IDRC-126e

Food Legume Improvement and Development

Proceedings of a workshop held at The University of Aleppo, Syria, 2-7 May 1978

Geoffrey C. Hawtin and George J. Chancellor, Editors

CANADA

Published by The International Center for Agricultural Research in the Dry Areas and International Development Research Centre

The International Development Research Centre is a public corporation created by the Parliament of Canada in 1970 to support research designed to adapt science and technology to the needs of developing countries. The Centre's activity is concentrated in five sectors: agriculture, food and nutrition sciences; health sciences; information sciences; social sciences; and communications. IDRC is financed solely by the Government of Canada; its policies, however, are set by an international Board of Governors. The Centre's headquarters are in Ottawa, Canada. Regional offices are located in Africa, Asia, Latin America, and the Middle East.

Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa

Hawtin, G.C.
Chancellor, G.J.
International Center for Agricultural Research in the Dry Areas, Aleppo SY
IDRC–126e

Food legume improvement and development: proceedings of a workshop held at the University of Aleppo, Aleppo, Syria, 2–7 May 1978. Ottawa, Ont., IDRC, 1979. 216 p.:ill.

/IDRC publication/. Compilation of workshop papers on /legume/ /food production/ in the /Middle East/ and /North Africa/ — discusses agro/bioclimatology/ and /cultivation system/s, /nutrition/al value and /food composition/; /plant production/ (particularly of /chickpea/s, /lentil/s, and /faba bean/s), /agricultural research/, /cultivation practice/s for /plant protection/; /plant disease/s, /insect/ /pest/s, /disease resistance/, /weed control/ problems (use of /herbicide/s in /arid zone/s); /plant breeding/ and /genetic improvement/. /IDRC mentioned/, /list of participants/.

UDC: 633.3 ISBN: 0-88936–202–5

Microfiche edition available

IDRC-126e

Food Legume Improvement and Development

Proceedings of a workshop held at the University of Aleppo, Aleppo, Syria, 2–7 May 1978

Editors: Geoffrey C. Hawtin and George J. Chancellor

Published by the
International Center for Agricultural Research in the Dry Areas
and the
International Development Research Centre

Contents

Production and Improvement of Grain Legumes in Egypt

Ali A. Ibrahim, Abdullah M. Nassib, and Mohamed El-Sherbeeny

Food Legume Research Section, Field Crops Institute, Agricultural Research Centre, Giza, Egypt

Food legumes are well known as rich and inexpensive sources of vegetable protein for human nutrition. In Egypt they play an essential role in the nutrition of the population, balancing the deficiencies of the basically cereal diet and supplying the bulk of the dietary protein requirements, especially to the people of the predominantly rural areas of the country. In addition to these nutritive considerations, legumes are particularly valuable in the agriculture of the country as, by virtue of their nitrogen-fixing capability, they are able to sustain high yields in the face of minimum inputs and at the same time improve soil fertility.

The legume crops grown in Egypt include: broad beans (Vicia faba), lentils (Lens culinaris), fenugreek (Trigonella feonumgraecum), chick-pea (*Cicer arietinum*), and lupin (*Lupinus termis*). Of these, broad beans are by far the most important, occupying over half the 500 000 acres annually devoted to legume production, and constituting a daily dish in the diet of most of the population. Lentils are secondary in importance, and chick-peas, although generally considered to be of minor significance, are becoming increasingly popular with growers due to the expanding market for their use in baby foods and other commodities.

Broad beans are cultivated throughout the country, with more emphasis on the regions of Middle and Upper Egypt (Fig. 1), and since 1950 their average yields have increased by about 39%, even though the area under cultivation has remained fairly static (Table 1). This reflects the considerable interest shown in the crop across the country and the consequently emphasized breeding efforts that have already culminated in the release of several varieties with better adaptation to the prevailing production conditions than local landraces. In contrast to this, both the area and production of lentils have declined considerably over the same period as a result of several major production constraints, which include unleveled soils, poor drainage, and severe waterlogging. These problems have arisen mainly as a consequence of the construction of the High Dam at Aswan and the introduction of canal irrigation into Upper Egypt where lentils are predominantly grown. The continuous decline in the annual acreage of legume crops, their sensitivity to climatic conditions, and the high and variable losses caused by pests and diseases are all contributing to the declining production situation, which is made all the more serious by the rapidly increasing population pressure.

Although some progress has been achieved in yield improvement, the total production of both broad beans and lentils is still below the local consumption requirements. This has meant that large quantities of both food grains are imported every year; in 1976, for example, imports of broad beans and lentils were 101 000 and 33 000 tons, or 28% and 46%, respectively, of total requirements.

Research Activities

Grain legumes are grown as winter crops of relatively short duration (sown in October/November and harvested in March/April) and usually in a 2-year rotation with

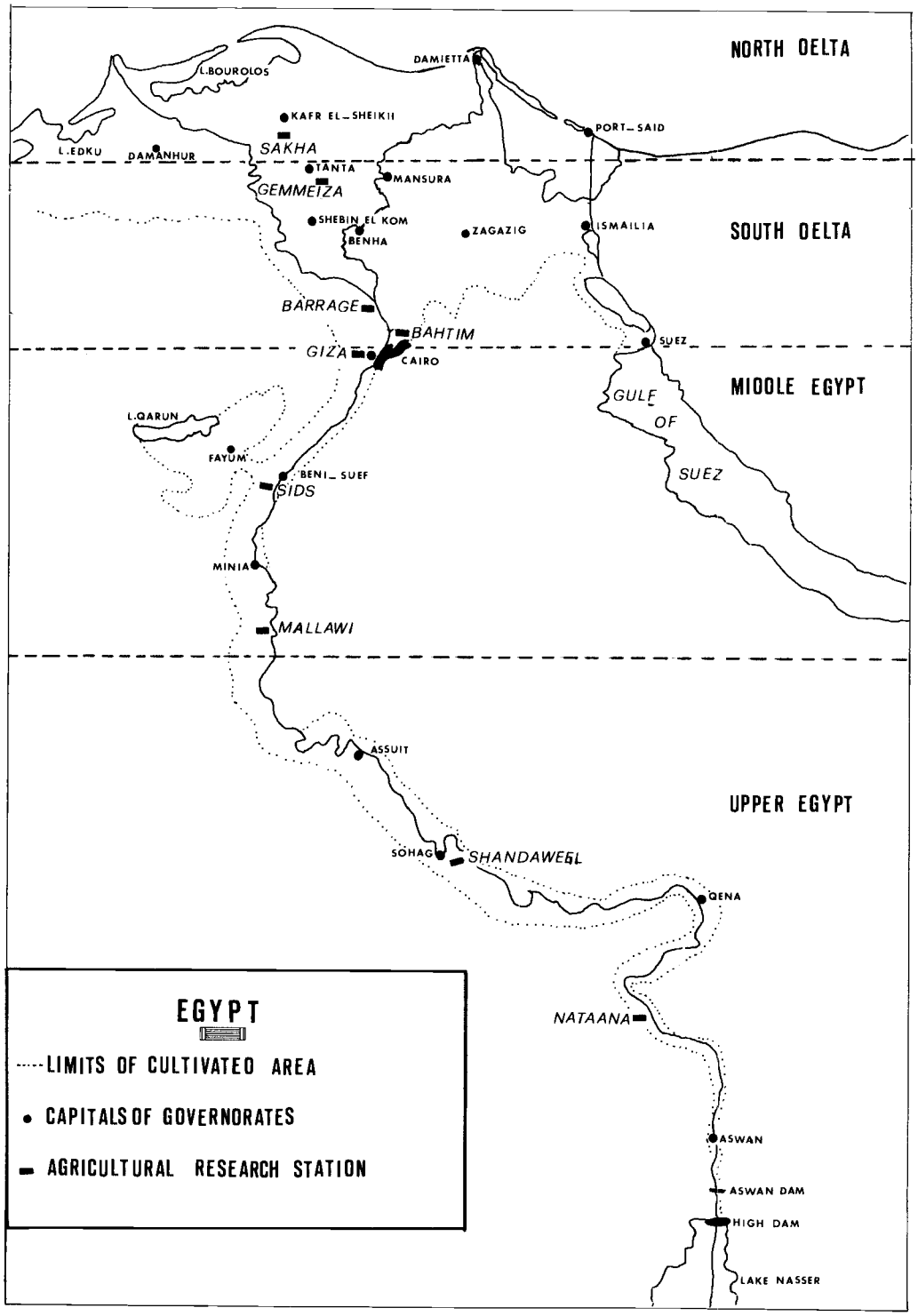

Fig. 1. Different environmental regions, the limits of cultivated areas, and Ministry of Agriculture research stations in Egypt.

TABLE 1. Average area ('000 feddans (1 feddan = 0.42 ha)), production ('000 metric tonnes), and yield (kg/ha) for broad beans, lentils, and chick-peas in Egypt during the 1950–1977 period.

	Broad beans			Lentils			Chick-peas		
Year	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
1950–54	328	225	1631	74	47.5	1527	12.0	8.2	1617
1955–59	353	238	1605	80	48.0	1436	11.0	7.1	1525
1960–64	365	282	1837	77	48.0	1489	11.0	8.0	1650
1965–69	349	299	2037	65	39.7	1444	9.2	6.3	1639
1970–74	283	280	2361	64	50.1	1868	8.2	6.1	1759
1975–77	266	261	2265	57	33.8	1407	9.4	6.8	1726

either cereals or cotton. As it is difficult to increase the area under legume cultivation due to limitations on land reclamation and competition from other winter crops, research geared to increasing production in Egypt is primarily focused on increasing yield per unit area. This research is carried out at Ministry of Agriculture research institutes and stations throughout the country (Fig. 1), and consists mainly of breeding, agronomic investigations, varietal purification, and the propagation of foundation stocks.

Breeding

The major goals of the broad bean breeding program are the incorporation of resistance to the major pests and diseases (including *Orobanche*) and early maturity into stable and high-yielding varieties that have seeds of a high nutritive and cooking quality. For lentils and chick-peas, however, the main priorities are to produce early maturing varieties that are resistant to root rot and wilt diseases and adapted to production conditions in the Nile Delta area. The introduction of such varieties will pave the way for an expansion of the lentil and chick-pea acreages into this nontraditional production region.

Since the early stages of legume improvement work in Egypt, the dominating breeding procedure has involved selection in local populations and in segregating generations following intervarietal crosses (individual plant selection as part of a pedigree breeding system). The success of this effort was limited by the narrow germ-plasm pool of local landraces, which was insufficient to ensure a broad genetic base to the breeding efforts. However, this handicap has been largely eliminated as a result of the provision of a large germ-plasm collection of diverse geographical origin through the ALAD–IDRC–ICARDA regional cooperative legume improvement program initiated in 1972.

A number of entries of broad beans showing good resistance to chocolate spot and rust, the major diseases of this crop, have been identified from this material. Other varieties with high protein contents, lodging resistance, and/or desirable yield components have also been found. An expanded breeding program has been initiated to combine these attributes with the adaptation to the local environment shown by native cultivars. This scheme involves hybridization followed by compositing promising lines of early generations for cross-polination by honey bees to produce improved populations. The traditional pedigree and improved bulk selection breeding methods will, however, be retained to produce populations for use in hybridization and pure-line breeding.

An intensive crossing program is planned for the production of new lentil and chick-pea lines from this recently introduced material. This will be accompanied by further screening and testing of the introductions and selected material for resistance to root rot–wilt diseases and adaptability to production in the Nile Delta region. Promising material arising out of all these breeding efforts is included in a network of yield trials designed to evaluate its performance in the various different environmental regions of the country (see Fig. 1).

The breeding work to date has resulted in the release of the following improved food legume cultivars:

Crop	Cultivar	Special characteristics
Broad beans	Giza 1	Tolerant to chocolate spot and rust; adapted to North Delta region.
	Giza 2	Wide adaptability; recommended for South Delta and Middle Egypt areas.
	Rebaia 40	Adapted to Upper Egypt.
	Giza 3	Replacement for Giza 1.
	Giza 4	Replacement for Rebaia 40.
Lentils	Giza 9	Adapted to rainfed basin regions.
Chick-peas	Giza 1	Large seeded; recommended for the Delta and Middle Egypt areas.
	Family 2	Small seeded; Adapted to all regions.

Diseases

Chocolate spot (*Botrytis fabae*) and rust (*Uromyces fabae*) are the most serious yield-limiting diseases of broad beans in Egypt and are especially prevalent in the Delta regions. Crop losses can be as high as 50% when the diseases become epidemic, but annual losses normally vary from 5 to 20%. Chemical control using foliar sprays has been found to be effective in minimizing losses, and Dithane M 45 is now recommended for field control of both diseases. Delaying planting until early November has also proved useful in reducing crop losses, especially in years of severe infection. Considerable attention has, in the past, been directed toward disease control through resistant varieties, and special screening nurseries at Sakha and Nobaria, where both diseases are prevalent, have been used in an attempt to identify sources of resistance in segregating generations, new lines, and introductions. Some promising material has been found, but no very strong sources of resistance have yet been identified and hence progress has been slow.

The most serious diseases of both lentil and chick-pea are those of the root rot–wilt complex (*Fusarium sp.* and *Rhizoctonia sp.*), which can also be severe on broad beans. It has been found that losses from these diseases can be minimized by improving such agronomic factors as drainage, soil leveling, and crop water supply. A special nursery for screening broad bean, lentil, and chick-pea varieties for resistance to these diseases has recently been set up at Giza. This involves the creation of severe conditions in "sick plots" and it is hoped will lead to the identification of some promising material in the near future.

Pests

Broomrape (*Orobanche* sp.)

This parasitic weed presents serious problems in the production of all three major legume crops in Egypt. Some crops are so severely infested that large areas have to be abandoned every year, resulting in immense yield losses. Of the eight species of *Orobanche* recorded in the country, *O. crenata*, *O. ramosa*, and *O. aegyptiaca* have been found to be the most common and to cause the greatest amount of crop damage in the food legumes.

Although there are no totally effective methods for controlling this pest, late sowing (until the end of November), flooding prior to sowing, deep sowing, planting of trap crops (crops that stimulate *Orobanche* seeds to germinate but cannot themselves be parasitized, e.g., fenugreek, coriander, or flax) in the rotation, and planting after rice have all been shown to reduce levels of infestation.

Insects

Aphids (*Aphis lanurni*) are the most important field pests throughout the country and are considered to be one of the major factors limiting legume production in Egypt. However, they can be satisfactorily controlled through the judicious use of chemical pesticides.

Considerable losses of broad bean, lentil, and chick-pea seed are also caused in store by infestations of seed beetles (*Bruchus rufimanus*, *B. lentis*, and *B. incarnatus*).

Others

Birds, especially sparrows, present a major production problem and cause extensive crop damage at the flowering and early pod-filling stages. At present there is no effective control measure that can be recommended to combat this problem.

Agronomic Practices

One of the major constraints to increased production of food legumes in Egypt arises from the fact that these crops are grown under traditional and often suboptimal production systems. Considerable research emphasis is thus being placed on determining optimal agronomic criteria.

Sowing Date

Investigations over the past 3 years have indicated that the optimum sowing date for broad beans varies with variety and location; Giza 2 and Rebaia 40 are best sown around mid-October in Middle and Upper Egypt, whereas the optimum time for planting Giza 1 in the North Delta is early November. Late sowing is to a certain extent recommended in these Delta regions for control of chocolate spot rust and *Orobanche*, which are widespread.

For lentils and chick-peas, studies have established the optimum sowing date to be during the first 2 weeks of November.

Population Density

The majority of broad beans grown in Egypt are produced on ridges to facilitate agronomic operations. Extensive research on ridge width, hill spacing within ridges, and number of plants per hill has established that the optimum population density for the existing varieties varies between 80 and 85 plants/m^2 (320 000–340 000 plants/acre). This may be achieved by sowing two plants per hill, on hills 20 cm apart on either side of ridges spaced at 60 cm.

All lentil seed is broadcast sown in Egypt using relatively high seed rates. Studies have shown that, although yield increases slightly with every increase in sowing rate, the optimum seed rate ranges from 35 to 45 kg/acre when broadcast into a well-prepared seedbed and followed by good leveling. Investigations on other methods of planting have indicated that the highest seed yield of lentils may be obtained by sowing 30 kg of seed per acre into ridges 60 cm apart.

The standard population density for chick-peas, used by farmers and research stations alike, is between 28 and 30 plants/m^2. However, the results of a 2-year study indicate that yield/acre increases progressively and significantly with increasing plant population up to 840 000 plants/acre. Further studies are required to determine an optimum density.

Irrigation

Results of studies on broad beans conducted at three locations representing the different environments of the country have shown regional differences between the optimum number and timing of irrigations. No significant differences were detected between treatments in the North Delta, and this can probably be attributed to the higher rainfall of this region. However, alterations in the watering regime in Middle and Upper Egypt resulted in considerable yield differences. Based on these and other results, the recommended irrigation pattern for broad beans in Middle and Upper Egypt involves four irrigations at 30-day intervals from the time of sowing. In the Delta regions, where a certain amount of rain may be received and increasing the irrigations has little effect on net yield, the necessity of chocolate spot and rust control has meant that a minimum number of irrigations are recommended.

The only commercial variety of lentil available in Egypt is Giza 9, which is adapted to nonirrigated basin land production in Upper Egypt. This variety is very susceptible to overwatering and thus, although water stress commonly results in low yields, most farmers do not irrigate for fear of causing severe crop damage. Investigations into the optimum watering regime for this variety have determined that two or three irrigations will give significantly higher yields providing that the seedbed is level and well prepared and the distribution of seed and irrigation is accurate. Much of Upper Egypt has come under perennial irrigation as a result of the construction of the High Dam, and, as a result, considerably more research needs to be done to produce lentil varieties less susceptible to overwatering to enable production in this traditional area to continue at its former level.

Fertilization

In general, Egyptian soils suffer from very low levels of both nitrogen and phosphate. In recognition of this, considerable research efforts have been directed toward ascertaining the effects of artificial fertilization on the legume crops.

Crop response to nitrogen applications of 36 kg/ha varied from a 10.5% yield increase in broad beans to a 6.2% increase in lentils. Applications of phosphate at a rate of 72 kg/ha caused a 15.7% increase in the yield of broad beans, but only about half this figure in lentils. Optimum yields of broad beans were obtained with applications of 36 kg N and 72 kg P_2O_5 per hectare, and applications of 18 kg N and 72 kg P_2O_5 to lentil crops were found to be the most economical.

Weed Control

Weeds compete strongly with the growing legume crops for both water and nutrients, and control is thus essential for efficient production. Manual methods of cultivation are still the only available means of carrying out this task in most of the legume-producing areas. To keep the fields clean, cultivation must be repeated three or four times during the growing season and this makes legume production very labour-intensive. With labour costs rising fairly rapidly, it is becoming increasingly urgent to develop other less labour-intensive control procedures.

Harvesting

Legume crops set their pods over a fairly prolonged period of time, and the pods consequently ripen rather unevenly. This makes harvesting difficult as not all the pods will be at the same stage of ripeness at any one time. To minimize harvesting losses, the plants have to be reaped before the pods are completely dry and left to mature in the field. It is advisable to harvest these crops early in the morning to avoid undue shattering, which becomes serious as the plants dry out in the heat of the day. Investigations have shown that the interaction between sowing and harvesting dates have a highly significant effect upon seed yield. It has been concluded that, if the legume crops are sown at the recommended optimum dates, harvesting may be carried out most efficiently after 140–152 days, 115–120 days, and 140–150 days for broad beans, lentils, and chick-peas, respectively.

Seed Quality and Multiplication

Seed samples of broad beans and lentils from various trials are routinely analyzed for protein content and cooking quality as part of a seed quality program. Results to date indicate that, within local material, locality rather than variety had the most effect upon seed quality as measured by these two criteria. However, there appears to be considerable variation in protein content within the material furnished by ALAD–ICARDA, and new facilities provided by IDRC should assist in developing an effective seed quality research program around this material.

The maintenance, purification, and distribution of seed of new varieties developed in Egypt is the responsibility of two organizations: the Grain Legume Section of the Field Crops Research Institute ensures the multiplication and supply of the breeder's, foundation, and registered seed in seed increase areas at the Ministry of Agriculture's experimental stations and farms; and the Seed Department of the Ministry of Agriculture has the responsibility for the production, inspection, testing, and distribution of certified seed to the producers.

Major Constraints to Legume Production

The work of the research department outlined above is directed toward providing solutions to the critical problems that at present limit the production of food legume crops in Egypt. These constraints may be summarized as follows:

- the lack of physiologically efficient, high-nodulating, and disease- and pest-resistant varieties, resulting in low crop productivity;
- the considerable gap between yields of varieties in experimental plots and the national average yield under production conditions, which may reflect a number of the agronomic factors outlined below;
- problems of soil salinity associated with poor drainage and bad water management and

the continued use of manual operations in land preparation, weeding, harvesting, and threshing, which are time consuming, costly, and result in considerable yield losses, rather than the more efficient mechanical methods; and

- the small average size of land holdings, which makes it difficult to effectively utilize improved production technologies.

Despite the considerable progress already made through the research efforts of the country toward solving these and other production problems, the further potential for considerable increases in yield, disease resistance, and nutritional quality is well recognized. The program, in close collaboration with other organizations in the region, is actively working toward the realization of this potential both through the improvement of yielding ability and through work designed to raise the productivity of newly reclaimed land, together with the development of varieties suited to the different conditions of these nontraditional areas of production.