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Faba bean (*Vicia faba* L.) cultivation and research in Italy

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SUMMARY - In Italy, faba bean is the main grain legume crop for dry seed production and the sixth most important crop after wheat, maize, barley, sugarbeet, and oat. Faba bean is also the third legume crop in importance, used for fresh seed consumption (after common bean and peas), and the fourth most important forage crop sown in annual monocolture herbage (after maize, crimson clover, and oat). Despite this situation, the area sown to this crop decreases 2.4% every year, and it dropped from 558,000 ha in 1953 to 110,800 ha in 1988, and this trend continues. The main production constraints are: (a) the increasing preference of meat proteins to the legume proteins in the human diet; (b) the reduction of the work animal population (i.e. horses) that are fed mainly with faba bean dry seeds; and (c) the limited number of high yielding, biotic (*Orobanche*, black bean aphid) and abiotic (frost, drought) stress tolerant, genetically stable, cultivars. Basic and applied coordinated research efforts have been made at national level to overcome the productivity limits and reduce the negative trend in faba bean cultivation.

*RESUME - "La culture et la recherche sur la fève (*Vicia faba *L.) en Italie". En Italie, la culture de la fève occupe la première place parmi les légumes secs, et la sixième place après la culture du blé, maïs, orge, betterave sucrière, et avoine. Elle est également au troisième rang parmi les légumes verts dont les graines sont utilisées pour la consommation en frais (après les haricots verts et les petits pois), et au quatrième rang parmi les cultures fourragères semées en monoculture annuelle (après le maïs, le trèfle incarnat, et l'avoine). Malgré cette situation, la surface cultivée en fève diminue de 2,4% chaque année, passant de 558.000 ha en 1953 à 110.800 ha en 1988, et cette tendance continue. Les principaux facteurs limitants pour sa production, sont : (a) la préférence grandissante accordée aux protéines animales par rapport aux protéines végétales dans le régime humain ; (b) la réduction du nombre d'animaux de labeur (par exemple, le cheval) qui s'alimentent principalement de fèves sèches; et (c) le nombre réduit de cultivars à haut rendement, résistants aux conditions adverses biotiques (*Orobanche, *aphide noir) et abiotiques (gelées, sécheresse), génétiquement stables, et dont les semences soient certifiées. De grands efforts coordonnés de recherche ont été accomplis à l'échelle nationale sur les aspects théoriques et appliqués afin d'améliorer la productivité et de stopper cette tendance négative dans la culture de la fève.*

Importance, production and farming system of faba bean cultivation in Italy

In Italy half of the 90 g of protein consumed per capita every day is from crop plants (Porceddu *et al.*, 1979a; Foti, 1979b). Considering an average per capita daily legume consumption of 11 g dry seeds and 31 g of fresh seeds and pods (Table 1) (Fidanza, 1979) and adjusting for moisture and protein content, it means that of the 45 g/day/per capita of plant protein consumed in Italy in 1979, 5 g or 11% comes from legume plants. Because in 1979, 19% and 61% of fresh and dry seed legume production respectively, were represented by faba bean seeds, and assuming all the faba bean seeds produced are used for human nutrition, it means that at the most 2.2 g (or 5%) of the daily intake of plant protein in the diet is from faba bean. Considering that these are overestimated figures, it can be implied that faba bean in Italy is used in very low amounts for human nutrition. On the other hand faba bean dry seeds and green forage are traditional components of livestock rations.

The faba bean varieties used for human nutrition (mainly as fresh seeds and also as dry seeds) belong to the *V. faba major* botanical group, whereas the *V. faba*

Table 1. Legume consumption in Italy (g/day/per capita)[a].

Period	Dry Seed	Fresh seed and pods
1981-1985	33.2	7.1
1901-1905	38.1	7.9
1926-1930	35.3	8.8
1951-1955	14.8	17.5
1965-1969	14.8	26.6
1971-1973	12.3	24.7
1976-1978	10.7	30.7

[a]Elaborated from Fidanza (1979)

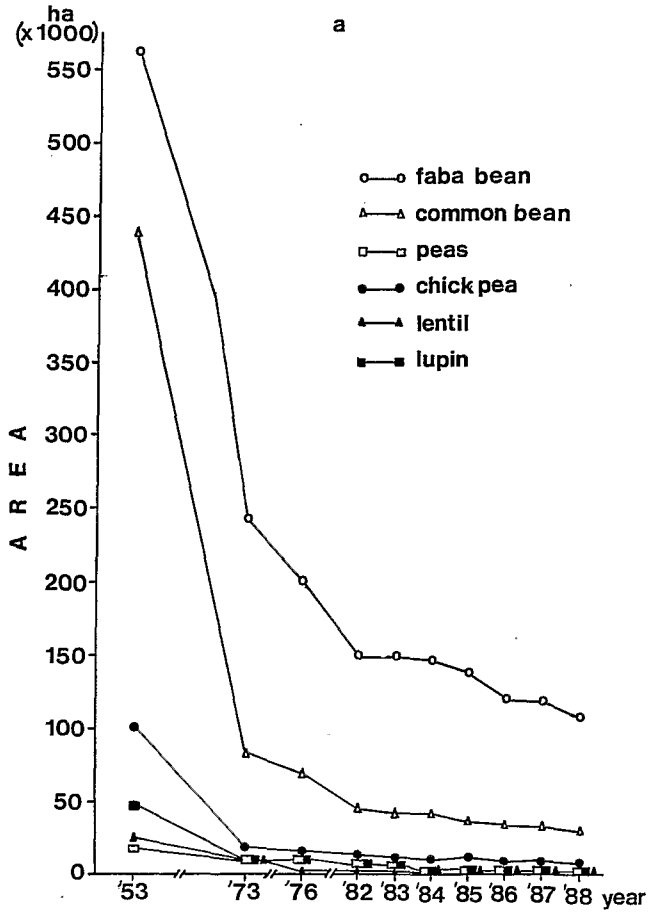

Fig. 1a. Area sown with faba bean and other legume crops in Italy (Source: ISTAT).

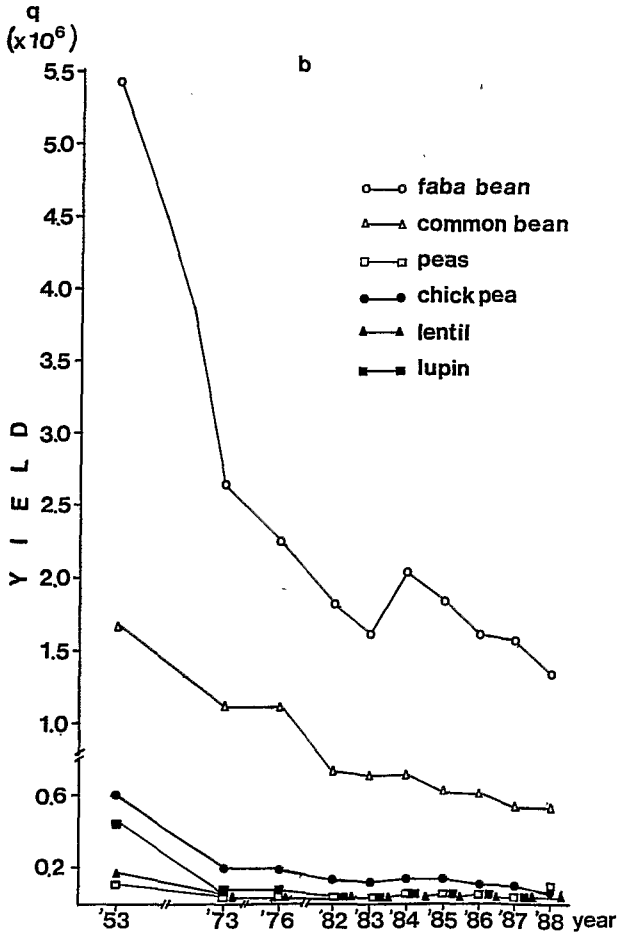

Fig. 1b. Dry seed production of faba bean and other legume crops in Italy (Source: ISTAT).

minor and *V. faba equina* botanical types are used for animal feeding.

In the current Italian farming systems, faba bean is cultivated as annual winter crop in semiarid environments for dry seed production, with occasional irrigation if the crop is to be used for fresh seed production or forage.

Production of major and *minor* faba bean types

The highest grain yield is obtained from October sowing, at a density of about 30 plants/m^2. In 1953 there were 558,000 ha devoted to this crop from which 0.53 million metric tons of dry seeds were produced (Fig. 1a and 1b); in 1973, only 43% of this area was used to grow faba bean, and in 1988 the faba bean crop area further decreased to 110,800 ha (which is only 20% of the area cultivated 35 years earlier) that gave a total dry seed production of 0.13 million metric tons. These data indicate that from 1953 to 1988 a 2.3% yearly decrease in crop area took place. The same decrease in crop area (-2.4% every year) was observed in the same period for

the other grain legume crops (common bean, peas, chickpea, lentil, lupin, and vetch).

Despite this trend, faba bean remains the most largely grown grain legume in Italy. In fact, 45.7% of the total grain legume crop area was devoted to faba bean in 1953, and this proportion steadely increased up to 68% in 1985. In the same period the faba bean yearly production accounted for 62% of the national dry grain legume yield (excluding soybean and *Arachis*) (Table 2).

Ninety percent of the faba bean area and production is obtained from the region between 37°00' and 42°40' latitude north, that include 46% of the Italian territory (Fig. 2). The regions in which faba bean is largely grown are Sicily, Apulia, Calabria, and Sardinia (Fig. 3a and 3b).

Production of *major* faba bean type for fresh consumption

The appropriate sowing time for this type of production is the end of October, at a rate that allows a plant density of 20 plant/m^2 in rows 50 cm apart. About 20,000 ha are used to grow major type faba bean for fresh seed consumption with an average production of 0.11 million metric tons (Table 3). This production represents 20% of the total legume crops (common bean, peas, and faba bean) grown in Italy for fresh seed consumption. The average yield/ha was 6.3 t/ha in 1982 which decreased to 5.45 t/ha in 1988. This yield is about 2.0 t less than the utilizable beans per ha obtained by the other legumes grown for fresh consumption (common bean and peas).

Production of *minor* and *equina* faba bean types for green fodder production

Forage production is mainly obtained from annual faba bean crop grown as monoculture, sometimes in irrigated conditions. The highest yield is obtained from crops sown in October at a rate that allows a plant density of at least 80 plants/m^2. The total sown area is around 36,000 ha (Table 4), from which an average of 0.8 million metric tons of green fodder (equivalent to 1x10^8 forage int. units) is obtained. This crop output makes faba bean the third most important annual specialized forage crop in Italy after maize and crimson clover.

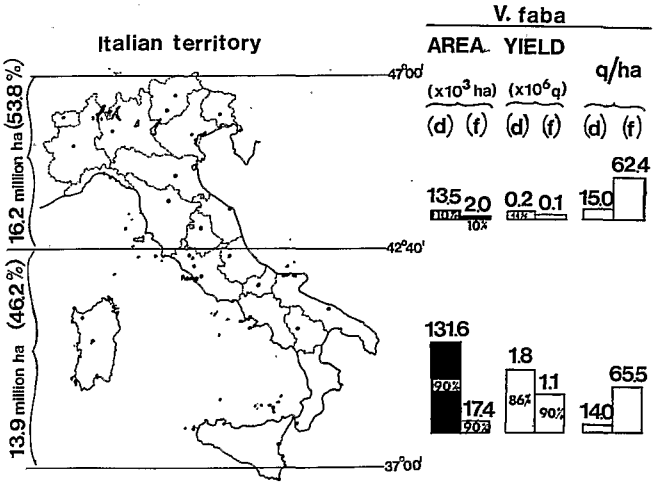

Fig. 2. Faba bean cultivation for dry (d) and fresh (f) seed production in Italy (Source: ISTAT).

Table 2. Area, production and yield of faba bean and other legume crops (common beans, peas, chickpea, lentil, lupin and vetch) grown in Italy for dry seed.

Year	Area (000 ha)			Production (000 t)			Yield (t/ha)	
	Faba bean	Other grain legumes	% of faba bean	Faba bean	Other grain legumes	% of faba bean	Faba bean	Other grain legumes
1953	558.0	661.8	45.7	535.7	317.2	62.8	0.96	0.45
1973	240.0	125.6	65.6	264.0	167.0	61.3	1.10	1.33
1976	200.0	110.3	64.4	222.0	150.6	59.6	1.11	1.36
1982	149.7	73.7	67.0	182.5	109.3	62.5	1.22	1.48
1983	148.4	71.2	67.6	167.2	102.8	61.9	1.13	1.44
1984	145.1	69.4	67.6	205.2	106.8	65.8	1.41	1.54
1985	135.8	64.0	68.0	183.9	91.7	66.7	1.35	1.43
1986	120.1	58.3	67.3	165.9	87.3	65.5	1.38	1.50
1987	120.8	54.6	68.9	163.1	80.0	67.1	1.35	1.46
1988	110.8	52.0	68.0	134.8	81.8	62.2	1.22	1.57

Source: ISTAT

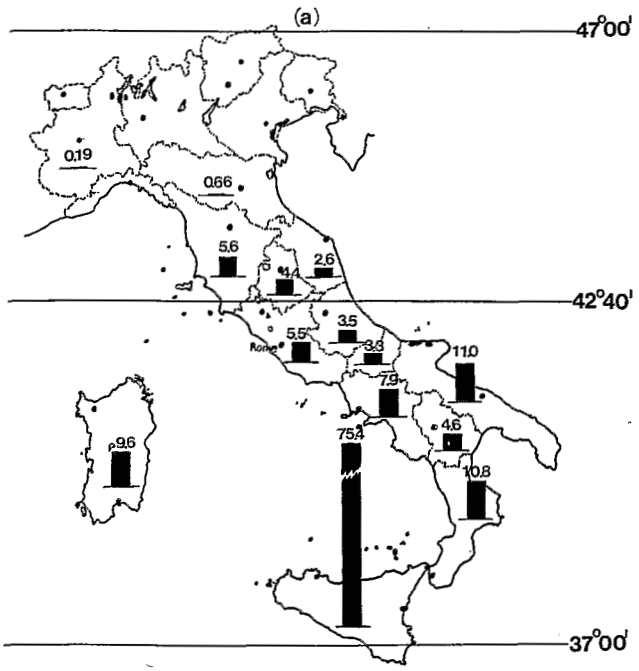

Fig. 3a. Area (000 ha) sown with faba bean in Italy in 1984 for dry seed production (Source: ISTAT).

Fig. 3b. Area (000 ha) sown with faba bean in Italy in 1984 for fresh seed production (Source: ISTAT).

Table 3. Area, production and yield of faba bean and other legume crops (common beans and peas) grown in Italy for fresh seed production.

Year	Area (000 ha)			Production (000 t)			Yield (t/ha)	
	Faba bean	Other legume crops	% of faba bean	Faba bean	Other legume crops	% of faba bean	Faba bean	Other legume crops
1982	19.9	70.5	22.0	125.5	511.9	19.7	6.31	7.26
1983	19.6	68.3	22.3	123.4	499.8	19.8	6.29	7.32
1984	19.3	66.0	22.6	126.2	500.4	20.1	6.52	7.58
1985	20.1	66.0	23.3	132.1	529.5	20.0	6.56	8.02
1986	17.5	63.4	21.6	113.4	479.5	19.1	6.48	7.57
1987	18.8	60.3	23.8	112.8	460.6	19.7	5.99	7.64
1988	20.2	58.8	25.6	110.0	436.4	20.1	5.45	7.41

Source: ISTAT

The data mentioned above indicate that the total area used to grow faba bean (for dry seed, fresh seed, and forage production) was around 204,000 ha in 1983 and 175,424 in 1987; this area corresponds to 2.2% and 1.9% of the land used to grow annual seed and forage crops (Table 5), which makes faba bean the sixth most important crop in Italy, after wheat, maize, barley, sugarbeet, and oat. However, the current faba bean and other grain legume production is not sufficient for the Italian market demand, and it has been estimated (Foti, 1979a) that every year over 50,000 tons of dry faba bean seeds are imported.

Table 4. Faba bean cultivation for forage production in annual and monoculture herbage in Italy.

Year	Area (ha)	Production (000 t)	F.U.[a] (x 10^6)
1983	36,501	758.9	96
1984	39,103	838.2	106
1986	36,665	894.7	112
1987	35,784	801.4	101

[a]F.U. = Forage Int. Units
Source: ISTAT

Table 5. Total area (ha) sown with faba bean in Italy for producing dry seeds, green seeds and forage (cut green fodder).

Year	Dry seeds	Green seeds	Forage	Total	%[a]
1982	149,660	19,895	DNA[b]	–	–
1983	148,396	19,599	36,506	204,501	2.2
1984	145,178	19,356	39,106	203,640	2.2
1985	135,814	20,138	DNA	–	–
1986	120,120	17,494	36,665	174,280	1.9
1987	120,820	18,818	35,784	175,424	1.9
1988	110,766	20,203	DNA	–	–

[a]Percentage of the Italian annual crop area sown with faba bean, considering that in 1983 9,050,000 ha were sown with annual crops
[b]Data non available
Source: ISTAT

Faba bean production constraints

The main reasons for a drastic (80%) decrease in faba bean production in last 35 years were: (a) lack of well characterized faba bean cultivars for dry seed production; (b) low yielding ability, low level of heterozygosity, and high genotype x environment interaction showed by the faba bean populations; (c) low tolerance to biotic (*Orobanche*, *Aphis fabae, Botrytis fabae,* etc.) and abiotic (frost, drought) stresses in the faba bean populations, mainly those having large seeds (*major* types); (d) insufficient agrotechnical information (i.e. optimal plant density, critical growth phase for water supply, weed control, etc.) and mechanical harvesting of the large seeded cultivars; (e) the decreased demand in the human diet of proteins from legume seeds; (f) the farmer preference to grow winter crops that assure higher incomes, such as durum wheat; (g) lack of diversified use of the faba bean seeds although there have been positive results in setting a process to remove deleterious fractions, and for preparation of concentrates (Foti, 1979a; Pompei, 1979).

According to Foti (1979b), the production and productivity constraints mentioned above are not the cause but the consequence of the decrease of faba bean cultivation area in Italy. In fact, Foti (l.c.) suggested that the primary cause of reduction in the faba bean growing area should be found in the following: (a) the increasing preference for meat proteins to the legume proteins in the human diet; (b) the decreased population of work animals (i.e. horses, cows, etc.) which were fed rations rich in dry (grounded or wetted) faba bean seeds; and (c) the lack of high yielding, genetically stable, and certified cultivars.

Probably, out of the three causes listed, the first two (especially the second) are not so important since there is a great demand of faba bean dry seeds to be used in feed rations of livestock in place of the imported soya bean seeds. The third cause is a serious one. As a matter of fact, in order to sow the 36,500 ha of faba bean for forage production in 1984, it was necessary to have 7,200 t of certified seeds; however, only 1,000 t of certified seeds were distributed to the farmers in that year (ISTAT, 1984) and these came only from five faba bean cultivars ('Manfredini', 'Gemini', 'Torre Lama Bianco', 'Torre Lama Scuro', 'Vesuvio') included in the National Register. It was also necessary to have about 6,000 t of certified seeds (considering 30 seeds/m^2 and a seed weight of 1 g) for sowing the 19,895 ha of faba bean for fresh seed consumption, but only 900 t were available (ISTAT, 1982-1988). The five cultivars indicated for green fodder production are also the only certified cultivars used for dry seed production. This means that the majority of the farmers' fields are sown with local populations in which outcrossing, seed mixture, and genetic drift cause the instability of the gene frequency and change in the genetic properties and performance of these populations from year to year. Therefore in the near future, new faba bean cultivars need to be produced. These cultivars should have genes for tolerance to the main biotic (*Orobanche* and black bean aphid mainly for cultivars that will be grown in the principal faba bean growing area such as Sicily, Puglia, Calabria and Sardinia) and abiotic (frost, drought) stresses, and be endowed with a high level of heterozygosity (i.e. the cultivars should be mainly synthetic varieties).

The main aspects related to the above problems have been reviewed extensively in the Italian literature and the breeding activities that are needed to attempt a scientific solution to them have been described (Scarascia Mugnozza *et al.*, 1979). In the following section an overview of the Italian research Institutions involved in breeding as well as agrotechnical studies to promote faba bean cultivation will be given.

Currently operating research system and major research achievements

In order to overcome the production constraints listed in the previous sections, four main collaborative research programs have been developed in Italy:

- The EEC Plant Protein Project (1976-1980) in which Italian Research groups participated in a joint effort at European scale, to assess the yield potential of the available cultivars for dry seed production, and to study the breeding methods suitable to constitute new faba bean cultivars.
- The CNR (National Research Council) five-year (1976-1980) Project on "Improvement of agricultural productivity through genetic interventions", subproject grain legumes.
- The CNR-IPRA five-year (1982-1987) project to study innovative approaches to increase agricultural productivity, in which several working groups dealt with *V. faba* basic research.
- The MAF (Ministry of Agriculture and Forestry) two-year (1986-1987, with a possible extension to four years) project on "Research and interventions for the quantitative and qualitative improvement of grain legume crops", subproject faba bean, chickpea and lentil.

In the EEC project the main achievements were reported in the proceedings of several meetings, one of which took place in Italy (Bond *et al.*, 1979), and the most important practical results were obtained in the "Joint Field Bean Test (JFBT)" (Dantuma *et al.*, 1983). The JFBT was carried out in 12 locations in Europe, and *major* and *minor* spring type cultivars from United Kingdom, Federal Republic of Germany, France, and The Netherlands, were included. In Italy, the JFBT was carried out in winter sowing at latitude 45°30' (by the Agronomy Institute of the University of Padua) and 41°00' (by the Plant Breeding Institute of University of Bari), and under these conditions it was possible to assess that: (a) the major types (i.e. cv 'Minica' and others included in European Register) were the best yielding cultivars although no one of the tested cultivars produced better than the local check, mainly at southern latitude; (b) only those cultivars showing reduced vegetative growth (i.e. cv 'Minica') are suitable in Italian environments.

In the CNR-FP 1976-1980 project, the aims were towards the improvement of faba bean cultivation in Italy by evaluating germplasm collections of local populations from all over the world, and selecting new lines through different breeding procedures. The results of the research activities have been published in several proceedings (Foti, 1979a; Pompei, 1979) and can be summarized as follows:

- Germplasm collection and evaluation.

  The evaluation of more than 700 accessions indicated that populations from Ethiopia, Egypt, and Afghanistan showed the highest protein content; in 87 accessions from Sicily some showed interesting seed weight (up to 3.25 g/seed) and protein content (up to 32%).

- Evaluation of the reproductive system in different environments.

  Autofertile and high yielding lines have been selected for dry seed (MGBF 20/2, MGBF 21/3, MGBF 168/8, etc.) and fresh seed (from cv 'Aguadulce', 'Muchamiel', 'Locale di Bari', and 'Reina Blanca'). An analysis of cross pollination ascertained the values of cross-fertilization of about 22% (Porceddu *et al.*,1979) and the conclusion was reached that faba bean is a species with a partial cross-fertilization system, ranging from 0 to a maximum of 50% depending on the number of bees present in the fields. The number of pollinating insects and the consequent rate of cross-fertilization have direct and indirect effects on the yield of the population in the following generation; in absence of pollinating insects, lack of tripping, inbreeding depression and lower ability of the inbred plants to self-fertilize were found to be the main causes of yield reduction (Frusciante and Monti, 1980; Monti and Frusciante, 1982).

- Estimation of biometrical parameters and use of different breeding procedures for selecting high yielding lines.

  Narrow sense heritability estimated at 42°00' of latitude was high (h^2>0.54) for date of onset of flowering, number of seeds per pod, and 100-seed weight. These traits showed also the lowest genotype x environment interaction, therefore, indirect selection for yield through traits showing high h^2 is expected to increase the yield stability of the selected materials. High yielding and stable *equina* lines (T5/25 and RS 28/4) and *minor* lines (C54/13, LS 245 vt, MS 125 vlt) compared to the respective control (cv 'Gemini' or cv 'Manfredini') have been selected.

- Improvement of the nutritional properties of faba bean formulations.

  Proteins extracted from minor type faba bean showed similar functional properties to the proteins extracted from soya bean, that is: 70% and 2% solubility at pH=2 and pH=5 respectively, and good water binding capacity and gelation properties; using a *minor* type faba bean seeds containing 28% protein, a recovery at high efficiency (88%) of a 62% protein concentrate, was achieved; this concentrate showed a biological value of 0.4 compared to lactoalbumin; alimentary pasta made with

a 53:47 mixture of semolina:faba bean flour, showed good rheological and cooking quality test parameters.

The MAF project was the ideal continuation of the CNR-FP I project, and was intended to permit multiple-environment evaluation of the available *V. faba* genetic stocks and to identifying the agronomical practices that could aid the expression of the yield potential of these genotypes and enlarge the cultivation area. The project had the following research lines:

- Evaluation, in 10 different environments throughout Italy, of the six *minor* type varieties included in the National Register of crop varieties, plus 14 *minor* and *major* type lines of new constitution. The evaluated characters were those related to the yield components. The participating institutions have been the Agronomy Institutes of the Universities of Bari, Catania, Florence, Naples, Palermo, Padua and Sassari, and ENEA.

- Study of the diffusion, diagnostic procedure, and source of resistance to the most common pathogenic fungi (*Botrytis fabae*, *Ascochyta fabae*, etc.) and broomrape (*Orobanche crenata*). The research institutes involved were the Institute of Plant Pathology of University of Catania, the Experimental Institute of Plant Pathology in Rome, and the Agronomy Institute of University of Bari.

- Germplasm enhancement and utilization in order to provide in the short run new varieties and lines with high yield potential and stability, with improved quality. In this research participate the Agronomy Institute of University of Palermo, the Department of Agrobiology and Agrochemistry of University of Tuscia (Viterbo), and the Plant Breeding Institute of University of Naples.

- Assessment of the possibility of mechanical sowing and harvesting of faba bean.

- Establishment of innovative agronomical practices that may favour the expression of the yield potential of faba bean varieties, mainly through the investigation of: (a) four different sowing dates (between October and March); (b) water supply during critical periods (after sowing, flowering, and seed filling); (c) chemical weeding; (d) different plant densities and fertilization treatments and (e) plant-*Rhizobium* interaction in the field using different faba bean varieties and *Rhizobium* isolates.

In the last two research areas only one or more Agronomy Institutes participated.

The results of the experiments performed in the framework of this project have not yet been published, and there are great expectations from that information to enlarge faba bean cultivation.

During the five-year CNR-IPRA project there were investigations on more basic aspects of *V. faba* genetics and breeding that focused on the study of seed storage protein genes, ribosomal genes, and crop physiology. The main achievements have been the following:

- Biochemical and genetical analysis of seed storage proteins, and study on the effect of unstable chromosomes on *V. faba* genetic variability were carried out at the Plant Breeding Institute of University of Naples. The legumin (purified through hydroxylapatite) and vicilin (purified through immunoaffinity) fractions of seed storage proteins were used to prepare monospecific antibodies. The screening of mutant faba bean lines after Western blotting analysis, allowed the identification of three (acidic) legumin subunit variants and five vicilin subunit patterns. The inheritance of legumin subunits was studied on F_2 seeds, and there were indications that legumin behaves as the product of a single Mendelian gene. A cytogenetic study was carried out on the effect of a dicentric chromosome induced by X-irradiation of pollen: several mutations were found which showed that also in *V. faba* the induction of unstable chromosomes can be a very important tool for induction of further new variability, as found in other species (Conicella *et al.*, 1984).

- Characterization of the genetic diversity for seed storage proteins in a world collection of faba bean was carried out at the Germplasm Institute, CNR, Bari. The legumin and vicilin pattern after SDS-PAG electrophoresis revealed that accessions from Afghanistan and Ethiopia showed the highest variability in legume subunits and the highest frequency of rare legumin subunits (Polignano *et al.*, 1989).

- Isolation and transfer into sunflower genome, of *V. faba major* legumin genes, was carried out at the Dept. of Agrobiology and Agrochemistry, University of Tuscia, Viterbo. A chimeric plasmid harboring legumin type B and *npt II* genes (*npt II* gene was chosen as selectable marker that confers resistance to the antibiotic G418) have been transferred into sunflower protoplasts through electroporation and microinjection. Only the electroporated protoplasts gave microcallus which survived for twenty days on media containing the antibiotic G418, but neither shoot nor root formation was observed on the regeneration media tried so far. Preliminary results from *in situ* hybridization indicate that legumin genes are located on two chromosomes (on the short arm of the L chromosome and on one of the submetacentric chromosome) of the *V. faba* genome (De Pace *et al.*, 1989).

- Physiogenetic studies on different faba bean plant types were carried out at the Plant Breeding Insti-

tute, University of Bari. A range of plant growth habits (from indeterminate to determinate) were tested for physiological response to different water and temperature regimes. It was observed that determinate growth habit is controlled by a recessive allele at a Mendelian locus which seemed to confer the pleiotropic effect of decreasing the yielding ability of the homozygous genotypes for that allele (Filippetti, 1986). Stomatal and transpiration behaviour parameters are not useful selection criteria for drought tolerance (Ricciardi and Steduto, 1988).

- RFLP of rDNA was carried out at Dept. Agrobiology and Agrochemistry, University of Tuscia. RFLP variants of rDNA have been found in *V. faba* and other *Vicia* species which were due to different number of subrepeats in the intergenic spacer of the rDNA genes clustered in over 2000 copies at one locus. The *V. faba vs* other *Vicia* species comparison of those variants indicated that the rDNA genes of *V. faba* evolved in a different direction from those of other *Vicia* spp. and no close relationship can be implied with *V. narbonensis, V. galilaea, V. hyaenisciamus, V. bythinica,* etc. (Delre *et al.,* 1988).

Using the funds from other contracts with CNR and the Italian Education Ministry, the following research on *V. faba* is being conducted:

- Plant Breeding Institute, University of Naples: Pollination studies, selection for autofertility, and selection methods for yield improvement. Using net cages and a modified selection scheme based on:
  - A four-year cycle of controlled pollination (two years of self-pollination and two years of open pollination).
  - Selection applied in the second year for self- fertility and the fourth year for combining ability, it was possible to identify superior *minor* type progenies with good general combining ability for yield and adequate self-fertility.
- Dept. Agrobiology and Agrochemistry, University of Tuscia, Viterbo: The following activities are being developed:
  - Assess the yield potential of synthetic *major* type varieties after one (Syn 1), two (Syn 2), and three (Syn 3) consecutive years of intercrossing in plots isolated by distance. The synthetics were based on four or six inbred lines (showing 89-92% self- fertility). The combined self-fertility character present in the original lines and the heterotic effect due to intercrossing, gave to the Syn 2 the best yield performance when compared to other Syn and control cultivars.
  - Study of the ability of *V. faba* to use natural resources (i.e. light) and fertilizers when intercropped at different plant density with durum wheat.
  - Isozyme analysis to identify molecular markers of genes. So far, five new isozyme gene markers have been identified (Mancini *et al.,* 1989).
  - RFLP of *V. faba* genome is under way for constructing a linkage map of biochemical markers.
- Agronomy Institute, University of Palermo: The physiological aspects of grain yield and the effect of plant density on the yield ability of faba bean is being studied. They have been able to show that a 30 plant/m^2 density allowed the highest productions in *minor* ('Vesuvio') and *equina* ('Gemini') faba bean cultivars (Stringi *et al.,* 1986).
- Germplasm Institute, CNR, Bari: The characterization of faba bean accession using SDS-PAGE patterns of seed storage proteins is continuing. A chemotaxonomical analysis (based on the paper chromatography and HPLC separation of phenolic compounds) of different *Vicia* species is being carried out with the purpose of identifing the closest relative of *Vicia faba* species. An evaluation of the germplasm collection of faba bean for tolerance to broomrape is taking place (Perrino *et al.,* 1988). This activity confirmed the tolerance of 'Locale di Castellana' (it produced 147 and 453 seeds from a 30 plant/plot when infested with 164 and 48 broomrape plants, respectively), while all the other tested accessions produced less than 100 seeds/plot even at low level of broomrape infestation.
- Extensive selection work and field testing is carried out at many University Insitutes (e.g. Agronomy Institute, University of Bari; Horticultural Institutes of University of Palermo and Catania, etc.) to find suitable lines for fresh seed consumption, deep-freeze food, and canning.
- ENEA (National Agency for Atomic Energy, Casaccia, Rome). A faba bean breeding program is carried out according to the following research lines:
  - Maintenance of breeding stocks under inbreeding.
  - Yield test of entries from ICARDA and Italy.
  - Selection of progeny-plants from breeding stocks and entries included in the yield trials.
  - Intermating of the selected material to enhance the production of recombinant genotypes.
- A close collaboration has been established between several Italian Institutions and ICARDA, Aleppo, Syria. Every year, materials from:

- The faba bean international yield trials of determinate (FBIYT-D) and indeterminate (FBIYT-L) plant type.
- The faba bean screening nursery for yield (FBISN), tolerance to chocolate spot (FBICSN), ascochyta blight (FBIABN), and rust (FBIRN).
- Fertility-*Rhizobium* evaluation, etc., are sent from ICARDA to the interested Italian Institutions. Field testing and selection are performed according to the local objectives and environmental conditions, and the breeding programs have been greatly benefited from those nurseries.

Conclusions

Faba bean is one of the most important legume in the Italian agricultural system. However, its importance (and in general the importance of the grain legume crops) is decreasing every year due to reduced preference for legume seeds in the human diet, low income that the farmer receives from the faba bean crop because of the small number of high and stable yielding cultivars, and lack of innovative agrotechnology for sowing, harvesting, and processing faba bean seeds.

The research institutions are devoting large efforts, also through international cooperation with other agricultural research and experimental agencies (e.g. ICARDA) to solve these problems. If in addidion to the above indicated research efforts, the nutritionists and the industry are able to find new and well accepted formulations of faba bean seeds, seed protein extract, and flour, for human nutrition as well as livestock rations, the decrease in the Italian faba bean cultivation could be stopped in a few years.

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