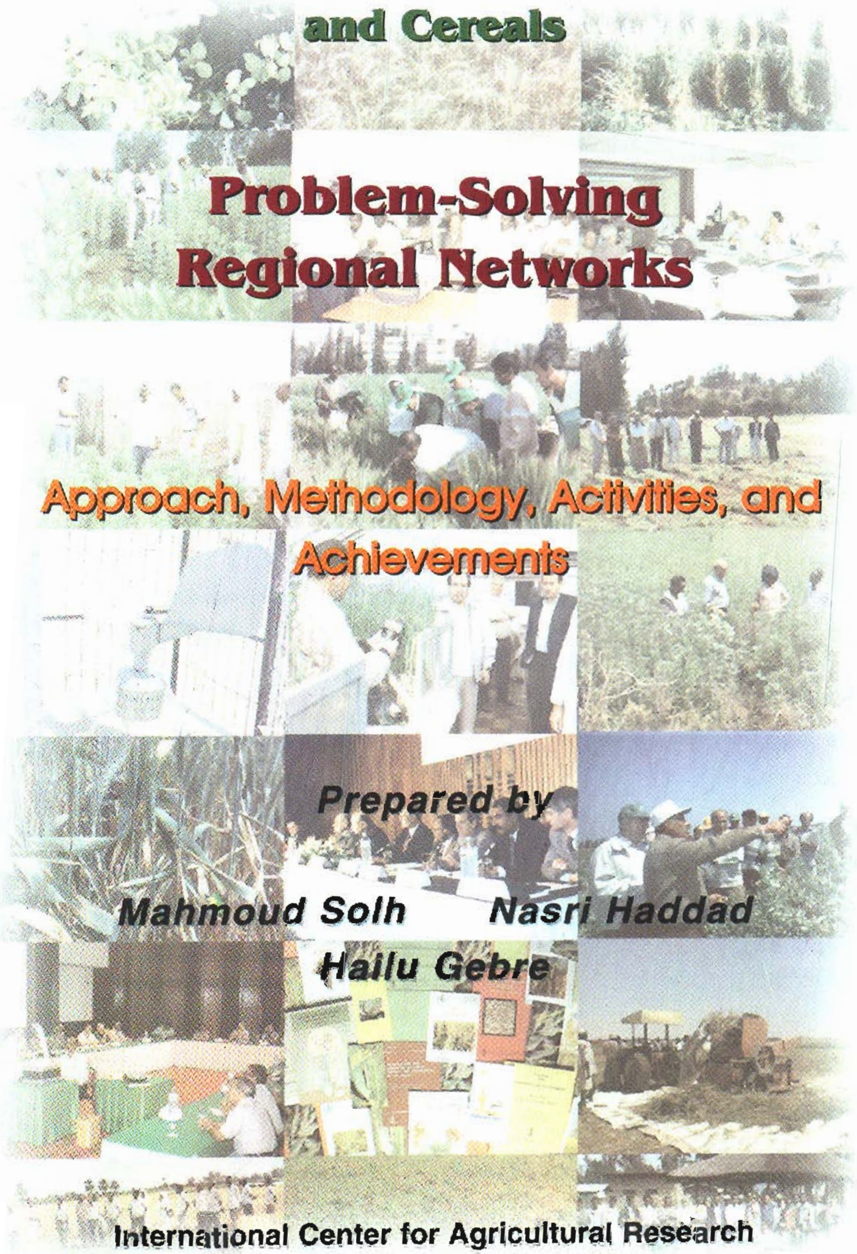
Nile Valley and Red Sea Regional Program on Cool-Season Food Legumes and Cereals



Problem-Solving Regional Networks

Approach, Methodology, Activities, and Achievements

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FOREWORD

The Nile Valley and Red Sea Regional Program (NVRSRP) is an extension of the Nile Valley Regional Program (NVRP) which started as the Nile Valley Project (NVP) in 1979 to improve faba bean in Egypt and Sudan through regional cooperation among the National Agricultural Research Systems (NARS) of these countries; donors; and ICARDA. In 1985 Ethiopia became a member of the project, and in 1988, NVP was expanded to become the NVRP on cool-season food legumes and cereals. Socioeconomic research is also included in addition to natural-resource management, which was added to the Egyptian component in 1993.

Years after the development of NVRP, it became evident that more collaboration to address problems of common interest to the countries in the region was needed. Hence, the problem-solving Regional Networks Project emerged to strengthen basic and applied research on these problems through complementary research, and was initiated as a major component of NVRSRP in 1995, at which time, Yemen also joined the Program.

The problem-solving Regional Networks Project, which is supported by the Netherlands Government, dwells on a multidisciplinary and multi-institutional approach for efficient utilization of expertise, human resources, and infrastructure in the member countries and ICARDA to address specific problems arising from biotic and abiotic constraints which may have enormous effects on the production of cool-season food legumes and cereals. The outcome of the research, which is directed towards finding solutions to overcome the damage caused by these stresses and bridge gaps in scientific knowledge, feeds into the technology transfer stream of the overall project, NVRSRP. Each network is headed by a lead country based on its comparative advantage with respect to the expertise of its national scientists in that area.

With the kind financial support of the Netherlands Government and the dedicated work of the scientists of the NARS of Egypt, Ethiopia, Sudan and Yemen, intensive work within the few years of the project's life has resulted in promising results. With the anticipated start of a new phase, it is hoped that cooperation within the project will result in further achievements for the welfare of the people of the region.

Prof. Dr. Adel El-Beltagy
Director General, ICARDA

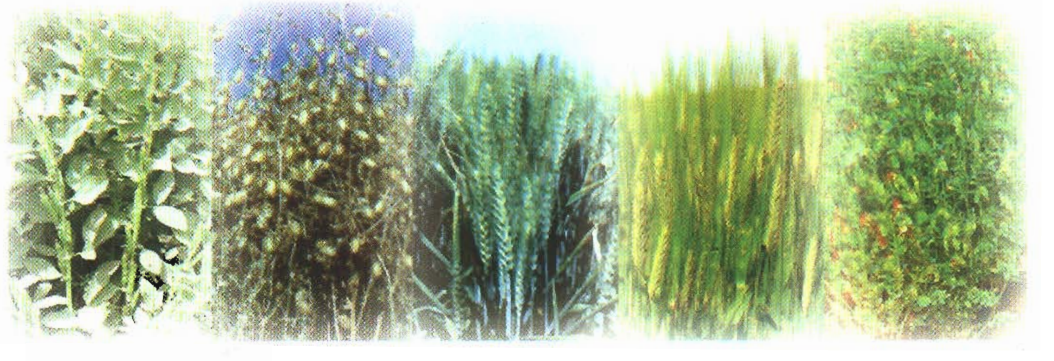
Nile Valley and Red Sea Regional Program on Cool-Season Food Legumes and Cereals

Problem-Solving Regional Networks

Background

Importance of the Crops

Winter cereals (wheat and barley) and cool-season food legumes (faba bean, chickpea and lentil) are among the most important food crops in the three Nile Valley countries—Egypt, Ethiopia and Sudan—and in the Republic of Yemen. They provide a major part of the daily diet of the population. In all four countries, cereals provide a large component of the diet; in Egypt and Yemen, wheat is the main cereal consumed; in Ethiopia, barley is also an important food, especially among the poorest communities. Pulses are an important source of protein, especially in Ethiopia where they provide 21% of the daily protein consumption. Faba bean (dry broad bean) is the most important pulse, representing 80% of the pulses produced in Egypt and 36% in Ethiopia, with lentil, chickpea and dry pea representing a further 30%.



Cropped Area

In the four countries combined, cereals are grown on more than 3 million ha, while food legumes are grown on 0.8 million ha. The production of these crops, however, is not adequate to satisfy the demand of a total population of 180 million, which is growing at an average rate of 2.5% per year. As a result, substantial imports are made every year to meet the deficits.

Crop Yield

Crop yields under farmers' conditions are usually low compared to their potential yields and fluctuate considerably from season to season. This is mainly due to variability in rainfall, both within and between years, and the susceptibility of the cultivated landraces and cultivars to diseases (such as rusts, wilt, root rots, chocolate spot and viruses), insect pests (such as aphids), and heat and drought stresses.

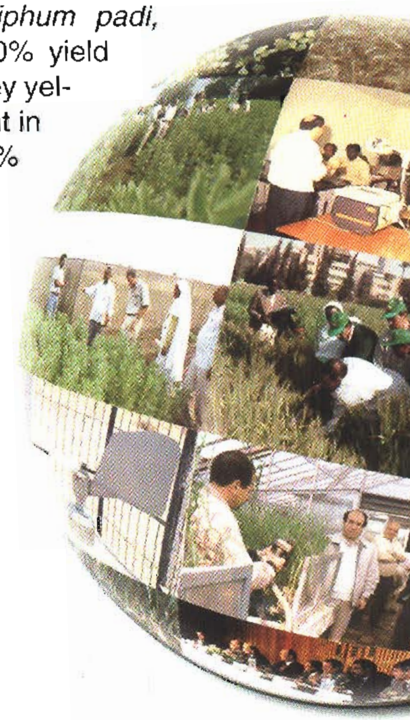
Biotic Stresses

The most damaging diseases are rusts in wheat; wilt, root rots and chocolate spot in cool-season food legumes; and various viruses in legumes, wheat and barley.

Leaf and stem rusts of wheat are economically important in all four countries, causing considerable yield losses in epidemic years. Yellow rust is very serious in the cool highlands of Ethiopia and Yemen and is also growing in importance in Egypt.

Wilt, root rot and chocolate spot diseases are major limiting factors in the production of faba bean, chickpea and lentil in all the Nile Valley countries. These diseases may cause up to 100% yield loss under heavy infestation depending on relative humidity, soil moisture and soil temperature.

Aphids are the most serious insect pests in both winter cereals and cool-season food legumes. Besides their direct damage, they transmit devastating virus diseases. The cereal aphids *Rhopalosiphum padi, Schizaphis graminum* and *R. maidis* cause up to 30% yield losses in wheat. These aphids are also vectors of barley yellow dwarf virus (BYDV) which is economically important in both Egypt and Ethiopia and may cause up to 100% yield loss. The legume aphids *Aphis craccivora, A. fabae* and *Acyrthosiphon pisum* are major insect pests in the Nile Valley countries. Yield loss due to aphids has been observed to reach 100% in faba bean in Sudan and Egypt, 50% in field pea and 25% in lentil in Ethiopia. *Aphis craccivora* is a vector of faba bean necrotic yellows virus (FBNYV) which adversely affects the production of faba bean. Ever since the epidemic in the 1991/92 growing season, faba bean production in Egypt has decreased considerably. This disease is a potential danger to Sudan, Ethiopia and Yemen.



Abiotic Stresses

Abiotic stresses such as heat, drought and moisture stress significantly contribute to the fluctuation of crop yields from season to season in the Nile Valley countries and Yemen.

Water is a primary limiting factor to agricultural production in Egypt, Sudan and the lowlands in Yemen. Agriculture in both Egypt and Sudan depends on the extensive use of irrigation from the River Nile. Unfortunately, with the increase in population and the expansion of agricultural area, particularly in Egypt, water resources are facing additional pressures for reallocation and more efficient utilization.

Rainfed barley production in Ethiopia, Yemen and Egypt is constrained by recurrent droughts resulting in yield fluctuation from season to season.

High temperature is a limiting factor to wheat production in Sudan, Upper Egypt and the lowlands of Yemen.

Socioeconomic Considerations

Socioeconomic considerations are important in the generation and transfer of appropriate technology to farmers. Marketing and institutional factors play an important role in the production stability of major food crops. Gender issues influence the transfer and adoption of technologies.

Informal Networks

Since the establishment of the Nile Valley Project (NVP) in 1979, unstructured networking was taking place between and amongst the NARS of the participating countries at that time, Egypt and Sudan. The same continued when Ethiopia joined in 1985 and later when NVP was expanded in 1988 to become the Nile Valley Regional Program (NVRP). Informal networks were created for sharing improved germplasm and for disseminating information through study visits, training courses and traveling workshops. NVRP facilitated contact of the NARS within and between participating countries to benefit from expertise developed in individual countries, ICARDA and other centers of excellence elsewhere in the world. It also strengthened coordination of research and networking at national and regional levels among the partners in the Program and beyond to utilize the limited human and physical resources available to the national programs more effectively. The mutual benefits that accrued from this informal activity justified the creation of a more structured approach to networking.

The Regional Networks Project

In September 1995, the Regional Networks Project with six networks was established to find solutions to the major biotic and abiotic stresses facing the five cool-season cereal and food legume crops. Initially, Egypt, Ethiopia and Sudan were involved, and Yemen joined later.

The six networks are:

- Wheat rusts: sources of primary inoculum of stem and leaf rusts, their pathways and sources of resistance;
- Management of wilt and root-rot diseases of cool-season food legumes;
- Integrated control of aphids and major virus diseases in cool-season food legumes and cereals;
- Thermo-tolerance in wheat and maintenance of yield stability in hot environments;
- Drought in barley and water-use efficiency in wheat; and
- Socioeconomic studies.

The Networks Project covers key aspects of cool-season cereals and food legumes, including wheat, barley, faba bean, chickpea and lentil.

Countries Involved in the Project

The project is established under the ICARDA Nile Valley and Red Sea Regional Program (NVRSRP) and covers four countries, namely, Egypt, Ethiopia, Sudan and Yemen. It is coordinated from ICARDA Cairo Office, Egypt.

Donor

The project is funded by the Government of the Netherlands for a duration of three years which started in September 1995 with a total budget of US$2,666,000.

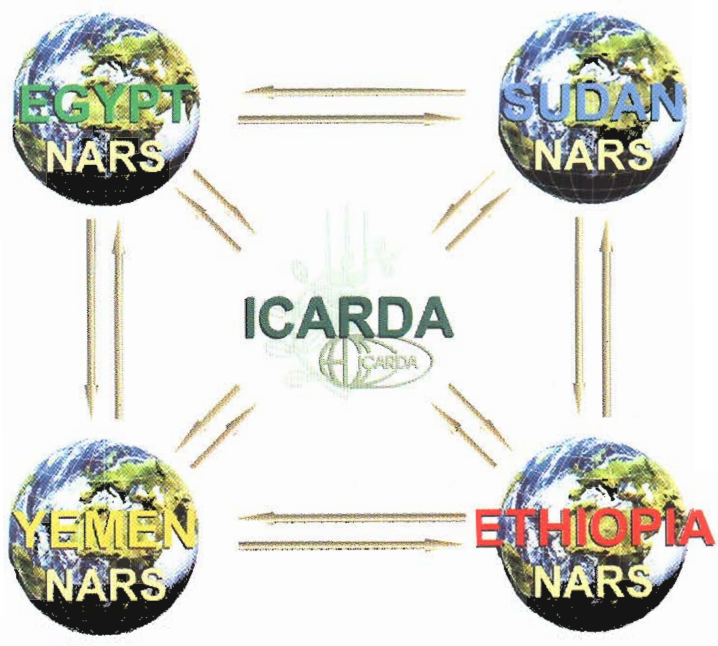
Objective

The overall aim of the project is to develop solutions to major problems of common interest facing food legume and cereal production in Egypt, Ethiopia, Sudan and Yemen and to ensure yield stability of these crops under adverse conditions by complementing research efforts in the region using networks.

The project aims to identify the main reasons for low and unstable yields of the five crops, the major factors that enhance tolerance to the effect of the biotic and abiotic stresses and sources of genetic resistance to these stresses. For these thrusts, attention is also given to building the institutional capacity and establishment of multidisciplinary teams of scientists capable of addressing these serious problems.

Methodology

The Networks Project is implemented through the Nile Valley and Red Sea Regional Program (NVRSRP) of ICARDA in collaboration with the National Agricultural Research Systems (NARS) of Egypt, Ethiopia, Sudan and Yemen. Research is jointly planned but conducted and reported by national scientists. Expertise at the Agricultural Research Center (ARC), Egypt; the Institute of Agricultural Research (IAR), Ethiopia; the Agricultural Research Corporation (ARC), Sudan; the Agricultural Research and Extension Authority (AREA), Yemen; as well as other national institutes in these countries is enhanced by training to obtain more qualified research manpower. Wherever necessary, the program aims, through ICARDA, at linking the national programs with centers of advanced research.



Strategy for Implementation

The main strategy adopted for the implementation of the problem-solving networks is:

- Enhancing self-reliance in the national programs in basic and applied research through capable leadership, coordination, program planning and execution.
- Enhancing cooperation among the scientists from Egypt, Ethiopia, Sudan, Yemen and ICARDA through exchange of technical know-how and germplasm in solving problems of common interest.
- Complementing research efforts to avoid duplication and make better use of the limited human and physical resources available to the national programs.

Program Coordination

The network programs rely on the part-time efforts of individual national scientists to implement activities according to a pre-set workplan and budget. Junior support staff also contribute to the project. Incentives for national scientists include provision of research equipment and facilities and logistic support; opportunities for professional enhancement through training and participation in workshops and conferences; professional recognition by fellow scientists and administrators through publications and reviews; and honoraria, if applicable.

Research plans are developed in multidisciplinary sessions among national scientists under the leadership of one lead scientist who also serves as the country Contact Scientist (CS) for that network. Finalization of the network activity occurs at the Regional Coordination Meeting in which country proposals are discussed in group meetings of the CSs convened by the Network Coordinator (NC). A Coordinator of the Regional Networks (CRN) is appointed to coordinate and manage all the networks in cooperation with their respective technical NC.

The **Regional Coordination Meeting** is attended by two senior scientists from each country, the NCs, CSs, CRN, the NVRSRP Regional Coordinator and relevant ICARDA scientists. The proposed workplans and training programs are reviewed by the **Regional Management Committee** and forwarded to the NVRSRP **Steering Committee** for final approval.

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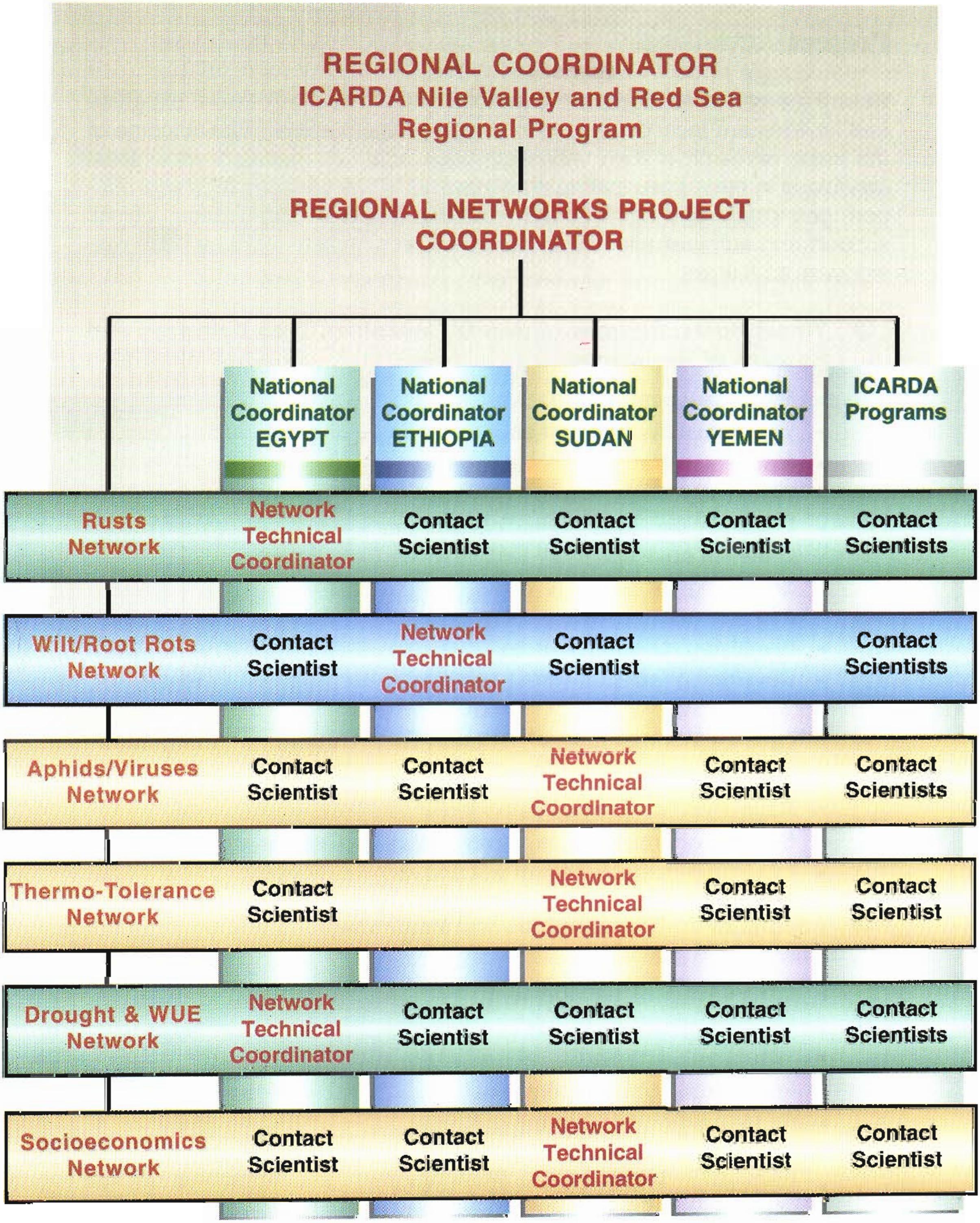
PROGRAM COORDINATION/ MANAGEMENT

Activities and Action	
Review Results and Develop Workplan and Budget at the National Level	**National Coordination Meeting** **National Management Committee Meeting** EGYPT + ICARDA ETHIOPIA + ICARDA SUDAN + ICARDA YEMEN + ICARDA
Review Results and Develop Workplan and Budget at the Regional Level	**Regional Coordination Meeting** **Regional Management Committee Meeting** EGYPT ETHIOPIA SUDAN YEMEN ICARDA
- Evaluate Program - Put Strategies - Approve Workplan and Budget	**Steering Committee Meeting** National Programs ICARDA Donor
Implementation	National Programs Institutions and Scientists with ICARDA Backstopping

The proceedings of the Regional Coordination Meeting are published in the form of an annual Workplan and Budget and an Annual Report of the Networks. These include, respectively, the details of the workplan and approved budget for the coming season and the highlights of research of the preceding year.

Monitoring of the program activities is done by the Network Coordinators with support from the Coordinator of the Regional Networks and technical backstopping of ICARDA scientists and the NVRSRP Regional Coordinator. Scientific missions visit the research work during the season and get feedback for future planning. An independent review mission will also be organized to evaluate the effectiveness of the project.

The NVRSRP Steering Committee Meeting is held annually to evaluate the progress and achievements towards the overall objectives of the NVRSRP, assess budget utilization, set the future strategy and decide on action for financing.



Networks Project Structure

Project Activities

Basic research is conducted in one country (lead country) where expertise and facilities are most developed in certain problem areas. The outcome of the basic research is then verified through adaptive research under local conditions in other participating countries. ICARDA provides technical support, germplasm and training, and facilitates research coordination, logistic support and administration. The major activities implemented by each network are as follows:

Wheat Rusts: Sources of Primary Inoculum, Their Pathways and Sources of Resistance

- Regional wheat rusts trap nurseries
- Wheat rust disease nurseries
- Mechanical trapping of rust spores
- Wheat rust disease nurseries
- Physiological race identification and virulence analysis
- Searching for alternate hosts of stem and leaf rusts
- Identifying resistant sources
- Developing resistant wheat cultivars

Rust

Integrated Management of Wilt and Root Rots in Food Legumes

- Surveying of major organisms causing wilt and root rots
- Race identification and pathogen variability in Fusarium wilt
- Screening for resistance to wilt and root-rot diseases
- Integrated management of wilt and root-rot diseases

Integrated Control of Aphids and Major Virus Diseases

- Integrated pest management
- Host resistance to aphids
- Wheat aphid nursery
- Faba bean aphid nursery
- Biological control of cereal aphids
- Virus disease survey
- Evaluation of wheat for barley yellow dwarf virus (BYDV) resistance

Aphids

- Evaluation of faba bean for resistance to bean yellow mosaic virus (BYMV) and faba bean necrotic yellows virus (FBNYV)
- Controlling FBNYV by cultural practices
- Developing resistant crop cultivars

Thermo-Tolerance in Wheat and Maintenance of Yield Stability in Hot Environments

- Development of heat-tolerant wheat populations
- Regional wheat screening nursery for heat tolerance
- Advanced regional wheat yield trial for heat tolerance

Heat

Drought

Drought in Barley and Water-Use Efficiency in Wheat

- Regional barley screening nursery for drought tolerance
- Regional barley yield trial for drought tolerance
- Development of drought-tolerant wheat populations
- Regional wheat screening nursery for moisture stress
- Wheat yield trial for moisture stress
- Water-use efficiency under reduced irrigation

Socioeconomic Studies

- Diagnostic studies
- Adoption of improved technology
- Assessment of technology impact
- Analysis of policy changes
- Role of women in agriculture

Research Achievements

The following are highlights of the achievements of the six networks.

- **Wheat Rusts (Stem, Leaf and Yellow Rusts): Sources of Primary Inoculum of Stem and Leaf Rusts of Wheat, Their Pathways and Sources of Resistance**

  - Nineteen stem rust and 28 leaf rust races were identified in the four countries and their frequency of occurrence in the region was recorded.

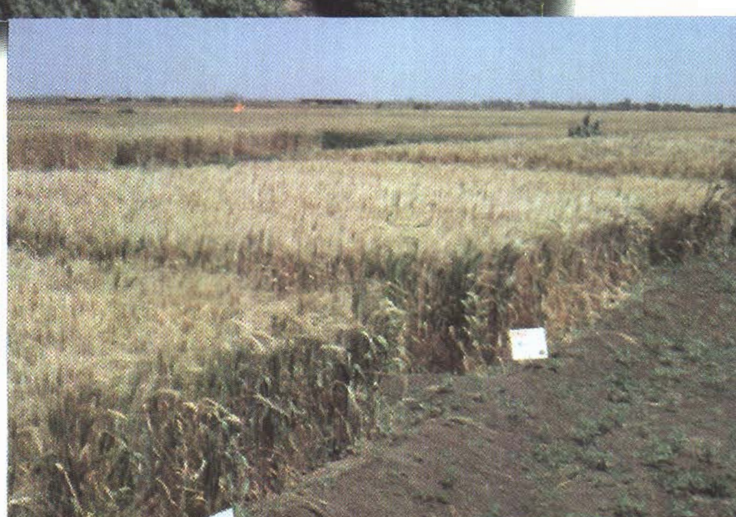
  - The performance of leaf and stem rust isogenic lines was tested and effective resistant genes for each country and the region were identified as follows:

Egypt:	*Lr's 21, 1, 22b, 18* and *26* *Sr's* Gt^+, *30, 7b, 26* and *8a*
Ethiopia:	*Lr's 1, 11, 21, 3Ka* and *17* *Sr's* Gt^+,*5, 30, 9e*, and *7b*
Sudan:	*Lr's 24, 26, 9, 17, 21* and *30* *Sr's 29, 5, 7b, 8a*, and Gt^+
Yemen:	*Lr's 9, 21, 17, 30, 3Ka* and *23* *Sr's 7b,* Gt^+,*5, 8a* and *9e*
Region:	*Lr's 21, 17, 3Ka, 30, 11* and *21* *Sr's* Gt^+, *7b, 5, 8a* and *30*

Resistance to rust in wheat

- These genes are now being incorporated into the high-yielding but susceptible cultivars in each country. A breeding program for this purpose has been started in all four countries to develop high-yielding, adapted, resistant cultivars.

- Five commercial wheat cultivars and advanced lines were found to be resistant to leaf rust in Egypt, 16 in Ethiopia, 18 in Sudan, and 25 in Yemen. With respect to stem rust, 15 cultivars performed well in the region. Nine cultivars showed good levels of resistance to both leaf and stem rusts in the region.



Promising wheat germplasm with resistance to biotic stresses

Location of disease trap nurseries and rust spore traps

- Eleven volumetric Burkard spore traps are currently in operation in the Nile Valley and Red Sea countries: four in Egypt, four in Ethiopia, one in Sudan, and two in Yemen. The results showed the following:

  - Spores were trapped throughout the year, except in September for stem rust and June–July for leaf rust in Sudan.

  - It has been concluded that leaf rust inoculum in Egypt is exogenic and its pathway is from the north to the south, whereas the inoculum in Ethiopia is endogenic. In Sudan, it also seems that the primary inoculum comes from outside the country, possibly from Yemen, given the presence of the spores all year round, or from other African neighboring countries.

  - For stem rust, it appears that the inoculum in Ethiopia and Yemen is present all year round due to the two-cycle cropping system. In Egypt, it may come from the north or from the south depending on wind direction. The question on primary inoculum needs further investigation.

  - Rust spores were found throughout the year, and in whatever quantities they occur they can be a source of inoculum to initiate infection.

  - A disease and trap nursery for the Yellow Rust Sub-Network was established in 1996. The nursery was organized in Ethiopia and distributed to Yemen, Egypt and ICARDA/Aleppo.

Management of Wilt and Root-Rot Diseases of Cool-Season Food Legumes

Survey of Root Diseases

- The most common pathogen in faba bean fields in the three countries was *Fusarium solani* which causes black root rot. *Fusarium oxysporum*, the causal agent of faba bean wilt, although common, was of secondary importance.

- *Fusarium oxysporum* f. sp. *lentis*, which causes lentil vascular wilt was the most important and prevalent pathogen of lentil in all the three countries.

Screening lentil for wilt and root-rot diseases

- *Fusarium oxysporum* f. sp. *ciceri* that causes chickpea vascular wilt was the predominant pathogen in chickpea in Egypt, Ethiopia and Sudan.

- *Rhizoctonia bataticola*, the causal agent of dry root rot, was also a major pathogen in chickpea fields in Ethiopia and Sudan, whereas *Sclerotinia sclerotiorum* which causes stem rot, was an important pathogen on chickpea in Egypt.

Race Identification

- Three races of *Fusarium oxysporum* of chickpea were found in Sudan. In Egypt, pathogenic variability was apparent within the collected isolates. This variability will be confirmed in the future by using standard differential sets.

- Lentil *Fusarium* isolates collected from Egypt and Ethiopia did not suggest the occurrence of pathogenic races of the pathogen in these countries. This will be confirmed by the use of a differential set to be developed by Ethiopia.

- From race identification studies, races of *Fusarium oxysporum* on chickpea have been identified in Sudan for which further screening and inheritance studies will be conducted.

Germplasm Evaluation for Resistance

- Several lines of faba bean, chickpea and lentil with varying levels of resistance to *Fusarium* sp. and black root rot have been identified in sick-plots in Egypt, Ethiopia and Sudan. These sources of resistance have been pooled to form regional nurseries to be exchanged between the network-participating countries. Lines with confirmed resistance will be further evaluated for their adaptation and yield potential and will be used in the hybridization program.

Resistance to wilt/root rots in chickpea

Integrated Disease Management

- Some disease control measures have been tested and identified to be effective against wilt and root-rot diseases of faba bean, chickpea and lentil. Among these are the following:

  - Resistant cultivars have been identified against the wilt pathogens.

  - Frequent irrigation reduces wilt and dry root-rot disease incidence.

  - Delayed sowing reduces wilt and root-rot incidence in Sudan.

  - Seed treatment with bio-control agents under controlled conditions showed potential in controlling root rots of faba bean and chickpea in Ethiopia, while seed dressing with fungicides showed good potential in controlling wilt and root rots of chickpea in Sudan.

- These disease control components and others will be combined in packages and tested in integrated disease management trials, both on-station and on-farm, to evaluate their combined effects.

Resistance to *Botrytis fabae*

❑ Integrated Control of Aphids and Major Virus Diseases in Cool-Season Food Legumes and Cereals

Survey of Aphids and Viruses

- Surveys in Egypt and Sudan have confirmed the importance and relative frequency of cereal aphids (*Rhopalosiphum padi, Schizaphis graminum* and *R. maidis*), legume aphids (*Aphis craccivora* and *A. fabae*) and viruses, such as barley yellow dwarf virus (BYDV) on cereals, and faba bean necrotic yellows virus (FBNYV) and bean yellow mosaic virus (BYMV) on faba bean.

- Surveys in Yemen have shown that the Russian wheat aphid (RWA) is serious on wheat and barley, whereas the pea and cowpea aphids are dominant on faba bean and dry pea. Common viruses detected on faba bean and lentil were alfalfa mosaic virus (AMV), faba bean necrotic yellows virus (FBNYV), bean leaf roll virus (BLRV) and chickpea chlorotic dwarf virus (CCDV). In Ethiopia, surveys showed that FBNYV is widely spread in faba bean and BYDV in wheat and barley. The predominant serotype of BYDV was PAV followed by SGV. Some of the surveys are conducted as a joint activity among the network countries.

Faba bean virus-infected plants

Survey of legume viruses

Safe Chemicals

- Promising safe chemicals (jojoba oil and surfactant Sisi 6) for the control of cereal aphids have been identified. These chemicals are inexpensive, non-phytotoxic and do not pollute the environment. However, their stability needs to be improved as they are easily washed away by rain.

Aphid-Resistant Lines

- Two wheat lines (Bush/Amigo/T101xSakha 69 and Bush/Amigo/T101xSakha 61) resistant to *R. padi* aphids have been identified. Seeds are being multiplied for commercial release in Middle and Upper Egypt. Three faba bean landrace lines (Alfashn-2, Al-Hammam-10 and Ahnasia-4) gave promising results with respect to resistance to aphids for three successive years in Egypt. In Sudan, two faba bean cultivars, SM-L and Pakistani, also gave promising results in their resistance to aphids for three successive years. In Ethiopia, six barley landrace lines were found to be resistant to the RWA, while 20 lines of dry pea were tolerant to the pea aphid. Gaucho 70% WS and *neem* seed extract were effective in controlling the pea aphid.

Biological Control of Aphids

- Studies on mass rearing techniques of aphid parasitoids were conducted at the Agricultural Research Center (ARC), Egypt. A significant correlation between temperature and development time of the hymenopterous parasite *Aphilinus ascychis* was found. The best feeding materials for acquiring good longevity were bee honey and sucrose.

Virus Control

- Twenty-two genotypes of wheat and 12 genotypes of barley were found to be tolerant to BYDV in Egypt. Out of 1500 genotypes of faba bean tested against FBNYV in the last three years, none was found tolerant. Faba bean necrotic yellows virus is causing serious losses on faba bean production in Egypt. Use of cultural practices such as roguing, optimal sowing date and chemical control decreased the incidence of the virus.

Integrated Control of FBNYV

Sowing Date	Roguing	% Infection	
		(+) Insecticide Spray	(-) Insecticide Spray
November 1	Yes	1.8	12.5
	No	15.0	24.7
November 20	Yes	9.5	24.1
	No	22.7	37.8
December 10	Yes	20.7	37.8
	No	37.9	52.2

- The incorporation of resistant genes to the cultivated wheat, barley and faba bean cultivars by crossing will start in order to develop adapted resistant cultivars to the serious virus diseases.

Thermo-Tolerance in Wheat and Maintenance of Yield Stability in Hot Environments

- Research on thermo-tolerance in wheat was initiated in 1993 within ICARDA's Nile Valley Regional Program. It was strengthened with the establishment of the network within the Regional Networks Project in 1995. Research has emphasized the development of heat-tolerant germplasm and morpho-physiological studies of the plant associated with heat tolerance. Characterization of the environments of representative sites in Egypt, Sudan and Yemen has also been completed.

- To broaden the genetic base for heat tolerance, 350 crosses were made in order to accumulate desirable genes from adapted high-yielding genotypes and others known for their heat tolerance. Segregating populations were distributed to the participating countries for selection.

- A screening nursery consisting of about 100 entries contributed from the national programs' advanced lines and released cultivars was established. It was grown in eight locations along the Nile Valley in Upper Egypt, and in Sudan and Yemen. Eighteen entries in the 1995/96 growing season and 29 entries in the 1996/97 growing season were selected from this nursery on the basis of their performance in the three countries. These entries will be further evaluated in the coming years for eventual inclusion into the national breeding programs.

- A search for traits associated with heat tolerance in wheat revealed that biomass, canopy cover at the 5-leaf stage, canopy temperature depression, number of heads per unit area, kernel weight and slightly late maturity were highly correlated with high yield under hot environments. These results also showed that good management and improved soil fertility might reduce the adverse effects of high temperature.

Drought in Barley and Water-Use Efficiency in Wheat

- In barley, 45 genotypes were screened for drought tolerance in rainfed areas in Egypt, Ethiopia and Yemen. Twenty genotypes proved to be drought tolerant and will be promoted to a regional drought tolerance barley yield trial. Six genotypes proved superior in grain yield under low rainfall conditions in Egypt, Yemen and Ethiopia.

- Fourteen promising wheat lines were selected from a screening nursery composed of 110 entries according to their performance in Egypt, Sudan and Yemen. They will be further evaluated under moisture-stress advanced yield trials.

- Moisture-stress advanced wheat yield trials, consisting of 24 genotypes selected from the screening nursery, were evaluated in eight locations: three in Upper Egypt, two in Sudan and two in Yemen. Seven genotypes proved to be tolerant to moisture stress. They will be further evaluated and eventually incorporated in the research work of the national programs.

- Early results indicated that reducing the number of irrigations improves water-use efficiency in wheat. Further investigation is necessary to assess the merit of these findings.

Socioeconomic Studies

- The network focuses on the diagnosis of crop production constraints, studies on adoption and impacts analysis of agricultural policy and gender issues. A unified research strategy was developed and implemented in the four countries, with respect to content and procedures. A uniform definition of parameters for measuring key concepts was adopted. Constraints to barley production in Ethiopia and Yemen that were identified in baseline studies are being addressed by breeders and agronomists. Constraints relating to water-use efficiency in faba bean were identified in adoption studies and have been incorporated into research activities in Egypt and Sudan. Constraints in wheat production relating to location differences in soil characters were identified through yield-gap analysis and are being incorporated into the research activities in Sudan. Major achievements include the following:

Diagnostic Baseline Studies

- Baseline studies in Ethiopia identified several different barley production systems; appropriate research strategies are needed to address the specific characteristics of each of these systems.

Adoption Studies

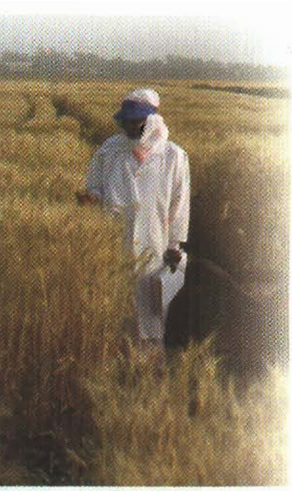
- Adoption studies revealed that farmers' adoption rates of the proposed technologies were moderate to high depending on the technology's composition. It was also evident that productivity is highly related with the level of technology adoption.

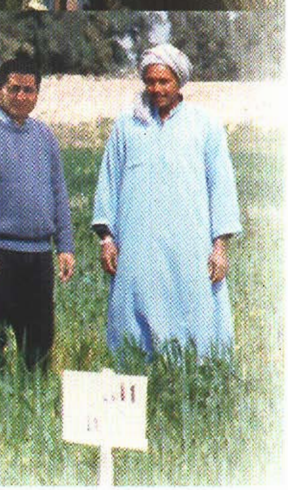
- The main constraints limiting farmers' adoption of the technologies are related to farmers' lack of access to inputs, which may result from the unavailability of the inputs themselves or to their costs which are too high for most farmers to afford. The constraints may also be related to socioeconomic factors such as the age and education of individual farmers.

- The performance of different technology components under alternative field conditions was studied and results were conveyed to the scientists concerned so that recommendations may be refined to suit the specific field conditions.

Impact Assessment

- Results of impact assessment studies showed that the proposed technologies have the potential to make a considerable contribution to the improvement of rural incomes and national food security.





The impact is largely a result of the yield gains realized, leading to higher farmers' income and higher national production of target crops, which in turn would reduce imports and lead to higher self-sufficiency rates.

Policy Analysis

- The institutional and policy framework under which farmers operate has a direct effect on the incentive structure which, among other factors, determines the level of technology use by farmers. The economies of the four countries are undergoing structural changes; the shift to open-market policies has resulted in higher production costs and higher crop prices as a result of the removal of subsidies and taxes, respectively. The results of the studies revealed that: (1) the proposed technologies are still economically efficient, and (2) there is a tendency towards more rational use of some inputs, especially chemicals, in Egypt.

Gender Analysis

- Gender issues are receiving more attention in the activities of the network. Gender was incorporated as an integral part in the analysis of the farming system. Baseline studies on the role of women in agriculture have been conducted, and have revealed that women play a considerable role in agricultural production, suggesting that research and technology transfer should take account of possible gender differentiation in specific agricultural activities. Women's access to information is inadequate, suggesting the need for appropriate extension strategies.

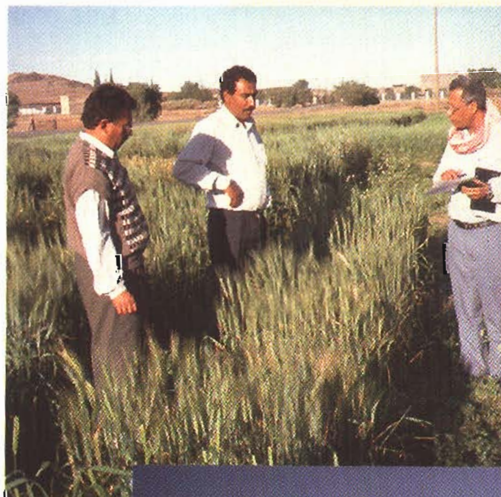
Yield-Gap Analysis

- Monitoring and evaluation of technology development and transfer have shown considerable yield variability between locations and between farmers within the same location. Yield-gap analysis attempts to identify and quantify the effect of factors causing this gap. Results of gap analysis of wheat in Sudan, for example, showed that in addition to the level of technology use, differences in soil characteristics and socioeconomic factors contribute to yield variability. The results of these studies provide feedback to the biological scientists in the development of appropriate technology with respect to tillage, irrigation regime and fertility management to suit different soil types, and to provide farmers with alternative crops to meet their needs.

Institutional Strengthening

The research activities in the various networks were implemented with regional complementarity in mind. Exchange of materials and results improve the efficiency of research. Essential field and laboratory equipment and facilities were made available which improved the research output. Human resource development through training, professional visits, meetings and conferences is a strong component of the Networks Project. Knowledge of researchers and technical assistants was upgraded with short training courses and workshops. Scientific visits were a good forum for exchange of experiences and served to enhance cooperation among regional scientists.

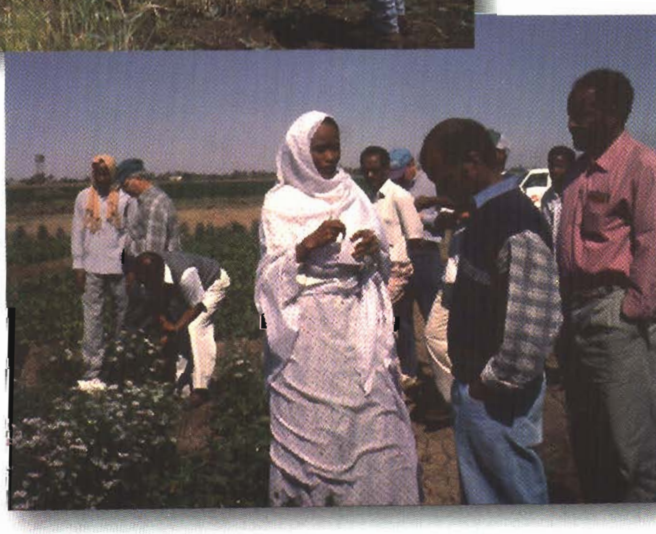
From 1995 to mid-1998, 121 trainees participated in short courses and training workshops, 31 scientists in professional visits, 29 in regional traveling workshops and 2 in joint field surveys. Ninety-two scientists attended the Regional Coordination Meetings in which research achievements and plans were discussed, and ten scientists participated in international conferences.



Ten technicians working in wheat rusts attended two short courses on Spore Traps/Cereals Disease Methodology, which were organized at the Agricultural Research Center (ARC), Egypt; 16 technicians participated in the Wilt/Root-Rot Diseases Course, 21 in two courses on Aphids/Viruses IPM and Rearing Techniques, and three in a course on Water-Use Efficiency, all organized by ICARDA. Eleven Egyptian scientists benefitted from an in-country course on Computer Use and 12 on Breeding Methods for Drought Resistance, also organized by ICARDA.

Training workshops on impact assessment and gender analysis were held in 1996 and 1998 with the participation of 17 socioeconomists from the four countries. M.Sc. degree training of two Sudanese scientists and a short course on gender analysis for one Sudanese scientist were completed and have considerably strengthened the socioeconomic research capabilities in Sudan.

A joint wheat rusts survey was conducted in Yemen during which yellow rust was identified as a major disease of wheat in the highlands. Joint surveys on food-legume viruses were also conducted in Yemen, Sudan and Ethiopia. Relevant ICARDA scientists participated in the joint surveys and traveling workshops. The surveys provided an opportunity for training national scientists.



Publications

Progress reports have been prepared and submitted to the donor every six months according to schedule. Annual workplan and budget, annual reports, workshop proceedings and specialized reports have been published. Several scientific papers were also presented at international meetings. A quarterly newsletter has just been established.

Phase II Proposal

A second phase of the Networks Project is essential in order to finalize the findings and achieve the overall objectives of the Project. A proposal has been prepared and submitted to the Netherlands Government for consideration for financial support.

Coordinators and Contact Scientists* Involved in Project Development and Implementation

ICARDA Regional Coordinators

Mahmoud Solh	Director of International Cooperation; Regional Coordinator (1990-1997), Nile Valley and Red Sea Regional Program (NVRSRP)
Nasri Haddad	Regional Coordinator, Nile Valley and Red Sea Regional Program (NVRSRP)
Hailu Gebre	Coordinator of the Regional Networks Project

Project National Coordinators

Egypt	Ethiopia	Sudan	Yemen	ICARDA
R. Abou El Enein	G. Gebeyehu	O. Ageeb	M. El-Ghouri	

Country Contact Scientists

Network	Network Coordinators / Lead Country	Egypt	Ethiopia	Sudan	Yemen	ICARDA
Wheat Rusts	Y.H. El-Daoudi, Egypt	Y.H. El-Daoudi	E. Bekele	M.M. Mahir	H.S. Bahamish	O. Mamluk/ H. Tobia-Rahme
Wilt/Root Rots	G. Bejiga, Ethiopia	N. Abou-Zeid	G. Bejiga	W.S. Suliman		W. Erskine/ C. Akem/ B. Baya'a
Aphids/Viruses	M.M. Hussein, Sudan	M. El-Hariri/ A.E. Aboul Ata	K. Ali	H. Kannan/ M.S. Hussein	H.S. Bahamish	K. Makkouk/ M. El-Bouhssini
Thermo-Tolerance	A. Elahmadi, Sudan	A. Abdel Shafi		A. Elahmadi	A. Sailan	O. Abdallah
Drought & WUE	M.G. Mosaad, Egypt	M.G. Mosaad	A. Assefa	A.A. Salih	A. Haider	S. Ceccarelli/ S. Grando/ H. Gebre
Socioeconomics	A.T. Ahmed, Sudan	A. El-Bilassi	H. Beyene	A.T. Ahmed	F. Al-Moflehi	R. Tutwiler

* In addition to some 100 scientists and several technical and support staff from the National Programs, ICARDA headquarters and Cairo Office.

About ICARDA

Established in 1977, the International Center for Agricultural Research in the Dry Areas (ICARDA) is governed by an independent Board of Trustees. Based at Aleppo, Syria, it is one of 16 centers supported by the Consultative Group on International Agricultural Research (CGIAR), which is an international group of representatives of donor agencies, eminent agricultural scientists, and administrators from developed and developing countries.

ICARDA's mission is to meet the challenge posed by a harsh, stressful, and variable environment in which the productivity of winter rainfed agricutural systems must be increased, but in a manner that is sustainable, and within the constraints of the natural-resource base.

The Center has a world responsibility for the improvement of barley, lentil, and faba bean, and a regional responsibility in West Asia and North Africa for the improvement of wheat, chickpea, forage and pasture crops—with emphasis on rangeland improvement and small ruminant management and nutrition—and of the associated farming systems.