

# ICARDA and Sudan

Ties that Bind



**International Center for  
Agricultural Research in the  
Dry Areas**

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**Cover:** Faba bean is an important component of the staple diet in Sudan. Collaborative research between ICARDA and Sudan has led to the release of new, large-seeded, high-yielding and disease-resistant varieties, which are significantly contributing to increased production of this crop.

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## Cooperation

**S**udan, together with Egypt, was at the core of ICARDA's first outreach program, begun in 1979, just two years after the Center's founding.

Since the establishment of the Nile Valley Project (NVP) in that year, ICARDA has worked with the Agricultural Research Corporation (ARC) in Sudan to identify and overcome farm-level production constraints. In collaboration with extension services, the Sudan–ICARDA project transfers to farmers productivity-enhancing technologies, focused on four important food crops: faba bean, lentil, chickpea, and wheat. The work has been targeted to increase the incomes of smallholder farmers and improve crop yield and quality. ICARDA has been the primary source of germplasm for evaluation and for enhancing breeding programs, and fostering human resource development through training.

Sudan reports success in its march toward self-sufficiency, thanks to progress in the agriculture sector. ICARDA believes that its research partnership with Sudan has contributed significantly to this success, through assistance in developing improved crop varieties and appropriate management technologies. These have resulted in increased yields and profits for poor farmers in the traditional growing areas. They have also led to the expansion of agriculture into neglected or previously uncultivated areas.



*An ICARDA researcher congratulates a training course participant.*

ICARDA's backstopping has played a substantial role in the development of improved cultivars released by ARC for different agro-ecological conditions. They include seven new cultivars of faba bean, eight of chickpea, three of lentil, and five of wheat. To cite a few examples, faba bean cultivar SM-L has large seeds with excellent cooking quality and is suitable for areas in the far north where temperatures are milder. Despite the difficulty of producing pure seed of faba bean due to a high probability of mixing, researchers have produced enough SM-L seed for further propagation. The same is true for Hudeiba 72, a medium-seeded faba bean recommended for parts of the north. Two other new faba bean cultivars, Basabeer and Hudeiba 93, tolerate water shortage and are also suitable for many areas in northern Sudan. El-Neilain, a high-yielding wheat variety, was released for warmer environments, whereas cultivar Wadi El Neil is assigned to the north due to its high potential in cooler climates. Imam, a new wheat cultivar named after the late Dr Adel Galil Ibrahim Imam, was released in 2002.

A full list of varieties released in Sudan since 1982 is given in Appendix 1.

## Food legumes

The Food Legume Improvement Program in Sudan endeavors to develop improved technologies and then transfers these to farmers to enhance productivity and yield stability, with due consideration to the sustainability of farming systems. ICARDA provides germplasm, technical backstopping, training, and collaborates with Sudan's national program scientists to develop research work plans.



*Food legumes are an important source of protein in the diets of the Sudanese.*

## Constraints overcome with improved technologies

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Faba bean, chickpea, and lentil are among the major sources of protein in the diets of the Sudanese. Together, these cool-season food legumes occupy about 75,000 ha, which stretches over 1000 km of the narrow strip of cultivable land along the Nile north of Khartoum. The area



*Farmers have adopted technology packages that have helped increase food production in Sudan.*

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contributes almost all of the cool-season legumes produced in the country. Because land holdings are small, farmers prefer high-value crops, such as legumes, and rely on family labor. Faba bean is the top cash crop in this zone. Like the other legumes, it improves soil fertility.

Untimely sowing, pests and weeds, and sub-optimal irrigation hinder faba bean production, while chickpea suffers from erratic soil moisture under the traditional flood-irrigation cultivation. Farmers use low-yielding, unimproved chickpea cultivars. Inadequate inputs and agronomic practices further reduce production. In cooperation with ICARDA, Sudan has developed technology packages for target farmer groups, as well as improved extension systems to deliver these packages to farmers. The packages are location-specific and meant to replace the blanket recommendations of the past, which were based solely on research carried out at experiment stations and took little account of farmers' expertise and on-farm conditions.

### Faba bean

An improved production package for faba bean (early sowing, frequent

irrigation, insect pest control, and proper weed control) was developed by the Sudan–ICARDA program and has been demonstrated to farmers for several years. In addition, faba bean has been introduced as a cash crop in North Dar Fur region in the far west, where yields are reasonably high (2.26–3.21 t/ha).



*A farmer weeds his crop of faba bean.*

An adoption study showed that:

- The different components of the package were adopted to varying degrees.
- Adoption rates for all components of the package have improved.
- Irrigation regime was the least adopted (18%) component.
- Sowing time and weed control were moderately adopted (66–71%).
- Adoption of the insect pest control component (46%) was below average.
- Productivity is highly related to adoption of the improved production package.
- Farmers are well aware of the recommended technologies and are convinced of the package's superiority over the traditional practices.

The major constraints reported by farmers were the unavailability of inputs, high cost of inputs, and lack of financial resources to buy inputs.

## Lentil

Collaborative research with ICARDA has promoted lentil production in northern Sudan where farmers grew little of the crop before. To avoid paying a multi-million-dollar import bill, the government encouraged collaborative on-farm research to demonstrate production potential, facilitated farmers' access to credit to purchase inputs, and offered guaranteed prices. As a result, in the period 1989-93, production area increased from 420 to 10,000 hectares, yields improved from 0.8 to 1.4

t/ha, and production increased from 340 to about 14,000 tonnes. This helped reduce lentil imports from over 9000 to about 700 tonnes. There was a setback, however, in the following two years, possibly due to bad weather, constraints in institutional support, and change in policy emphasis. For example, lentil is traditionally grown in the River Nile Governorate, particularly in the Rubatab area. Its productivity increased by 31% during the period 1990-1995 as a result of adoption of the technological package. Due to some adverse factors, however, productivity has been sharply declining (0.4–0.5 t/ha).

Research continues and hundreds of lentil accessions are being evaluated every year for adaptability and high yield. As a result, a new variety, named Nedi, was released in 1998. This variety achieved an average yield of 1.7 t/ha at Shendi and Hudeiba research stations.

### Chickpea

Sudan–ICARDA chickpea collaboration has made remarkable progress in research and technology transfer over the past 15 years, making use of germplasm provided by ICARDA and its sister center the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Plant improvement is based on selections—mostly from advanced breeding lines from ICARDA—for adaptation, high and stable yield, resistance to wilt/root-rot disease, earliness, and large seed size. Evaluations at Hudeiba and Shendi stations in 1983/84–1986/87 led to the release of the kabuli variety Shendi-1 (line ILC 1335) for use by farmers in northern Sudan. On-farm evaluation of chickpea lines at Rubarab, Wad Hamid, and Jebel Marra in 1990/91–1992/93 led to the release of line ILC 915 under the name Jebel Marra-1. Evaluation of large- and medium-seeded kabuli chickpea lines under farmers' conditions in the above mentioned locations in 1993/94 and 1994/95 led to the release of large-seeded lines FLIP 88-36C and FLIP 88-44C. On-station breeding at Hudeiba and Shendi resulted in many promising medium- and large-seeded genotypes with 50–100% higher grain yield than the checks (Shendi-1 and Jebel Marra-1). Atmor, Salawa, and Wad Hamid, which are resistant to wilt and root-rot diseases, were released in 1996; and Matama was released in 1998.

Apart from selection and breeding, researchers addressed major agronomic aspects of chickpea cultivation, including research into optimum sowing time, crop establishment, nutrition, and irrigation. Improved irrigation practices were developed. Some of the new cultivars are suitable for flood-irrigation, where farmers sow their crops on dates determined by the receding of unpredictable floods, making use of stored soil moisture.

Work to develop ascochyta-blight-resistant chickpea varieties that thrive in cool, wet winter conditions helped earn for ICARDA and ICRISAT the 2002 King Baudouin Award from the Consultative Group on International Agricultural Research (CGIAR).

### Dry peas

Collaboration on drypea was initiated in 1987. Two cultivars, Krema-1 and Ballet, were selected and released for cultivation in Sudan.

## Wheat and the struggle with weather and inputs

Traditionally grown in the north, wheat has recently expanded southwards, where land is more abundant and water is more easily supplied through gravity irrigation systems, as opposed to the small-pump irrigation in the north. However, winter temperatures increase greatly as one moves to the south, with its harsher environments. Wheat in the south suffered from high winter temperatures, for which the available cultivars were poorly adapted.



In collaboration with Sudan and other countries involved in the Nile Valley and Red Sea *Sudan could one day be self-sufficient in wheat, thanks to the development and adoption of improved varieties and production technologies.*

Regional Program, ICARDA has established a Thermo-Tolerance Network to enhance wheat productivity by improving its adaptation to high temperatures. The network's main approach is to exploit existing genetic diversity for this characteristic, by identifying simple and practical morphological and physiological traits that can be used as selection tools.

Evaluation studies led to the identification of several high-yielding cultivars adapted to heat stress, including Seri 82, Anza, El Neilain, Condor's/Baladi #18, Attila, and Pfau/Vee #5. The studies revealed traits, such as number of spikes per m<sup>2</sup>, grains per spike, kernel weight and plant height, useful for plant selection in severely heat-stressed environments.

Wheat is now an attractive crop in the short-winter zones south of Khartoum. It has few competitors for labor during the periods of peak demand and, in addition to its importance in generating cash, is a leading import-substitute crop at the national level.

There is good potential for further improvement. Wheat self-sufficiency, which increased from 13% in the mid 1980s to over 60% in 2002, is a realistic possibility for Sudan. Even in unfavorable environments, some farmers occasionally obtain yields of over 6.5 t/ha, while others consistently realize over 2 t/ha. With inputs and effective extension, the yield gap between low- and high-yielding localities could be narrowed further. ICARDA is assisting Sudan in an extensive program of on-farm verification trials and demonstrations of production technologies.

## **Adoption and economics of wheat**

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Wheat area and production in Sudan's largest wheat producing region, the Gezira, have been declining due to high costs of inputs and lack of finance available to farmers. The government's efforts are now directed toward expanding wheat production area in the River Nile and Northern Governorates, where climatic conditions are more favorable for wheat.

Adoption studies of wheat production technologies in River Nile Governorate revealed that the recommended package was attractive to farmers. However, the rate of adoption was modest due to lack of inputs and credit, and due to irrigation problems.

The economics of wheat production in central and northern Sudan were also examined, and it was found that sub-optimal use of inputs in central Sudan adversely affected wheat productivity and its comparative advantage. Wheat in northern Sudan was less competitive in the cropping pattern due to the weak financial capabilities of farmers, poor adoption of production packages, and soil problems (high-terrace soils). These hindered sustained wheat production. An enabling agricultural policy is needed, one that could motivate producers through the provision of essential inputs at the right time and at reasonable costs, reliable markets, and secure prices.

## **Regional cooperation to enhance self-sufficiency**

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At the regional level, ICARDA cooperates with Sudan through the Nile Valley and Red Sea Regional Program (NVRSRP), which encompasses Egypt, Eritrea, Ethiopia, Sudan, and Yemen. NVRSRP facilitates contact within and between the national agricultural research systems of the participating countries. It also strengthens coordination of research and networking among the program partners at the national and regional level, and beyond, to utilize more effectively the limited human and physical resources available to the national programs. Informal networks were created in 1988 for sharing improved germplasm and for disseminating information through study visits, training courses, and traveling workshops. The mutual benefits that accrued from this informal activity justified the creation of a more structured approach to networking.



*By pooling resources and prioritizing regional initiatives, national programs can make the most of limited resources.*

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In September 1995, the Regional Networks Project was formally established to find solutions to the major biotic and abiotic stresses facing the five cool-season cereal and food legume crops in the region.

The six networks are:

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

Sudan has a regional coordinating role in the networks devoted to aphids, thermo-tolerance, and socioeconomics.

Among the major achievements, Sudan has evaluated the performance of leaf and stem rust isogenic lines and effective resistant genes were identified, i.e., *Lr's* 24, 26, 9, 17, 21 and 30, *Sr's* 29, 5, 7b, 8a, and *Gt*<sup>+</sup>

Two faba bean cultivars, SM-L and Pakistani, were identified as tolerant to aphid infestation. The tolerance has been confirmed over several years.

Sudan also played a lead role in work on thermo-tolerance in wheat and maintenance of yield stability in hot environments (see section on wheat).

The Networks Project was implemented through NVRSRP by the national agricultural research systems of Egypt, Ethiopia, Sudan, and Yemen, as well as other national institutes in these countries. Whenever necessary, ICARDA helps national programs link with centers of advanced research.

A new project was sponsored by the International Fund for Agricultural Development in 2002. It aims to build on the results and achievements of the Networks Project and to disseminate to farmers the improved technologies developed for sustainable production of cereals and cool-season legumes.

Plans for research and technology transfer are developed in multidisciplinary sessions of national scientists, led by one scientist, who also serves as country Contact Scientist. Plans are finalized at Regional Coordination Meetings, at which country proposals are discussed in meetings of Contact Scientists convened by the Network Coordinator. A Project Coordinator is appointed to manage the project in cooperation with the respective National Coordinators.

## Seed and food security

Developing seed systems to deliver the results of research to farmers was seen as such a simple matter that early seed projects assumed that once quality seed was made available farmers would rush to buy it. The limitations of this approach were reflected in the poor adoption of improved varieties in many countries, which are now paying greater attention to ways of creating a more sustainable seed supply without dependence on subsidies. In this endeavor, Sudan has moved to privatize its seed industry.

Furthermore, training of staff from national seed programs has been a key activity of ICARDA since 1995. Using a train-the-trainers approach, the Center makes all the logistical arrangements for a course, plans the teaching program, sponsors the participants, provides an ICARDA staff member as a technical resource person, and provides teaching materials.



*An efficient seed-supply system can help ensure that the results of agricultural research, in the form of quality improved seed, are made available to farmers.*

This approach to training has many advantages. The most important one is the ability to tailor courses to the needs of the participants, within the context of their own seed program. Specific problems can be discussed in detail and experience from different areas or organizations within the country can be shared.

The courses cover such topics as crop inspection, seed testing and processing, but most importantly, seed economics and management.

Following the train-the-trainers approach, ICARDA has organized in-country courses on forage and pasture seed production and quality assurance in seed testing in collaboration with Sudan's Seed Administration and local seed companies. This will assist Sudan improve forage and pasture seed production and satisfy quality assurance standards set by the International Seed Testing Association. Participants in earlier courses, held at ICARDA in Syria, have shared their knowledge with colleagues at home, making use of resources and facilities available locally. This work will continue.

## **Institutional development**

Institutional development in support of agricultural research is critical. Since its founding in 1977, ICARDA has cooperated with ARC in a wide spectrum of human resource development efforts, such as training, development of linkages, strengthening of facilities for on-farm and on-station research, and giving access to publications.

Degree and non-degree, short- and long-term training and participation in workshops, conferences, and other scientific activities have been arranged to improve the skills of a large number of researchers and technicians from Sudan.

To date, 383 researchers, extensionists, and farmers have taken part in various training courses, on-farm trials, farmer field days, and traveling workshops. The activities also afford researchers, extensionists, and farmers opportunities to exchange ideas. Policy makers have also been involved, through field visits and briefings on research results.

*Training of Sudanese scientists has helped improve the efficiency of the country's research efforts.*



Annual research coordination meetings are held to plan how to make best use of human and physical resources. Regional linkages are forged and maintained at traveling workshops, review meetings, and workshops sponsored by NVRSRP. Sudan, like the other countries in the Program, has benefited from the collective experience of identifying and solving production problems at the farm level.

## **Where to from here**

The establishment of effective on-farm research systems that enlist the full participation of farmers, extension agents and researchers, has permitted the development of technologies that increase production of important food crops in a sustainable manner. This is the major achievement of agricultural research in Sudan, and ICARDA has had the privilege of working with the country's national agricultural research to help make this happen. The journey is not over, and Sudan-ICARDA cooperation continues to move forward. To widen its institutional cooperation with Sudan, an agreement was signed in 2000 between ICARDA and the National Center for Research in Sudan. Together, ICARDA and Sudan can continue to help improve the nutrition and incomes of the rural poor in the country and throughout the region.



*Agricultural research and development is helping to increase food self-sufficiency and improve the nutrition and income of the rural poor in Sudan.*

# Appendix 1

## Cereal and Legume Varieties Released by the National Program in Sudan

### Year released/Variety name

#### *Durum Wheat*

1996 Cham 1  
1997 Waha

Havata, Salawa,  
Wad Hamid  
1998 Salawa, Wad  
Hamdi, Matama-1,  
Burgaig

#### *Bread Wheat*

1987 Wadi El Neel  
1990 El Neilain  
1992 Sasaraib  
1996 Argine  
Bohaine  
Nessr  
2000 Imam

#### *Lentil*

1990 Aribo1  
1993 Rubatab  
1998 Nedi

#### *Faba Bean*

1990 Shambat 75  
Shambat 104  
Sellaim-ML  
1992 Hudeiba 72  
1993 Shambat 616,  
Basabeer,  
Hudeiba 93

#### *Kabuli Chickpea*

1987 Shendi 1  
1994 Jebel Marra-1  
1996 Atmor,

## About ICARDA and the CGIAR



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).

ICARDA serves the entire developing world for the improvement of lentil, barley and faba bean; all dry-area developing countries for the improvement of on-farm water-use efficiency, rangeland, and small-ruminant production; and the Central and West Asia and North Africa region for the improvement of bread and durum wheats, chickpea, and farming systems. ICARDA's research provides global benefits of poverty alleviation through productivity improvements integrated with sustainable natural-resource management practices. ICARDA meets this challenge through research, training, and dissemination of information in partnership with the national agricultural research and development systems.

The results of research are transferred through ICARDA's cooperation with national and regional research institutions, with universities and ministries of agriculture, and through the technical assistance and training that the Center provides. A range of training programs is offered, from residential courses for groups to advanced research opportunities for individuals. These efforts are supported by seminars, publications, and specialized information services.



The CGIAR is an international group of representatives of donor agencies, eminent agricultural scientists, and institutional administrators from developed and developing countries who guide and support its work. The CGIAR receives support from many country and institutional members worldwide. Since its foundation in 1971, it has brought together many of the world's leading scientists and agricultural researchers in a unique South–North partnership to reduce poverty and hunger.

The mission of the CGIAR is to promote sustainable agriculture to alleviate poverty and hunger and achieve food security in developing countries. The CGIAR conducts strategic and applied research, with its products being international public goods, and focuses its research agenda on problem-solving through interdisciplinary programs implemented by one or more of its international centers, in collaboration with a full range of partners. Such programs concentrate on increasing productivity, protecting the environment, saving biodiversity, improving policies, and contributing to the strengthening of agricultural research in developing countries.

The World Bank, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), and the International Fund for Agricultural Development (IFAD) are cosponsors of the CGIAR. The World Bank provides the CGIAR System with a Secretariat in Washington, DC. A Science Council, with its Secretariat at FAO in Rome, assists the System in the development of its research program.

