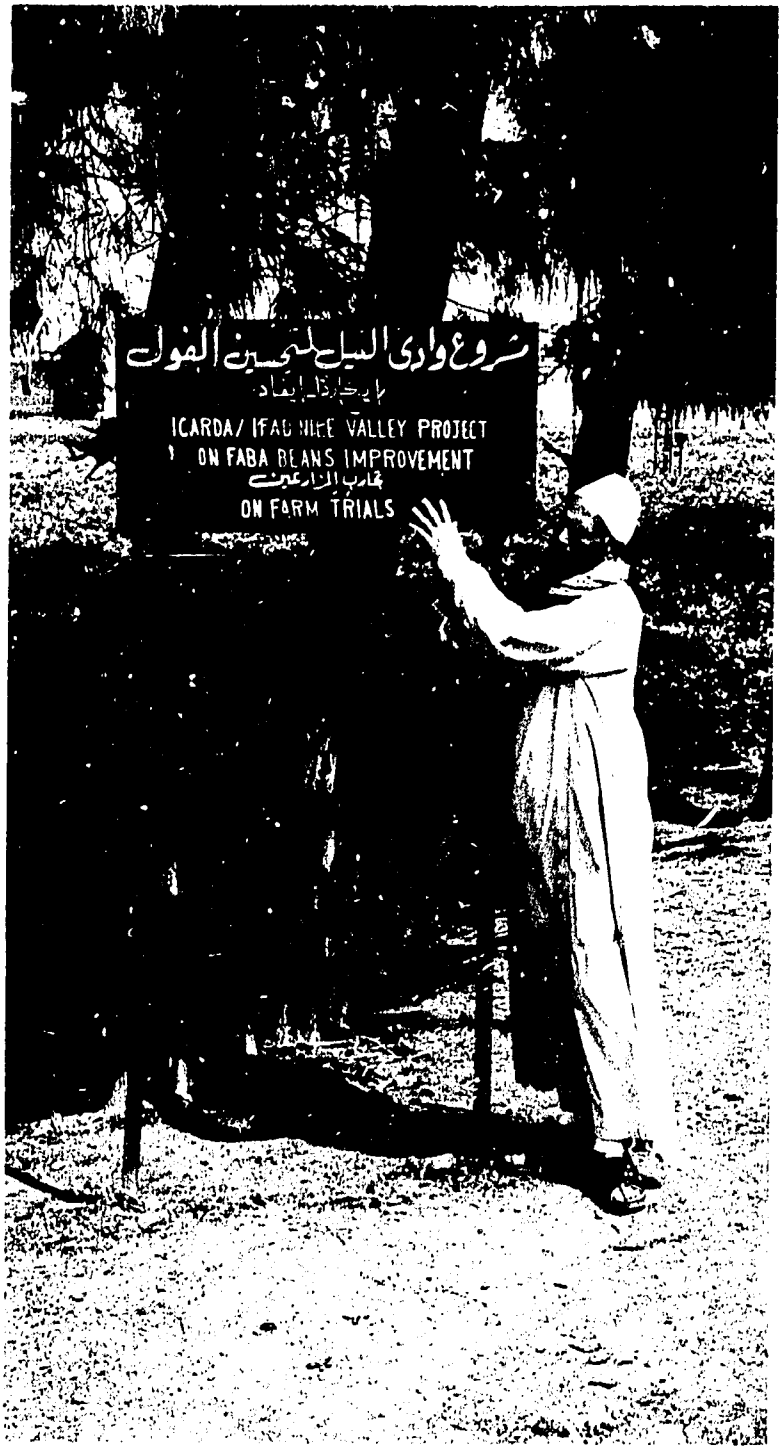
New Dimensions for Faba Bean Research and Production in Egypt and Sudan

A PROFILE OF THE ICARDA/IFAD NILE VALLEY PROJECT

One of many farmers who takes part in the research process in the on-farm trials in the Nile Valley Project. (His field of faba beans is in the background.)



FOREWORD

Through the leadership of national senior scientists in Egypt and Sudan, the ICARDA/IFAD Nile Valley Project strives to unravel the production constraints and increase the yields of one vitally important crop — faba beans. It is a unique model for cooperation between the International Center for Agricultural Research in the Dry Areas (ICARDA) and the national programs it seeks to serve, and, perhaps most important of all, it involves the farmer himself in the research process. This unique "model" in development cooperation could not have been attempted by ICARDA without the generous support of the International Fund for Agricultural Development (IFAD) and the encouragement and support of President Abdelmuhsin M. Al-Sudeary.

The Project's new pragmatic and direct approach is likely to prove the best modality of action under the circumstances prevailing in the Nile Valley and perhaps in other countries with a similar situation. For the first time, it has endeavored to integrate the agricultural research efforts of Egyptian and Sudanese scientists and to effectively proceed in implementation. The strategy adopted by ICARDA is to place responsibility for leadership, coordination, and the actual execution of the work plan in the hands of the national scientists, with ICARDA playing a catalytic role. This also is in line with the basic strategy of IFAD whose financial support made possible the beginning of this Project in 1979 and its continuation since then.

Much progress has been made in three exciting years, glimpses of which are described in this publication. Our scientists from ICARDA, who frequently visit the project, have praised both the quantity and quality of the research being undertaken.

More objectively, perhaps, scientists and policy executives from diverse regional, national, and other international institutions have spoken in praise of the progress achieved. We held a world conference on faba beans in Cairo in March of 1981 in which more

than 100 participants took part from Europe, North America, Australia, Asia, and the Far East, as well as from Egypt, Sudan, and the Near East. Their verdict could be summed up by a comment from one distinguished researcher from the United Kingdom: "The Nile Valley Project is a glorious feather in the cap of ICARDA."

Whatever progress has been achieved would not have taken place to such a measure had it not been for the donation generously given by IFAD and the unqualified support of the Minister of Agriculture and his staff in Egypt and the Minister of Agriculture and his staff in Sudan. IFAD has recently pledged its commitment to support a second three-year phase with even a more generous donation. We in ICARDA are humbly proud.

Mohamed A. Nour
Director General—ICARDA

Children in Sudan with faba bean sandwiches. Because of millions of new mouths that need to be fed every year in Egypt and Sudan, the goal of food security takes on a new urgency.

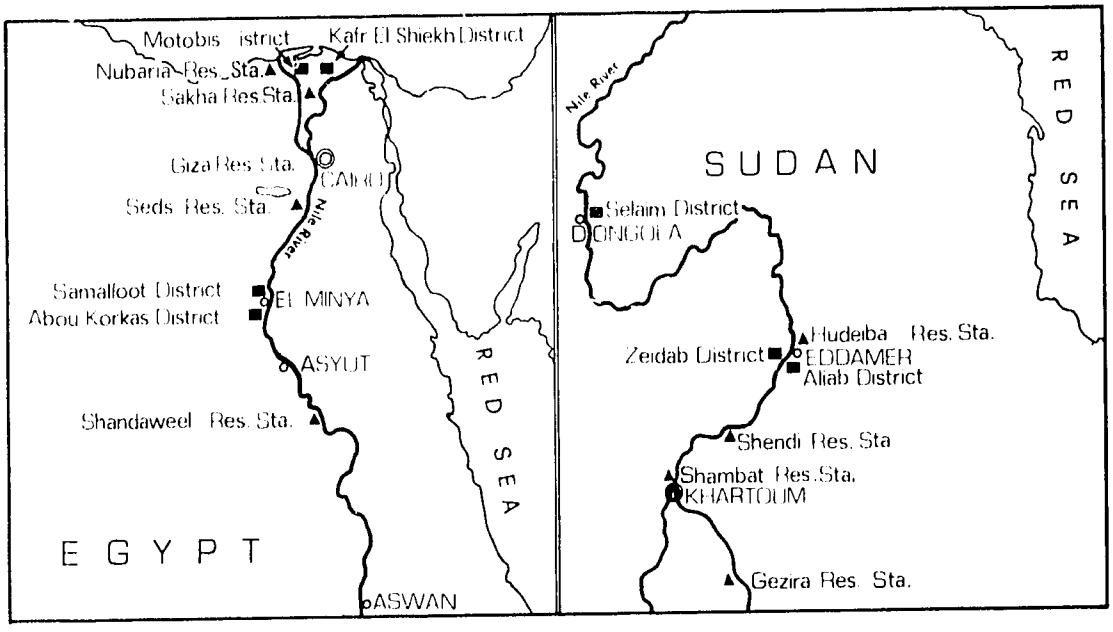
INCREASING NEEDS AND NATIONAL FOOD SECURITY

Millions of people in Egypt and Sudan, particularly those at low and middle income levels, depend on faba beans *(Vicia faba)* as a main staple food for both breakfast and supper. In recent years, demand has been outstripping local production, and, with all the additional mouths that must be fed every year, the goal of food security for these two large nations takes on a new urgency.

To supplement local production, Egypt has imported faba beans from Ethiopia, Poland, Morocco, England, and Canada. These imports have been expensive and in some years difficult to find at any price. Sudan imports only small amounts, and it is safe to assume that because of the shortage of foreign exchange imports will be allowed only in case of emergency. Therefore, barring acute conditions, the Sudanese must depend on local producers for this high protein staple food which has been known since ancient times.

In West Asia and North Africa, including Egypt and Sudan, faba beans are the most important pulse crop. In Egypt, however, production has fallen in recent years. Acreage planted to the crop for dry bean consumption has decreased from a 10-year average of 147,860 hectares during 1961-70 to 110,953 hectares during 1971-80. This was due to several factors, chief among them the competition from other winter crops such as wheat and Egyptian clover (berseem). At the same time, there has been an increased demand from a rapidly growing population. Egypt imported 37,000 tons of faba beans in 1980 to help meet this demand.

With less land devoted to the crop, it is more important than ever that researchers find ways and means of increasing yields. Approximately 30% of the acreage is in the Nile Delta, 45% in Middle Egypt, and 25% in Upper Egypt (Figure 1). Approximately 200,000 Egyptian



■ On-Farm Trial Sites

▲ Research Stations

Main faba bean producing areas

FIGURES 1 & 2. *Major faba bean production areas in Egypt and Sudan, experiment stations involved in the Nile Valley Project, and the location of on-farm trials.*

farmers — most of them with small holdings — grow faba beans.

Sudan, in contrast, has enjoyed an increase in both the acreage planted and the amount of faba beans produced. The largest production comes from the Northern and Nile provinces, with small amounts from Khartoum and Gezira provinces (Figure 2). In the 10-year period (1961-70), the area planted to faba beans averaged only about 8,500 hectares, but in the following 10-year period the average was about double this figure. (The area planted in 1979/80 was the largest ever — more than 20,000 hectares with a production of 38,000 tons.)

The present acreage sown to this crop in Sudan is the result of a long, erratic process of expansion during the past two decades. During that period, not only has the crop's area increased substantially, but yields have also increased and become more stable — from an average of 242 kg per hectare in the 1960's to 303 kg in the 1970's. Despite this progress, the demand for faba beans in Sudan exceeds the domestic supply.

CONSTRAINTS TO HIGHER YIELDS

Numerous constraints limit faba bean yields in both countries. These include water management, diseases, insect pests, weeds, soil salinity, and planting or harvest timing conflicts with other crops. With the exception of certain diseases, many of the major constraints are similar in Egypt and Sudan as shown below:

	Egypt	*Sudan*
Chocolate spot *(Botrytis fabae)*	+	–
Powdery mildew *(Erysiphe polygoni & Leveillila taurica)*	–	+
Rust *(Uromyces fabae)*	+	–
Viruses	–	+
Orobanche	+	–
Root rot/wilt diseases	+	+
Aphids *(Aphis craccivora)*	+	+
Bruchids	+	+
Salinity	+	+
Weeds	+	+
Irrigation problems	+	+

Diseases and pests are a major constraint to increased yields. Left, a close-up of a young parasitic *Orobanche.* ***Right, faba beans destroyed by it; in the background a resistant variety.***

A UNIQUE RESEARCH AND DEVELOPMENT STRATEGY

With the main objective of strengthening on-going efforts to overcome the constraints and to increase and enhance the production of this most important and vital crop, a unique ICARDA/IFAD Nile Valley Project was devised in 1979 which involves national and international research and development organizations and their personnel. (See listing in back of this publication.) It is unique because most of the research is done by national scientists and tested on farmers' fields. Unlike most other national/international projects, senior scientists from their respective ministries of agriculture and universities are responsible for the planning and implementation of their research work under the Nile Valley Project. It provides funds for certain support staff and equipment, as well as honoraria for individual scientists who are on contract to the Project.

As no new full-time ICARDA scientific appointments are made to serve the Project, the Center's role is largely one of acting as a catalyst, providing back-up at scientific, technical, logistic, and administrative levels. Funds from IFAD, which are channelled through ICARDA, finance the capital and operational components of the work. (IFAD provided a $3,000,000 technical assistance grant over a three-year period beginning in the 1979/80 season and a new three-year phase is forthcoming.) Other agencies are involved on a cooperative and complementary basis, including the International Development Research Center (IDRC) of Canada which supports legume development programs in both Egypt and Sudan and the German Technical Agency (GTZ) which also supports legume research at the Universities of Cairo and Alexandria.

National scientists in the Nile Valley Project represent many different disciplines, including plant breeding, agronomy, soil fertility, plant physiology, en-

A farmer cooperator and a researcher examine one of the fields in the on-farm trials in the Nile Delta between Cairo and Alexandria.

tomology, plant pathology, weed control, water management, economics, and nutrition. Another important feature is the direct involvement of extension workers and farmers in the on-farm trials. The farmers' knowledge of local situations is used to the fullest extent, and they are linked in a working relationship with the extension workers and scientists from their national and regional experiment stations. In turn, national as well as ICARDA scientists are brought into close contact with farmers and their needs, aspirations, and problems.

To be more specific, the Nile Valley Project has been organized to:

- Determine the gap between yields obtained by most farmers and those at the experiment stations and seek to close the gap.
- Strengthen the core research and national faba bean improvement programs by providing technical support and funds for the development of key research facilities such as a plant breeding laboratory, seed storage units, plastic greenhouses, and screenhouses.

- Introduce new and improved germplasm material which is higher yielding, resistant to certain diseases and pests, and has higher protein content. (Faba beans average about 25% protein now, but recent research indicates that it can be raised to 30% or more.)
- Identify and develop suitable locations for off-season plantings to grow two generations of breeding material for rapid advancement of varietal improvement.
- Conduct on-farm trials to evaluate varieties and cultural practices and to provide a feed-back link between the results of these trials and the continuing experimental work at research stations in both countries.
- Assess the current status of seed production and distribution to improve the availability of quality seeds to farmers.
- Undertake surveys and economic analyses of existing agricultural practices and new technology to determine their limitations from the viewpoints of farmers.
- Train national program scientists on various aspects of faba bean production and improvement.
- Build a communication linkage between ICARDA and national scientists.
- Develop extension publications and other educational materials in cooperation with the relevant institutions in both countries.

Farmers are involved in the practical running of on-farm trials, and they compare technology with their own time-tested methods.

RESULTS OF ON-FARM TRIALS

Phase I of the project started during the 1979/80 cropping season with trials planted at 26 different sites on farmers' fields in Egypt and at 10 sites in Sudan. The following year, the number of sites in Egypt was increased to 34 and in Sudan to 18. These trials were conducted by national program scientists in close collaboration with extension workers and farmers who were involved in the practical running of the trials. In most cases, specific plots were allotted to farmers. This made it possible for them to take part in the research process and to compare new ideas and technology with their own time-tested methods.

An on-farm trial (above) in Egypt's Nile Delta in which recommended practices were adopted — adequate plant population, weed control, and fertilizer. Right, a farmer and a research worker inspect a faba bean field in the same area in which traditional practices were followed — low plant population, no fertilizer, and no weeding.

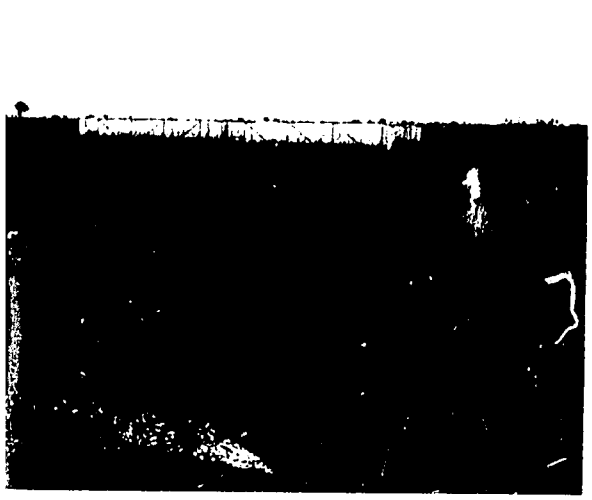
In Egypt's Minya Province, which accounts for about 30% of the total faba bean production in the country, 6 out of 16 on-farm trials during the 1980/81 season showed a grain increase from 0.61 to 0.97 t/ha under a recommended population of about 60,000 plants per hectare compared with a much lower farmers' population of about 30,000. At 8 other sites the same trend was observed, although the yield differences were not statistically significant. At recommended levels of nitrogen (N) and phosphorus (P), yield increases were recorded at 7 sites for grain and at 10 for straw.

In Kafr El-Sheikh Province, the recommended plant population resulted in improved seed yields at 7 of 14 sites. Farmers' populations, however, were generally higher than in Minya and in a few sites exceeded the recommended level. At these sites, the higher plant populations proved superior. By applying the recom-

TABLE 1.
Level of inputs in the on-farm trials in Sudan (1980/81).

Inputs	Zeidab		Aliab	
	R	F	R	F
1. Seed rate (kg/ha)	67	167	67	167
2. Times irrigated	10	5	14	7
3. Times weeded	2	1	2	1
4. Times insecticide applied	3	Nil	3	Nil
5. Date of planting	1/11	21/11	1/11	21/11
6. Recommended method of land preparation and planting includes disc plowing, harrowing, levelling, and 60 cm ridging followed by hand-sowing at 20 cm spacing. The farmer practice consists of disc plowing, harrowing, levelling, hand scattering of seeds on a flat seed bed or ridging by local implements.				

R = Recommended practice; F = Farmers' practice.



Increased irrigation frequency resulted in higher faba bean grain yields. Right, an ICARDA agricultural economist and a Sudanese researcher interview a farmer as part of a socio-economic survey in Sudan.

mended level of N and P, increases in seed yield ranging from 0.02 to 0.82 t/ha were obtained at 11 of the 14 sites. Although foliar diseases appeared only late in the 1980/81 season, 11 sites showed a positive response to application of a fungicide (Dithane M.45) and had a mean seed increase of 9.6% compared with the unsprayed control.

In Sudan, 1980/81 on-farm trials were conducted at 7 sites in Zeidab, 5 in Aliab, and 5 at Selaim irrigation schemes. At the former two schemes, 6 production changes (Table 1) were examined in a minifactorial set of 8 treatments (Table 2) to identify the yield gap between the potential and actual yields on the farms and to see if certain production practices could close at least part of that gap. The change in production practices were: (1) date of planting, (2) variety, (3) irrigation, (4) weed control, (5) method of planting, and (6) pest

TABLE 2. Treatment combinations for on-farm trials in Sudan (1980/81).

Treatment	Planting date	Variety	Irrigation	Weed control	Planting method	Pest control
1	F	F	F	F	F	F
2	R	R	R	R	R	F
3	R	R	R	R	F	F
4	R	R	R	F	R	F
5	R	R	F	R	R	F
6	R	F	R	R	R	F
7	F	R	R	R	R	F
8	R	R	R	R	R	R

R = Recommended practice; F = Farmers' practice.

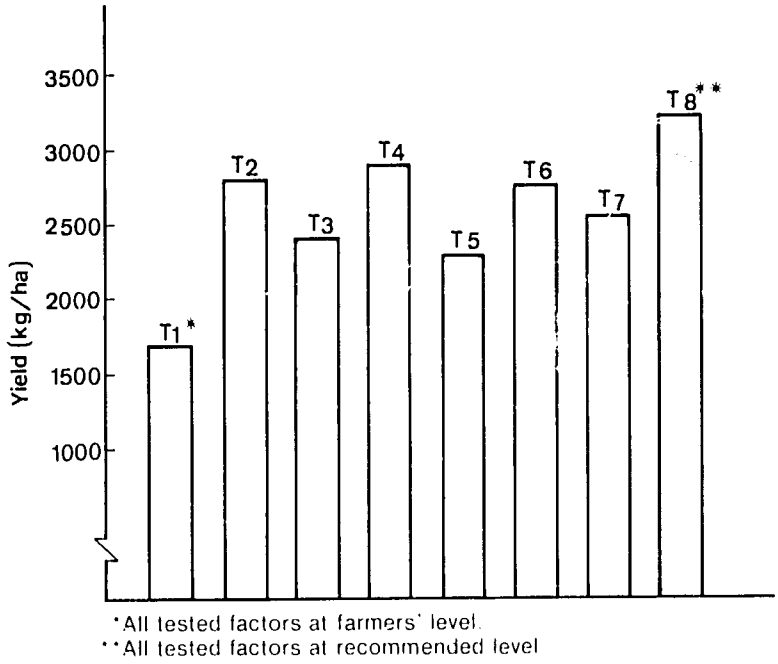


FIGURE 3.
Faba bean yield response to 8 different treatments at two schemes in Sudan.

control. Each of these factors was studied at two levels — the recommended and the farmers' practice.

A combination of all 6 factors at the recommended level resulted in a 1.21 t/ha (64%) yield increase over the farmers' practice at Zeidab and a 1.34 t/ha (39.8%) increase at Aliab. (Note the yield response to 8 different treatments for both areas combined in Figure 3.) At both sites, increasing irrigation frequency was the major factor responsible for the seed yield increases, but at Zeidab early and improved methods of planting were also important factors; at Aliab pest management contributed substantially. At all locations the new variety — Hudeiba 72 — showed little or no superiority over the local one.

An economic analysis evaluated the different treatment combinations in the trials by measuring the benefits gained and costs incurred from each combination tested in the trials. Then the best alternative treatment in terms of highest income, greatest net

Weeding faba beans — a recommended practice for increased yields.

return, and least operating capital was determined. The highest benefit cost ratio was treatment 5 for the farmer with scarce operating capital, but treatment 8 was the best choice for the farmer with sufficient operating capital because of its higher net benefit (Table 3).

TABLE 3.
Economic analysis of 8 different treatments at two irrigation schemes in Sudan (1980/81).

	T1	T2	T3	T4	T5	T6	T7	T8
Yield	1750	2755	2403	2867	**2262**	2685	2485	**3070**
Gross benefit	487	766	668	797	**629**	746	691	**853**
Variable cost	119	160	175	137	**125**	160	160	**174**
Net benefit	368	606	493	660	**504**	586	531	**679**
Increase in variable cost over T1 (farmers' practice) (SL/ha)	—	41	56	18	**6**	41	41	**55**
Increase in net benefit over T1 (SL/ha)	—	238	125	292	**136**	218	163	**311**
Benefit cost ratio	—	5.8	2.2	5.5	**22.7**	5.3	3.9	**5.6**

* *SL = Sudanese pound.*

RESULTS OF BACK-UP RESEARCH

During the first year of the Project (1979/80), a total of 30 experiments were conducted on plant breeding, agronomy, plant pathology, weed and insect control, water management, microbiology, and plant nutrition. Socio-economic studies were also carried out. The following year, 47 experiments were underway in Egypt and 17 in Sudan with genetic improvement, nodulation, and seed quality studies added.

As part of the work on genetic improvement, many lines supplied by ICARDA and other sources were evaluated in Egypt for *Orobanche crenata* resistance and 113 of these were reported to be tolerant. Two lines from ICARDA (BPL 733 and BPL 278) and one from Egypt (F 402) showed very low levels of infection. At all sites in Egypt, F 402 showed significant superiority over the released and widely grown variety Giza 2 and was less susceptible to parasitism by *Orobanche* which can completely wipe out a crop if the soil is heavily infected. F 402 is being multiplied for distribution to farmers. Progress is also being made on the development of cultivars resistant to chocolate spot *(Botrytis fabae)* which is a serious disease in the northern region of the Nile Delta.

Back-up agronomic studies in Egypt during 1980/81 included testing the performance of several faba bean lines and cultivars under tillage and no-tillage systems following rice and cotton. The latter practice is common among Egyptian farmers in some areas. Results showed that untilled soils yielded higher than tilled with increases in seed yields of 18% after rice and 11.4% after cotton. The lines behaved differently under both tillage systems, but most of them responded better to no-tillage.

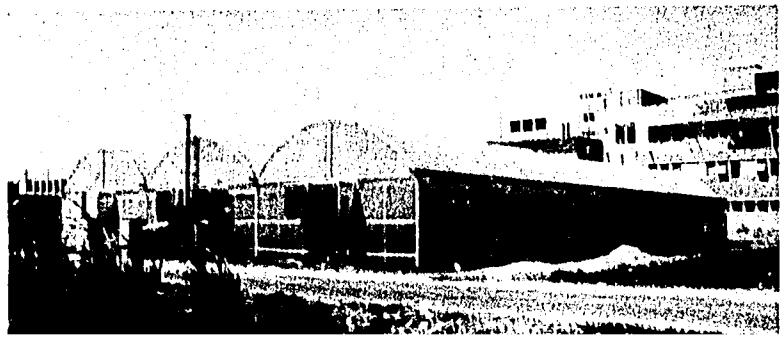
In Sudan, wilt and root rot diseases caused by *Fusarium oxysporum* and *Fusarium solani* f. sp. *faba*,

Faba bean breeding trials at ICARDA's Tel Hadya Research Station near Aleppo, Syria.

One of the important ICARDA functions is to provide new and improved material to the Project from its germplasm "bank."

Left, a new faba bean line from Egypt — F402 — showed a significant superiority over the widely grown Giza 2 variety (right) and was less susceptible to parasitism by Orobanche.

Faba bean leaves being infected with chocolate spot disease in a laboratory as part of a program to develop resistant varieties.



Scores of faba bean lines are crossed and tested for disease resistance and other characteristics in these new plastic greenhouses at the Agricultural Research Center of the Egyptian Ministry of Agriculture (Giza).

respectively, are responsible for early deaths in faba bean seedlings. These soil-borne diseases are widespread, but their prevalence varies considerably with the locality. Both early planting (early October) and longer watering intervals (3 weeks) are factors conducive to maximum disease development.

Because of the inefficiency of the chemicals applied as seed dressing or foliar sprays, efforts are being made to develop resistant strains. Large numbers of genetic stocks (680) were evaluated and screened for resistance or tolerance to root rot and wilt diseases under natural field conditions at Shambat. Only 54 genotypes were found to show some resistance to the wilt complex, with the remainder being susceptible.

An agro-economic survey in Sudan showed that faba beans are still the top winter crop in terms of cash flow and profitability despite a decrease in the selling price and an increase in costs over the year before. Per hectare averages of gross revenue, total cost, and net revenue were 478.2, 247.5, and 230.7 LS, respectively. The average rate of return equaled 1.935. This meant that each Sudanese pound spent in the production process generated almost two pounds of gross revenue.

EMPHASIS ON NUTRITION

More attention is now being paid to nutritional factors, and this emphasis will continue in Phase II of the Project. Studies are underway by the National Research Center in Cairo on favism — a hemolytic syndrome in susceptible individuals. (Glucose 6-phosphate dehydrogenase deficient persons are susceptible to this disease.) The causitive agent in faba beans has been tentatively identified as being vicine and/or convicine or the aglycone forms of these toxic compounds.

Sample surveys are being made in several areas to determine the extent of the problem. If they indicate it

is serious, efforts will be made to breed varieties low in vicine and convicine and to develop methods to reduce these compounds in the final product.

CONFERENCES, TRAINING AND INFORMATION SERVICES

Regular coordination conferences have been organized by ICARDA to bring together persons associated with the Nile Valley Project, including national program staff from Egypt and Sudan, ICARDA scientists, consultants, and representatives of IFAD and the Consultative Group for International Agricultural Research (CGIAR). In March 1981, the Project hosted the first international faba bean conference in Cairo. More than 100 scientists from 16 countries throughout the world participated, and a selection of papers they presented at the conference has been published in a book entitled, "Faba Bean Improvement."

Another important contribution of ICARDA to the Project has been the training of personnel of the Egyptian and Sudanese national programs. Eight research workers from Egypt and Sudan visited the ICARDA center at Aleppo, Syria for short training periods during 1980/81. In January 1981, a special training course on Faba Bean Production and Improvement, taught by national program scientists and coordinated by ICARDA's Training Officer, was held at the Hudeiba Research Station in Sudan. It was attended by 14 research technicians from Sudan and Egypt. In addition to these activities, 6 national program scientists have been selected for postgraduate studies in the UK, USA, and Canada.

ICARDA also provides a news and information service — *FABIS* — for faba bean researchers worldwide. Several articles written by national scientists as a result of research conducted within the Project have been published in the *FABIS* Newsletter.

In addition to classroom and laboratory activities, part of the training for this Sudanese takes place in a faba bean field at ICARDA.

Participants in ICARDA's Food Legume Production and Research Training Course get some practical instruction in the field.

NATIONAL SCIENTISTS ON THE PROJECT (1980/81)

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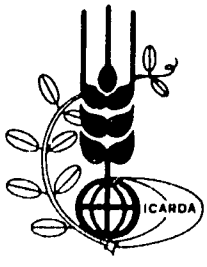

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