Status and scope for production of Faba bean in the Mediterranean countries

Saxena M.C.

in

Cubero J.I. (ed.), Saxena M.C. (ed.).
Present status and future prospects of faba bean production and improvement in the Mediterranean countries

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 10

1991
pages 15-20

Status and scope for production of faba bean in the Mediterranean countries

M.C. SAXENA
FOOD LEGUME IMPROVEMENT PROGRAM
INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH
IN THE DRY AREAS (ICARDA)
P.O. BOX 5466, ALEPPO, SYRIA

SUMMARY - Faba bean, being a crop of Mediterranean origin, plays an important role in the farming systems of the countries around the Mediterranean sea. Besides being an important food crop, it contributes to feed and fodder supply for livestock and affects positively the soil productivity for the cereal crops grown in rotation. The Mediterranean basin countries account for nearly 25% of total global area and production of faba bean in the world and the average yield in this region is nearly the same as the world average. However, there is a great potential for improving the productivity and yield stability if the biotic and abiotic stress factors are effectively controlled and inherent yield potential of the cultivars is improved. Active research groups have developed in the region which have interacted well with institutions such as ICARDA and CIHEAM. The networks so developed will have to shoulder increasing responsibility of research on this crop as ICARDA plans to transfer crop improvement research function to the national programs retaining only the germplasm resource and information dissemination activities within its future mandate.

RESUME - "Situation actuelle et perspectives de la production de fève dans les pays méditerranéens". La fève, une culture d'origine méditerranéenne, joue un rôle important dans les systèmes agricoles des pays de la Méditerranée. Elle n'est pas seulement importante pour la nutrition humaine mais elle contribue aussi à l'approvisionnement en fourrage et concentré pour le bétail tout en ayant un effet positif sur la productivité du sol pour les céréales qui font partie de la rotation. Les pays du bassin méditerranéen couvrent presque 25% de la surface totale cultivée et de la production mondiale de fèves, et le rendement moyen dans la région est très proche de la moyenne mondiale. Cependant, il existe un certain potentiel pour améliorer la productivité et la stabilité du rendement si l'on arrive à contrôler d'une façon efficace les facteurs de stress biotiques et abiotiques et si l'on peut améliorer les potentiels de rendement des cultivars. Des groupes de recherche se sont formés dans la région et ont une bonne interaction avec des institutions telles que l'ICARDA et le CIHEAM. Les réseaux ainsi développés devront faire face à une responsabilité croissante concernant la recherche sur cette culture, étant donné que l'ICARDA envisage de transférer des activités de recherche pour l'amélioration de cette culture aux programmes nationaux, en gardant seulement les ressources phytogénétiques et les activités de diffusion de l'information pour son prochain mandat.

Introduction

Faba bean (*Vicia faba* L.) is one of the earliest domesticated food legumes in the World. Although its origin is still unclear (Ladizinsky *et al.*, 1988) it is widely believed to have originated in the Mediterranean – West Asia region probably in the late Neolithic period (Bond, 1976; Cubero, 1974; Witcombe, 1982). On the basis of the botanical evidence available, various suggestions have been made that the crop originated in North Africa, region south of the Caspian Sea and West and Central Asia. Numerous ancient writers have referred to the cultivation of faba bean, and one of the oldest references is in an ancient Sumerian cuneiform text dated to the early part of the second millennium B.C. No progenitor of faba bean is known but other evidences suggest that the center of diversity and cultural origin was somewhere in the Near or Middle East, and the culture of the species radiated out in four directions: to North Africa, South Europe, North Europe and Far–East (Cubero, 1984). The strong Mediterranean linkage is also indicated by the diversity of the usage to which faba bean is put in the diets of the people in this area.

Importance

The Mediterranean origin of the crop imparts a special significance to faba bean in the agriculture of the Mediterranean basin, where it has multiple functions in the traditional farming systems. It is a cheap source of good quality protein for human diet to complement and enrich the cereal dominated food of the poorer section of the population and an item to bring variety and flavour to the foods of those with better economic status. Its dry seeds are consumed as a pulse and as different snack–foods and the green immature beans are used fresh or pickled as garnish for main dishes, cooked as vegetable or eaten fresh as dessert. Dry seeds and fresh beans are also canned and dry seeds, particularly of the *minor* variety of *Vicia faba*, are used for making compound animal feed. The significance of the latter will further increase in the Mediterranean basin countries as they attempt to reduce the import of soybean and soymeal because of economic reasons. The green haulms and dry straw are used as fodder and there has been a long tradition of using dry chopped straw for brick–making in this region.

The crop also plays an important role in improving the productivity of the cereal crops in the rainfed farming systems in the Mediterranean region through improvement in physical, chemical and biological properties of the soil. Yields of rainfed cereal crops following faba bean have been higher than those in a continuous cereal rotation and almost at par with the cereal crop following a fallow in Tel Hadya, Syria (Saxena, 1988). Beneficial effect of rainfed faba bean on rainfed wheat was also observed at Meknes, Morocco and one of the factors responsible for this improvement was the greater depth and proliferation of roots of wheat following faba bean than following wheat (Ben Bellah, personal communication). In addition, rainfed faba bean is able to fix nearly 80 kg N/ha in the Mediterranean environments through symbiosis (Saxena, 1988) and this can account for a substantial influx of nitrogen in the farming systems of dry areas where fertilizer input is generally minimal because of risks associated with the uncertainty of rain.

Area, production and yield

The annual global area for the period 1985–87 under faba bean was 3.24 million ha as against 3.68 million ha for the period 1979–81 (Table 1). This shows a reduction of 12% in last six years. The global production, however, did not change and remained around 4.3 million tons (Table 1) because of rise in the productivity of the crop from 1162 kg/ha in the period 1979–81 to 1328 kg/ha in the period 1985–87.

The major agroecological regions that contribute to faba bean production include (a) Far–East, (b) West Asia, (c) North Africa, (d) Nile Valley and Ethiopia, (e) Europe, and (f) Central and South America. Of these geographical regions, major parts of West Asia, North Africa, parts of Nile Valley and parts of Europe have Mediterranean environment. On the basis of statistics for 1985–87 the countries around the Mediterranean sea account for 25% of area (0.810 million ha) and 26% of production (1.109 million tons) of faba bean in the world with the mean yield (1369 kg/ha) being only marginally higher than the world average (1328 kg/ha).

Table 1. Faba bean (dry), area, production and yield in different major production regions in the world.

Regions	Area (000 ha)		Production (000 t)		Yield (kg/ha)	
	1979-81	1985-87	1979-81	1985-87	1979-81	1985-87
WORLD	3685	3241	4285	4305	1162	1328
AFRICA	739	860	912	1121	1233	1328
North Africa	289	348	178	269	706	748
Algeria	48	77	27	32	573	412
Libya	7	8	7	9	1007	1012
Morocco	165	203	97	193	560	954
Tunisia	69	60	47	36	682	615
Nile Valley	122	155	256	351	2108	2208
Egypt	103	125	219	302	2134	2762
Sudan	19	30	37	49	2082	1653
Ethiopia	328	357	476	500	1458	1402
ASIA	2318	1763	2716	2388	1171	1354
China	2267	1700	2633	2283	1161	1343
West Asia	49	63	81	104	1369	1253
Cyprus	1	2	2	2	1429	1285
Iraq	10	7	12	8	1215	1018
Jordan	<1	1	<1	1	683	553
Syria	8	8	14	13	1772	1605
Turkey	30	45	53	80	1748	1805
EUROPE	354	300	480	569	1355	1887
Mediterranean	304	244	385	385	1589	1680
France	23	39	70	133	3063	3403
Greece	5	4	11	6	2048	1778
Italy	161	126	205	171	1277	1352
Portugal	36	25	21	19	586	768
Spain	79	50	78	56	972	1099
SOUTH AMERICA	200	205	92	110	458	536

Source: FAO (1988)

Of the total area of faba bean in the Mediterranean basin, North Africa accounts for major share (43%) followed by Mediterranean Europe (30%), Nile Valley (19%) and West Asia (8%). However, the productivity in North Africa is lower (748 kg/ha) than in the Nile Valley (2208 kg/ha), Mediterranean Europe (1680 kg/ha) and West Asia (1253 kg/ha). Therefore the production in the Nile Valley and Mediterranean Europe far exceeds that of North Africa and the percentage contribution of these geographical regions and West Asia to the total production of faba bean in the Mediterranean basin comes to 32, 35, 24 and 9%, respectively.

The moisture supply seems to play a dominant role in determining the productivity in these regions. The yields in the Nile Valley and the Mediterranean Europe are higher than in North Africa because the crop is generally fully irrigated in the Nile Valley and the total seasonal precipitation in the faba bean growing areas in the Mediterranean Europe is not as low and uncertain as in North Africa. In West Asia the yields are higher than in North Africa again because perhaps a larger proportion of the crop is either grown under irrigation or under higher rainfall conditions of the Mediterranean coast.

Prospects for yield increase

Amongst the leguminous crops grown in the Mediterranean region faba bean seems to have highest yield potential. However, the species shows very high sensitivity to various elements of environment: photoperiod, thermal regimes, moisture supply and soil fertility. Over the long period of its cultivation, the crop has undergone large natural selection and selection by man and therefore ecotypes and cultivars specifically adapted to different sets of environmental combinations have developed. This narrow adaptation to environment has been a great challenge to plant breeders.

Genotypes adapted to specific environments, when grown with appropriate husbandry and care, show an impressive yield potential which is several times higher than the average yields obtained in the Mediterranean basin. For example, in a study conducted during 1981/82 and 1983/84 at the Tel Hadya station of ICARDA in North Syria (Saxena *et al.*, 1986), where four contrasting cultivars of faba bean were grown under three different soil environments: A = maximum growth condition provided with artificial rooting medium, liquid NPK fertilizer and assured moisture supply through supplemental irrigation, and protection against diseases, pests and lodging; B = normal soil and cultural conditions including small maintenance dose of phosphorus, 22 kg P/ha, assured moisture supply through supplemental irrigation; and C = same as B but without any supplemental irrigation; seasonal precipitation was 355 mm in 1981/82 and 230 mm in 1983/84. It was possible to achieve a yield level of 6 t/ha (Table 2). In large plot trials under farmers conditions in Egypt and Sudan, where faba bean is grown with assured moisture supply, yields of over 4 t/ha have been harvested. However, in order to be able to achieve these yield levels, there is a need for having genotypes well adapted to local environments. For example in the study at ICARDA, it was clear that only those varieties that were adapted to the Mediterranean environment available in North Syria during winter sowing (i.e. 'Aquadulce' and 'Giza–3') could attain high yield levels whereas the North European varieties did not perform as well in spite of getting maximum growth conditions (Table 2).

Table 2. Yield, harvest index, and water-use efficiency based on total seasonal moisture supply (rain + irrigation) of four contrasting faba bean cultivars at Tel Hadya, Syria, as affected by soil moisture and soil fertility treatments. Tel Hadya 1981/82 and 1983/84.

Cultivar	Soil environment[a]	Total biological yield (kg/ha)		Seed yield (kg/ha)		Harvest index		Water use efficiency for seed yield	
		1981/82	1983/84	1981/82	1983/84	1981/82	1983/84	1981/82	1983/84
Minica	A	9414	9637	4578	3564	0.49	0.37	8.8	8.8
	B	6263	4455	3131	1864	0.50	0.41	6.0	11.5
	C	2061	967	970	191	0.47	0.20	2.8	0.8
Aquadulce	A	11345	14691	6008	6073	0.53	0.41	12.0	15.0
	B	8121	6611	4909	3040	0.60	0.46	9.8	7.9
	C	2909	2061	1620	897	0.56	0.44	4.8	3.9
Giza-3	A	9818	13552	5689	5976	0.58	0.44	17.3	14.8
	B	7333	5762	4101	2618	0.56	0.45	8.2	6.8
	C	2828	2029	1479	1074	0.52	0.53	4.4	4.7
Herz-freya	A	7636	10364	3317	3080	0.43	0.30	6.4	7.6
	B	6909	–	2812	–	0.41	–	5.4	–
	C	1495	904	578	211	0.39	0.23	1.7	0.9

[a]See text for explanation

Major constraints to production

The major constraints that limit the realization of full yield potential of faba bean and cause instability in the yield are both abiotic and biotic. Their relative importance, however, varies depending on the geographical location and the agroecological conditions of the crop production.

The main abiotic stresses in the Mediterranean area include cold early in the crop season, drought at various stages of growth, and heat during the reproductive growth and pod filling stages. Salinity also constraints production in some of the coastal areas.

The main biotic stress factors encountered in the Mediterranean basin are mentioned below.

Major diseases

- Fungal diseases
  - Chocolate spot (*Botrytis fabae* Sard.)
  - Ascochyta blight (*Ascochyta fabae* Speg.)
  - Rust (*Uromyces viciae fabae* (Pers.) Schroet)
  - Root and Stem Rots
- Viruses
  - Alfalfa Mosaic Virus (AMV)
  - Bean Leaf Roll Virus (BLRV)
  - Bean Yellow Mosaic Virus (BYMV)
  - Broad Bean Mottle Virus (BBMV)
  - Broad Bean Stain Virus (BBSV)
- Nematodes
  - Stem Nematode (*Ditylenchus dipsaci* (Kuhn) Filipjev)
  - Root Lesion Nematode (*Pratylenchus* spp.)
- Parasites
  - Broomrape (*Orobanche crenata* Forsk.)
  - *Cuscuta* spp.

Major insect pests

- Field pests
  - Aphids (*Aphis fabae* Scop., *A. craccivora* Koch, etc.)
  - Sitona weevil (*Sitona lineatus* L., *S. limosus* Rossi)
  - Leafminer (*Liriomyza congesta* Becker)
  - Army worm (*Spodoptera exigua* Hubner)
  - Pod borer (*Helicoverpa armigera* Hubner)
  - Stem borer (*Lixus algirus* L.)
  - Thrips (*Thrips tabaci* L., *Caliothrips impurus* Pries.)
- Storage pests
  - Bean seed beetles (*Bruchus rufimanus* Boheman, *B. dentipes* Bawdi).
  - Cowpea seed beetle (*Callosobruchus maculatus* F.)
  - Adzuki bean beetle (*C. chinensis* L.)
- Vertebrates
  - Birds, rats, voles, mice, etc.

Realization of full yield potential of the cultivars and of the natural endowments of the environment would necessitate that the influence of these stress factors is kept to the minimum. Research to improve the resistance/tolerance of the cultivars of faba bean to these stress factors as well as to develop integrated pest and disease control is key to obtaining high and stable yields of faba bean.

Research networks and future research thrust

Research on removing the above mentioned constraints to production or reducing their negative effect on the productivity of faba bean has been underway in many national programs in the Mediterranean basin where multi–disciplinary research teams have developed. These are effectively interacting, in conducting joint research, with international centers such as ICARDA and CIHEAM, both of which have functions to encourage research and training in the improvement of faba bean. ICARDA was assigned world mandate for research and training function for this important crop by the Consultative Group on International Agriculture Research (CGIAR). Having worked for more than 11 years on this crop, substantial progress has been made at ICARDA in improving this crop and results have been reviewed in various ICARDA publications (Hawtin and Webb, 1982; Saxena and Stewart, 1983; Saxena and Varma, 1985), including Annual Reports, international journals, and the proceedings of the First International Conference on Cool Season Food Legumes held at Spokane, Washington in July 1986 (Summerfield, 1988).

The networking done by ICARDA through the International Food Legume Nursery and Trial Program and through the regional programs has led to the development of research groups that specialize in tackling specific problems for the eventual benefit of all the countries in the Mediterranean basin. Some examples, by no means complete, are given below:

– Alternative plant types:	Egypt, France, Turkey, ICARDA
– Aphid resistance:	Egypt, Sudan, ICARDA
– Ascochyta blight resistance:	France, ICARDA

– Biological nitrogen fixation:	France, ICARDA
– *Botrytis* resistance:	Egypt, Morocco, Tunisia, France, ICARDA
– Cold tolerance:	France, W. Germany, Turkey, ICARDA
– Germplasm collection/conservation:	Italy, ICARDA
– Land races:	Tunisia, Morocco, ICARDA
– *Orobanche* control:	Egypt, Morocco, Spain, ICARDA
– Nematode resistance:	France, Morocco, Tunisia, ICARDA
– Quality and use:	Egypt, France, ICARDA
– Rust resistance:	Egypt, ICARDA
– Wide–crossing, genetics:	Spain, ICARDA

Research carried out by these groups will be presented in this Seminar and should serve as a solid base for researches to be carried out in the future so that the productivity and yield stability of the crop in the Mediterranean basin could further be improved. This Seminar has come at the most opportune time in the history of the development of ICARDA, as it moves forward to execute its plan of transferring major crop improvement research responsibility to the respective national programs and of working with them from a base in North Africa to ensure that the gains of research on faba bean improvement in the past are consolidated and brought to bear on the ongoing research in the region. Working with institutions such as CIHEAM in strengthening the networks for faba bean research, and restricting its own direct activity in future to collection, conservation, evaluation and distribution of faba bean germplasm, information dissemination and training, ICARDA aims to fulfil the recent CGIAR directive for the Center regarding this important grain legume.

The major research objectives for the future have to cover much of the same aspects as have been identified earlier to consolidate research gains made in the past and to solve the newer problems that may become serious in the future. The main objectives, should be:

- Increased yield potential through the improved plant type and improved physiological functions.
- Improved yield stability to be obtained by incorporating disease and pest resistance; frost, drought and heat resistance, and reducing the dependence of the crop for pollination on the pollinating insects.
- Improving the contribution of faba bean in the cropping systems by increased biological nitrogen fixation.
- Developing integrated control of pests, diseases and parasites.
- Reducing post harvest losses and diversifying post–harvest uses and improving nutritional value.

Research will also have to be undertaken for improving the techniques adopted for faba bean crop improvement work. Some of the topics that need consideration are as follows:

- Gene mapping in wild relatives as well as cultigens and development of techniques for identification of desirable genes in the progenies.
- Techniques for wide crossing and *in vitro* culture.
- Improved techniques for screening breeding material for biotic and abiotic stresses.
- Understanding the mechanisms for resistance and tolerance to various stress factors.
- Improved techniques for screening breeding material for nutritional factors.

References

BOND, D.A. (1976): Field bean, *Vicia faba (Leguminosae* Papilionatae). Pages 179–182 *in* Evolution of Crop Plants (Simmonds, N.W., ed.). Longman, London, U.K.

CUBERO, J.I. (1974): On the evolution of *Vicia faba*. Theoretical and Applied Genetics *45*:47–51.

CUBERO, J.I. (1984): Taxonomy, distribution and evolution of the faba bean and its wild relatives. Pages 131–144 *in* Genetic Resources and their Exploitation: Chickpeas, Faba beans and Lentils (Witcombe, J.R. and Erskine, W., eds.). Martinus Nijhoff/Dr. W. Junk Publishers for ICARDA and IBPGR.

FOOD AND AGRICULTURE ORGANIZATION (FAO) OF THE UNITED NATIONS (1988): Page 33 *in* FAO Yearbook Production, No. 41, 1987. FAO, Rome, Italy.

HAWTIN, G. and WEBB, C. (eds.) (1982): Faba Bean Improvement. Proceedings of the Faba Bean Conference held in Cairo, Egypt, March 7–11, 1981. Martinus Nijhoff Publishers, The Hague, The Netherlands, 398 pp.

LADIZINSKY, G, PICKERSGILL, B. and YAMAMOTO, K. (1988): Exploitation of wild relatives of the food legumes. Pages 967–978 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Kluwer Academic Publishers, London, U.K.

SAXENA, M.C. (1988): Food legumes in the Mediterranean type of environment and ICARDA's efforts in improving their productivity. Pages 11–23 *in* Nitrogen Fixation by Legumes in Mediterranean Agriculture (Beck, D.P. and Materon, L.A., eds.). Martinus Nijhoff Publishers, Dordrecht, The Netherlands.

SAXENA, M.C., SILIM, S.N. and MURINDA, M.V. (1986): Effect of moisture supply and fertilizer application on the yield build–up of some contrasting faba bean genotypes. Vortraege fuer Pflanzenzuechtung *11*:40–48.

SAXENA, M.C. and STEWART, R.A. (eds.) (1983): Pages 123–128 *in* Faba Bean in the Nile Valley. ICARDA/IFAD Nile Valley Project and Martinus Nijhoff Publishers, The Hague, The Netherlands.

SAXENA, M.C. and VARMA, S. (eds.) (1985): Faba Beans, Kabuli Chickpeas, and Lentils in the 1980s: An International Workshop. Proceedings of the Workshop, 16–20 May 1983. ICARDA, Aleppo, Syria, 395 pp.

SUMMERFIELD, R.J. (ed.) (1988): World Crops: Cool season food legumes. Kluwer Academic Publishers, London, U.K. 1177 pp.

WITCOMBE, J.R. (1982): Genetic resources of faba beans. Pages 1–13 *in* Faba Bean Improvement (Hawtin, G. and Webb, C., eds.). Martinus Nijhoff Publishers, The Hague, The Netherlands.