	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Olive	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Onion	0	2	1	0	0	0	0	0	0	0	0	0	0	0	3
Other fruits	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Papaya	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Pea	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Peach	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Pear	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Pigeonpea	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Plum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Pomegranate	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Potato	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Rabbits	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Range	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3
Rodents/bird	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3
Sesame	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Sheep	0	0	3	0	0	0	0	1	0	0	0	0	0	0	4
Snails	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3
Soil	0	0	0	0	0	0	0	0	0	0	0	5	0	0	5
Sorghum	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Soybean	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Statistics	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Strawberry	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Support	6	2	0	0	0	2	0	0	5	3	0	0	0	2	20
Tobacco	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Tomato	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Toxicology	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Triticale	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Walnut	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Water	0	0	0	0	0	0	0	0	0	0	0	7	0	0	7
Watermelon	0	0	1	0	0	0	0	0	1	0	0	0	0	0	2
Weeds	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Wheat	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
ALL	14	40	66	3	17	2	5	3	29	3	3	12	1	2	200

Annual Planning at AREA

In North Yemen, each of the three regional agricultural research stations are managed independently of one another and are directly linked to the AREA headquarters. The national commodity coordinators, who are assigned to function as the inter-regional coordinations at technical level, play an important role in the review and planning of annual research programs. They, with relevant researchers and extension workers at regional level, review research progress, identify research priorities for the next season, and formulate research proposals. In addition, the inter-project, inter-regional, and international coordination in commodity research in the country is the responsibility of the national commodity coordinators.

The chronology of annual planning at ARA is summarized in Table 81. It consists of three stages:

- Stage 1:** Review of research progress at regional level by relevant research groups, national commodity coordinators, and extension representatives, to identify research topics, and to formulate research proposals. This stage takes from two days to one week.
- Stage 2:** Discussion of the research proposals at the national level in the annual coordination meeting by the AREA assistant director general, technical director, and national commodity coordinators. The discussions are for two days.
- Stage 3:** Discussion and approval of prepared program by the research coordination committee (RCC) which takes one day.

The approved research program is implemented through a multidisciplinary approach at regional station levels by researchers and heads of technical sections.

In South Yemen, the El-Kod and Seiyun Research Centers are organized into disciplinary research sections. The introduction of multidisciplinary research teams (MDRTs) at each of these centers has improved the annual research program planning. The MDRTs are chaired by a senior researcher in each center. Research staff from various disciplinary sections, subject matter specialists from the extension unit, and the farming system research group participate in developing the research proposals at commodity, center, and regional levels. In addition to their role in planning, the MDRTs provide an effective mechanism for joint implementation of research results, and ensure coordination between research teams, and guarantee interinstitutional coordination.

As mentioned earlier, there are five MDRTs at El-Kod Research Centre: fruits (banana, citrus, mango, and papaya), vegetables (tomato, onion, potato, watermelon, and melon), cereals (sorghum and maize), legumes (cowpea and groundnuts), and industrial crops (cotton and sesame); and four MDRTs at Seiyun Research Centre: fruits (dates, orange, lime, grapes, and papaya), vegetables (tomato, onion, potato, and garlic), cereals (wheat and sorghum), and legumes and forages (cowpeas, alfalfa, peas, chickpeas, faba beans, and beans).

Table 81: Chronology of Annual Planning at ARA and DRE, 1988-1989

Date	Operation	Time Required	Person Responsible
A. North Yemen			
November-December	Review of research progress, identify priority research topics for the next season at regional level, and formulate research proposals	2 days-1 week	Research groups each headed by the relevant National Commodity Coordinator; Extension Workers
January	Discussion of research proposals in the Annual Coordination Meeting	2 days	Assistant Director General; Technical Director; National Commodity Coordinators
January	Discussion and approval of the proposed program plan	1 day	Research Coordination Committee (RCC)
B. South Yemen			
April	Preparation of annual research report.	4 weeks	Researchers
May	Discussion of annual reports and proposed annual research programs	4 weeks	Researchers; MDRTS-SMS
June	Discussion and approval of the proposed program plan	4 weeks	MDRTS Coordinating Committee
August	Discussion and approval of annual plans and reports	3 days	Members of the NRETC

The MDRTs in each center have a coordination committee consisting of the director of the center as the chairperson and MDRT leaders as members. This committee's main functions include the final approval of the annual research programs of different teams, including on-farm trials and special projects, the review of annual research results, and the finalization of technical recommendations prior to their submission to the joint research/extension technical committee.

Proposed programs from the two centers are presented to the National Research and Extension Technical Committee (NRETC) for discussions and approval (Table 81).

The chronology of annual planning at DRE could be summarized in the following three stages:

Stage 1: Preparation of annual research progress reports and proposed research activities for the next season by all researchers at the two centers. This stage is carried out during April.

Stage 2: Discussion of annual research progress reports and proposed research activities by researchers, MDRTs, and SMS during May.

Stage 3: Discussion and approval of the proposed program plan by MDRTs coordination committee.

Stage 4: Discussion and approval of the proposed programs by NRETC.

Planning at AREA has benefitted from the above experience of the previous ARA and DRE. AREA has adopted a decentralized planning system at regional as well as at headquarters levels. Each regional station or center sets up its own priorities of research activities for the coming seasons, within the guidelines developed by the board of directors. There is a Research and Extension Technical Committee (RETC) in each regional station or center responsible for discussion and approval of research proposals developed by scientists. At headquarters level, commodity programs which have been approved at regional station or center level are combined and integrated and submitted to the AREA board of directors for final approval.

Planning at AREA could be summarized in the following:

a. At regional level

Phase I: Programs are formulated by disciplines. Scientists develop their proposals. This phase takes about two months.

Phase II: Programs approved by RETC in Phase I are discussed and approved at commodity level by MDRTs. This phase takes about one month.

Phase III: Commodity programs are submitted to RETC for discussion and approval. This phase takes three days.

b. At AREA headquarters management and board of directors level

Phase I: Regional commodity programs which have been approved at regional level are combined, integrated, and submitted to the board of directors of AREA for final approval. This phase takes about one month.

Phase II: Approved programs are sent back to implementing regional stations and centers. This phase takes about one month.

It is worthy to note that AREA is in the process of establishing a system to coordinate programs between stations and/or centers located in similar agroecological zones in the northern and southern governorates. It is planned that the overall coordination of commodity programs will be achieved through the establishment of the national commodity programs network which is planned to be implemented by the national coordinators. This process will ensure the integration of experiences in the northern and southern parts of the country in one united national system.

Improving the Planning Process

The planning of research programs at AREA tends to cover most crops grown or to be introduced to the country, as well as the country's natural resources (Table 78). While the five-year research plan has helped AREA to improve political support to allocate more financial resources of national and external sources to build up its physical and human resources needed to implement the research program; AREA has faced many problems in implementing the research program, mainly because of shortages of trained manpower in the regional research stations. On the contrary, constraints for implementing research programs at the two research centers were mainly due to the lack of financial and physical resources.

Planning is a set of approaches that, when followed, make research institutions more efficient and effective. Effective in utilizing human, physical, and financial resources and effective in tackling the main problems of agricultural development in the country. The main task of research managers is to develop a research program relevant to the mandate of the research institution and the beneficiaries of research results. Efficient planning helps in achieving this task.

Two sets of five documents should be prepared through the research program planning process at the national and institutional levels. The first set consists of **three** documents to be prepared for government planning and finance purposes, while the second set consists of **two** detailed programming documents to be prepared as operational plans for the research to be implemented to achieve its goals and objectives.

The preparation of the **first** set, the three government documents, is guided by two major government documents. These documents help the research institute to prepare its planning documents for financing its research activities. They include:

1. The national economic development plan which establishes the guidelines by which research institutions prepare and present to the government **strategic and five-year research plans** as parts of the agricultural development strategy and five-year plan, respectively.
2. The government procedures for resource allocation which guide research institutions in preparing and presenting their **annual program and budget** for support from the government.

The **second** set includes the preparation of:

1. A **long- and short-term research-program plan**, the preparation of which is guided by the national research strategy, world knowledge, and technical possibilities.
2. A detailed **annual research program** (action plan: experiment and study proposals), the preparation of which is guided by long- and short-term research programs, world knowledge of current results, and client circumstances.

The short-term research program will guide the preparation of the five-year plan for research to be submitted as part of the agricultural development plans; and the annual research program will guide the preparation of the annual budget (see figure 10).

Research institutions in Yemen lack a national **agricultural research policy and strategy** to guide the preparation of **detailed long- and short-term research program** covering research activities on which **five-year and annual plans** are based.

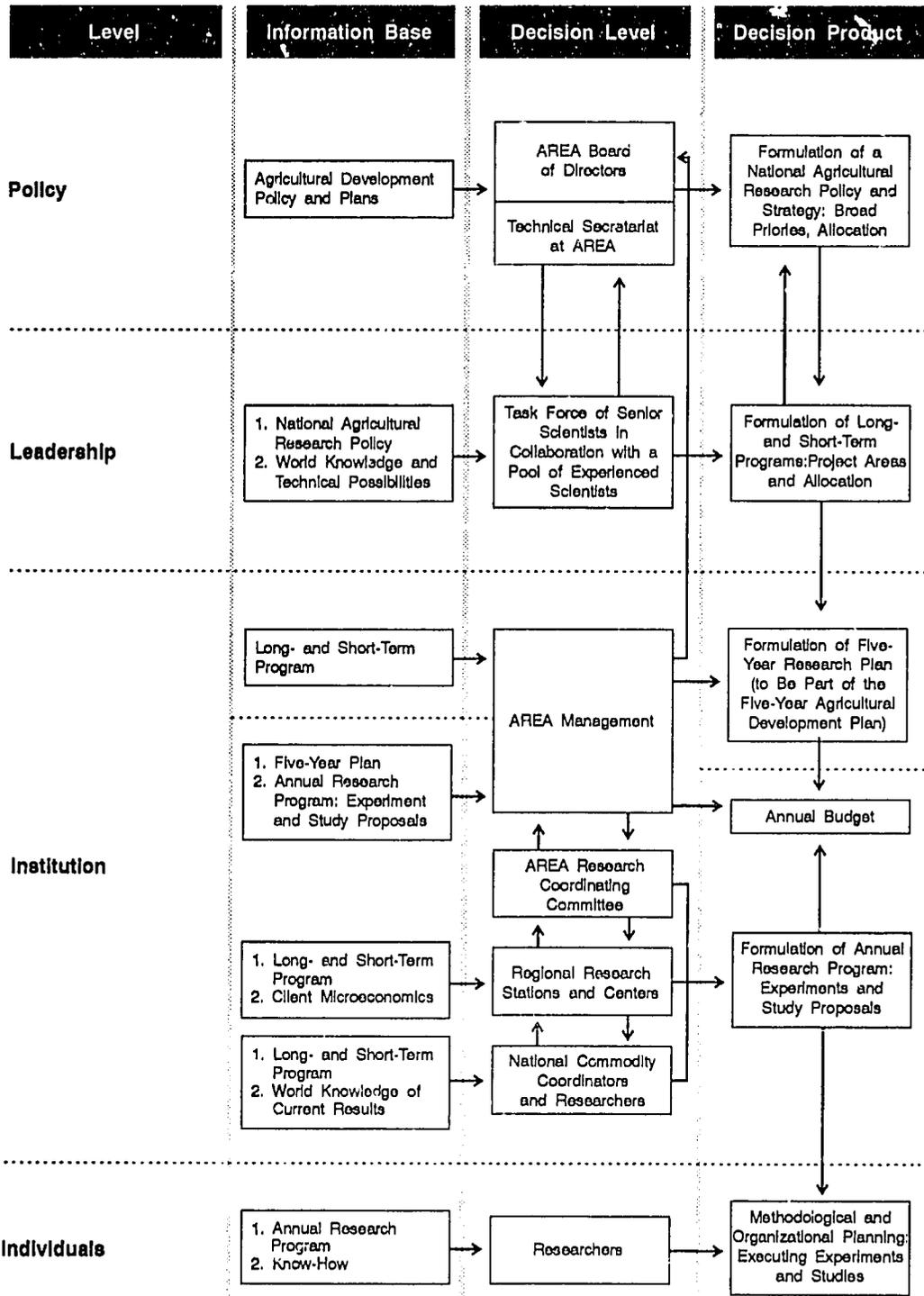
A proposal for AREA to improve its planning process is given in figure 10. The proposal calls for formulation of a national agricultural research policy and strategy and long- and short-term research program.

Nowadays science is considered more a "strategic opportunity." Such a perspective, emphasizing as it does the search for opportunities, leads to particular concerns about the requirements of conducting research and the effective implementation of research priorities. In this approach, a national agricultural research strategy may be outlined and the budget allocated in accordance with priority choices determined by groups or committees.

The research choices in a strategic plan are distributed among types, kinds, duration, and areas of agricultural research. **Types** of research could be classified as basic, strategic, applied, and adaptive research. **Kinds** of research include on-station, off-station, and on-farm research activities. **Duration** deals with the time span of research activity, which could be short-term — less than one to five years — or long-term — more than five or ten years. **Areas** of research cover commodity and noncommodity research. Commodity research on crops, forestry, livestock and fisheries is carried out to improve production and productivity through research on genetic improvement as well as production and protection factors. There is also postharvest research which covers transport of agricultural products, marketing, storage, processing, and human nutrition. Noncommodity research covers ecology and natural resources as well as macro-level socioeconomic research.

Therefore, strategic options and a broad allocation of resources have to be determined in a time frame of 10-20 years. AREA, with its organizational structure (figure 10), should take the lead in a strategic planning exercise to guide future research activities in the country. This exercise should be accompanied by a formulation of the long- and short-term research program in which research areas are identified and resources allocated to them.

Figure 10: Principles of Formulating and Implementing Agricultural Research Strategy and Program: A Proposal for AREA



Recommendations on Research Policies and Plans

1. The responsibilities of AREA should be reviewed to include some critical points, such as:
 - AREA is the sole national institution mandated to carry out agricultural research in Yemen;
 - AREA carries out commodity research — crop (field, fruit, and vegetable), forestry, livestock, and fisheries — and noncommodity research — agroecological, natural resource (mainly soil and water), and socioeconomic — to develop appropriate technologies;
 - AREA contributes to the technology-transfer and adoption processes in Yemen.
2. To improve the planning process of agricultural research, a proposal to AREA was developed. It includes the principles of formulating and implementing an agricultural research strategy and program. An organizational framework for decision making in the planning process was proposed (Figure 10).
3. Planning of agricultural research should not be driven by structural organization, but rather by functional organization. Thus, national commodity and noncommodity research programs should continue to dictate the planning of research programs and facilitate multidisciplinary research within AREA and between AREA and other institutions in the country, e.g., the universities.

Research Program Management

Introduction

Research program management covers many issues concerning implementation, resource mobilization, monitoring and evaluating on-going research activities and research results, managing information, and others. Researchers at AREA and academic staff at the faculties of agriculture were requested to select the three most difficult management activities to perform to their satisfaction. The results of their individual difficulties indicated that evaluating past activities, obtaining additional resources, and implementing policy and planning priorities were the most difficult for them to manage. Communications with farmers and other clients was the least difficult to manage (Table 82).

Table 82: Difficulty of Management Activities
(n=100)

Management Activities	1st Most Difficult	2nd Most Difficult	3rd Most Difficult	Total Points
Evaluating past activities	66	28	8	102
Obtaining additional resources	60	16	19	95
Implementing policy and planning priorities	63	20	10	93
Improving use of operating resources	33	32	7	72
Maintaining physical resources	42	16	4	62
Maintaining on-going activities	15	20	4	39
Improving morale of non-professional staff	0	20	12	32
Maintaining effective control and discipline of staff	6	14	10	30
Talking to staff about their problems	12	10	6	28
Communicating with farmers and other clients	15	4	8	27
Other	3	4	1	8

Note: Agricultural researchers were requested to select the three most difficult management activities to perform. Total points were calculated by multiplying the number of respondents who selected the various criteria by a factor of 3 for the 1st most difficult, 2 for the 2nd most difficult, and 1 for the 3rd most difficult.

Implementing the Research Program

On-station and on-farm research: Research-program activities, especially in North Yemen, have grown up during the last decade to cover more commodity and noncommodity areas. Subsequently, the resources needed to implement the growing program were increased tremendously during the eighties.

In North Yemen, the approved 200 agricultural research projects for the five-year research plan (1987-91) were mostly implemented by AREA in its research farms in the three regional research stations for on-station research; by AREA in collaboration with rural and agricultural development projects in the Tihama, the southern uplands, northern highlands, central highlands, and eastern agroecological regions for off-station on-farm trials; by AREA in collaboration with farmers for on-farm trials; and by the General Corporation for Fisheries Development (GCFD) for fisheries research projects at Hodeida, Khokha, Luheya, and Salih located at the Red Sea.

Coordination of implementation of commodity-research trials is the responsibility of the six national commodity coordinators — cereals and legumes, industrial crops, vegetables, fruits, forestry, and livestock and range.

In South Yemen, the two research centers implement their on-station and on-farm research activities which are grouped into five teams for El-Kod — fruits, vegetables, cereals, legumes and forages, and industrial crops — and four teams for Seiyun — fruits, vegetables, cereals, legumes and forages. Coordination between the two centers is the responsibility of four national coordinators selected from nine MDRT leaders at the centers level. Animal husbandry research focuses on sheep and goat breeding and feeding. Research activities are carried out at the Mujahed Goat station and the El-Feyush sheep station in Lahej.

On-farm trials in North Yemen are usually carried out in cooperation with extension workers at the rural and agricultural development projects; while in South Yemen, these are carried out in cooperation with extension and cooperative departments in farmers' field.

Farming systems research (FSR) was introduced into South Yemen in 1982 under an FAO sponsored project and was merged with the overall research activity at the El-Kod Research Centre. The FSR and economics sections are responsible for on-farm research to characterize farming systems in target areas, to identify production constraints for MDRTs to develop on-farm trials program, to participate in conducting on-farm trials, and to assess technologies adoption and impact.

Teamwork: Teamwork has been achieved in preparing AREA research projects in its regional stations through the leadership of the national commodity coordinators, and in the two research centers through the MDRTs. It is also ensured at implementation level for on-station and on-farm trials.

National commodity coordinators ensure coordination in executing experiments and studies in a multidisciplinary approach. In addition, they coordinate between

stations/centers at technical level, AREA and bilateral projects, and AREA and regional and internal research organization. They also assist extension in preparing extension publications.

Monitoring and Evaluation

Monitoring and evaluation are most effective when integrated into planning and implementation of agricultural research. AREA has developed various mechanisms to monitor and evaluate its research progress. National commodity coordinators normally review research progress at station level with relevant research groups in the planning process to develop research proposals for the next year's program, discuss proposals at RCC meetings, and participate in developing the research program. In addition, national coordinators receive periodic program reports from researchers, and compile experimental results for each commodity, and present them in a consolidated way in the AREA's report. Heads of sections and field units at El-Kud and Seiyun Research Centers prepare quarterly reports on their research progress and submit them to their superiors. Impact studies on adoption of technologies are carried out by a farming research system unit.

Output and impact of research: Research output in Yemen has included improved technologies and publications. Improved technologies developed by AREA research staff are new crop varieties, chemical control methods, mechanical technologies, and cultural practices. AREA staff have published journal articles, research reports, conference reports, books, and the AREA annual reports (Table 83).

The impact of research on production has been observed, in particular, in vegetables, fruits, and to a certain extent cereals. Very little is published on adoption of improved technologies by farmers.

For more efficient and effective research, a modified monitoring and evaluation system should be developed and adopted by AREA in order to make research activities more relevant and of higher quality to serve development purposes. This system should be an integrated part of the research planning and implementation process and should include periodic recording, analysis, reporting, and storage of data to be used for management purposes and post and impact evaluation studies on the adoption and effect of improved technologies on production.

Information Management

Information needs for research institutions could be classified in the following categories:

1. scientific and technical information where libraries and documentation centers deal with this type of information to assist scientists in their research activities;
2. administrative information, which covers file keeping, correspondence, human resources, etc.;
3. financial information;

4. technical information on research activities;
5. research program management information.

Table 83: Output of AREA Research

Output	North Yemen	South Yemen
New genetic materials	13 cereals; 15 vegetables; 10 fruits; 2 industrial crops; 1 legume	1 cereal; 2 industrial crops; 3 vegetables; 1 fruit
Chemical technology	3 cereals; 1 industrial crop; 1 vegetable; 1 livestock	1 cereal; 3 vegetables
Mechanical technology	1 fruit; 1 forestry; 1 livestock	-
New cultural practices	3 cereal; 1 industrial crop; 6 vegetables; 5 fruits	1 cereal; 2 vegetables; 1 fruits
Journal articles	25	26
research reports	105	56
Conference papers	100	6
Published books	10	-
Recently published annual report for the year	1989	1989

The first category was dealt with earlier under central support services in the physical resources section, where it was recommended that a national agricultural library and documentation center be established.

Administrative and financial information are managed according to government procedures and regulations. However, use of modern information technology will assist research managers in dealing more efficiently with these types of information.

Technical information on research activities will assist researchers in monitoring, evaluating, and executing research activities.

Lack of information on research program management can be a major impediment to effective management of research programs. Research managers need to know exactly what experiments their researchers are doing, with which facilities, and at what costs. Without this type of information, research managers cannot perform, or improve, essential functions such as planning, programming, coordinating, monitoring, and evaluating agricultural research activities.

For improving the availability of technical information on research activities and research program management to researchers, research managers, and decisionmakers, modern information technology could be used successfully.

AREA has to be concerned with improving research-program management information by gathering diverse information to help improve planning, programming, coordinating, monitoring and evaluation of its research program. The product of this information-gathering exercise is called a management information system. It puts the various types of information required for research management into one system. This system relates budgets and personnel and other information to research activities.

Recommendations on Research Program Management

1. AREA should strengthen the integration of the MDRTs in South Yemen with national commodity coordinators in North Yemen and continue developing a unified system for implementing research programs by multidisciplinary teams, especially for commodity improvement, as well as for implementing research activities across regional research stations and research centers within AREA (intra-institutional) and between AREA and other institutions in and outside the country.
2. AREA should increase the operational budget to allow for funding of more on-farm trials to test and validate technologies and to conduct joint trials with extension.
3. An improved monitoring and evaluation system should be developed to monitor and evaluate research activities to make them more relevant and of higher quality to serve development processes. This system should be an integral part of the research planning and implementation process and should include efficient periodic recording, analysis, reporting, and storage of data to be used for research management purposes.
4. An improved information-technology system should be developed to improve management of research-program information and management of technical information on research activities.

Summary report of the National Seminar on the Agricultural Research System in the Republic of Yemen, Southern Upland Regional Research Station, Taiz, Yemen, 13-15 September 1992.

Introduction: The workshop was organized as part of the finalization of the review of the NARS in Yemen. The review was finalized in a draft form in April 1992 and submitted to the government in June 1992. The draft was a product of the national team, with technical backstopping from AOAD and ISNAR.

Organizers: AREA, AOAD, and ISNAR.

- Participants:** 1. National representatives from MAWR (Deputy Minister for Plant and Animal Production, Department of Planning, and Department of Plant Production), MHESR (The Deputy Minister), MPD (Aden office: Director of the Department of Agriculture Production), University of Sana'a (Dean of Agriculture, and senior lecturer), University of Aden (Associate Dean of Agriculture and two senior lecturers), AREA (Deputy Director for Research, Deputy Director for Extension, three Heads of Departments in the Headquarters, and five Directors of Stations and Centers), and RDAs and RDPs (Director General of Southern Uplands Regional Projects, Director General of Tihama Development Authority, and Northern Upland Development Authority.)
2. The national study team.
 3. Representatives of AOAD and ISNAR.

Language: Arabic

Work Program: The workshop was divided into five sessions. Each session was headed by a senior member of the participants and assisted by a secretary, who collected comments and compiled them in a report presented in the last session. Participants were requested to present comments in written form for documentation and further use in writing the final review.

The review document was distributed ten days prior to the date of the workshop to enable participants to read it beforehand.

The opening ceremony commenced on the 13th of September at 10:00 a.m. The welcome speech was given by Dr. Abdel Wahid Mukred, Director General of AREA, who gave a brief explanation of the background of the study, the methodology, and interpretation of the data.

Dr. Mukred stressed the importance of the review in the overall compilation of information and background database which will be used in further research planning and priority setting.

It was emphasized that everybody should actively participate in the discussions throughout the workshop. Success was wished to everybody.

The AOAD speech was presented by Mr. Ismail Al Mutawakel, Regional Director of AOAD Office in Sana'a. In his speech Mr. Al Mutawakel gave a brief account of the importance of the agriculture sector and the role of research in solving production problems. The participation of AOAD as implementing agency was highlighted and the outcome of the study was positively assessed.

ISNAR's representative, Dr. Ghazi Hariri, highlighted in his speech the importance of the review in providing information to interested parties locally and internationally.

In his speech, Dr. Hariri explained the misunderstanding and the communication problems which delayed the presentation of the draft review, but nevertheless expressed his satisfaction in finalizing the draft, and the organization of the workshop. Brief account of the remaining work to be done before the review is finally approved was elaborated. Dr. Hariri wished the workshop success.

The speech of Dr. Ahmed Ali Mughel, the Vice-Minister and national study team leader, stressed the importance of the review and praised the efforts of the national team. Difficulties associated with data collection were explained. The national study team leader expressed his willingness to support further activities to finalize the study.

The technical sessions were organized to cover the major chapters of the study. These were:

- First Session, 13 September 1992: Discussion of the agriculture sector;
- Second Session, 14 September 1992: Discussion of ATMS;
- Third Session, 14 September 1992: Discussion of the NARS in Yemen;
- Fourth Session, 15 September 1992: Continuation of discussion of the NARS;
- Fifth Session, 16 September 1992: General discussion and comments.

A team was organized to summarize discussions and list conclusions and recommendations. These were presented in the closing ceremony.

Additional comments were added by the participants.

The national team was asked then to revise the draft review together with Dr. Hariri, ISNAR representative.

The draft review was finally revised by the national team and Dr. Hariri and a master copy in which all corrections and additions were made was handed over for final editing and publication.

It was agreed that inclusions not yet provided should be sent to ISNAR not later than the end of September 1992.

Conclusions and Recommendations

General

- The participants highly praised the draft review in terms of information provided and comprehensive nature of the chapters.
- The participants stressed the need to update data and use available government official statistics and documents.
- Updating the review and preparation the final version should be done by the national team with the guidance of AOAD and ISNAR.
- Data should be compiled for both parts of Yemen wherever possible.
- The integration of fisheries research into AREA's mandate was deemed an unpractical recommendation because two different ministries are involved.
- The review should be translated into Arabic and made available to everybody interested.

Chapter 1: Agriculture Sector

- The workshop evaluated positively the interpretation of data in this chapter, however more elaboration was recommended on issues related to policies and water resources and to explain trends in agricultural production.

Chapter 2: ATMS

- The importance of this chapter was highly praised. It was recommended that the compiled information should be analyzed for each part of Yemen to gain knowledge from the experience of each part of the country. It was suggested that a special local workshop be organized for a thorough analysis of the function of ATMS. However, information collected on ATMS should be considered a database to be reviewed annually and updated.

Chapter 3: Agricultural Research System

It is of vital importance that detailed information be provided on the history of research in the southern part of the country

- The evaluation of the experiences of both parts of the country must be documented for further development.
- The importance of a management information system was stressed. AREA was urged to utilize ISNAR's knowledge to improve its management capacities.
- The provision of additional operating funds to facilitate research and verification trials was brought forward in the discussions. It was agreed that budget allocations are not adequate for operating sound research activities, especially operating funds.

The workshop stressed the importance of adopting a salary scale similar to that of the universities to prevent migration of research staff to universities. Special emphasis was placed on the importance of an incentive system to encourage researchers to compete for better quality work and innovation.