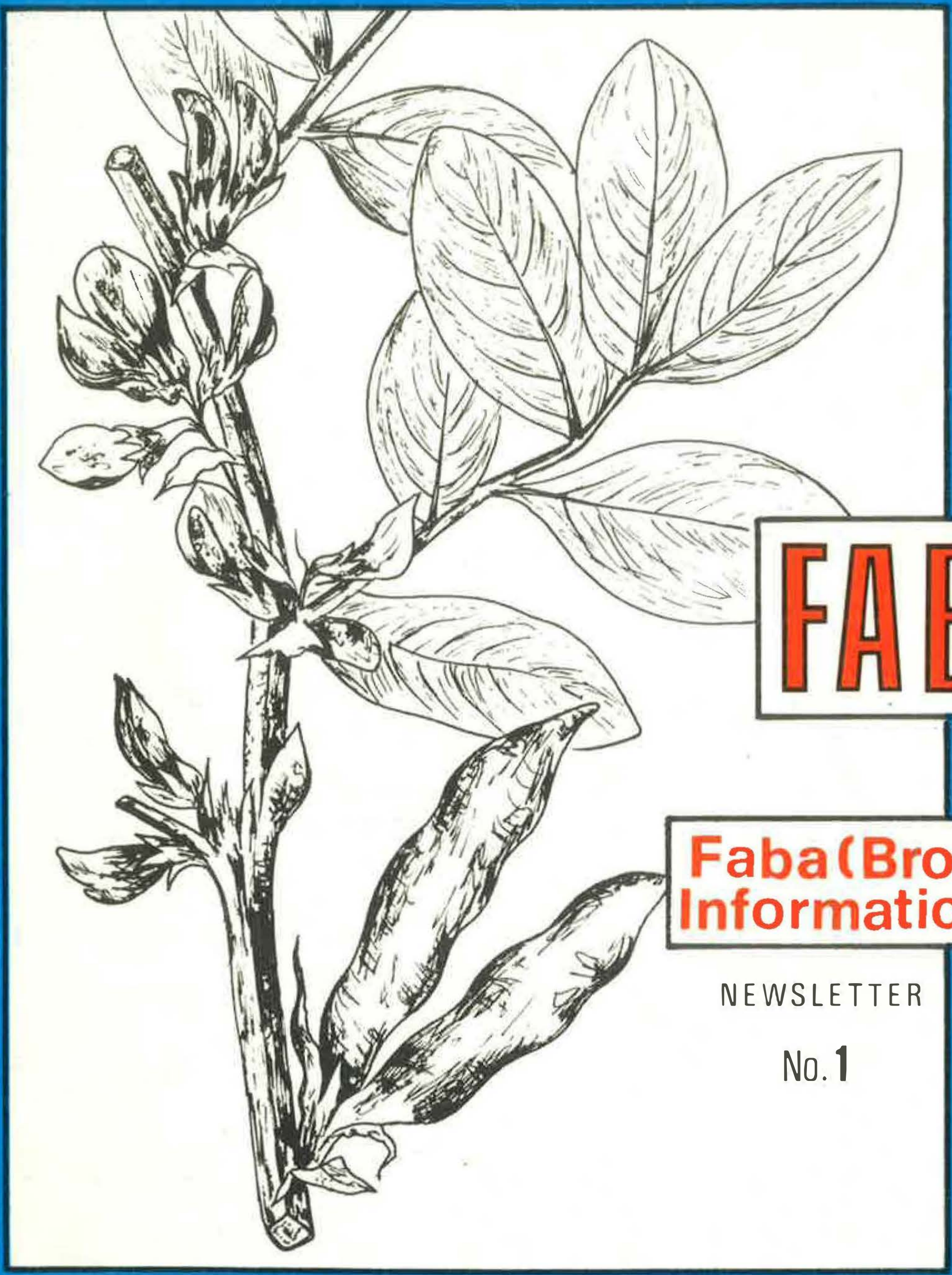

FABIS

Faba (Broad) Bean Information Service

NEWSLETTER

No. 1

JUNE 1979

THE INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS

ICARDA

CONTENTS

FABIS

Introduction

This first annual newsletter forms part of an information service which is aimed at improving communications between Vicia faba researchers who are concerned with this plant as a crop species. This service is seen as a flexible entity in that publications other than the newsletter could appear under the name of FABIS. Such additional publications could include details of the Vicia faba research being carried out by different people and institutions, lists of germplasm collections, anotated bibliographies and production figures for the crop in the different countries around the world where it is grown. We hope that you will let us have your views on these and other possible topics for future publications.

We have been in contact with approximately 200 Vicia faba researchers throughout the world and it is clear that there is an urgent need for a news and information service for this crop. There are many researchers who have limited access to the literature and who are badly in need of information on current research being carried out elsewhere in the world. We also hope that the newsletter will help to acquaint researchers in developed countries with the problems and needs of the countries where the crop is most important as a human food.

In general, we hope that the FABIS service, and the newsletter in particular, will stimulate the exchange of information and views between individuals in all parts of the world and that such dialogues will be brought to the attention of as many researchers as possible.

The Name of the Service and the Crop

The name chosen for the news and information service came from a suggestion by M. Frauen of Gottingen University, West Germany. FABIS (Faba Bean Information Service) reflects the fact that the service deals with all Vicia faba types and varieties. The many different names given to the crop in the English language are reviewed by D. A. Bond in the first Short Communication in this newsletter. This short article should clear up doubts concerning the naming of different crop types.

Up until recently ICARDA has referred to the whole species as 'broadbeans', but as this name is only used for the large seeded types in many parts of the world it is now proposed to drop this term in favour of 'faba bean'. D.A. Bond's article implies the suitability of faba bean as the species name, and it is already occasionally used as such in many European countries.

All future contributors to FABIS are urged to use faba bean only when referring to the whole species (Vicia faba). Sub-classes of the species may be referred to variously as field bean, tick bean, small faba bean etc. for the small seeded types and broadbean, large faba bean etc. for the large seeded types, but much confusion will be avoided if one term is used for the whole species.

The FABIS Co-ordinating Committee

Ten people have agreed to act as members of a Co-ordinating Committee for the news and information service, each one representing a different country or region. The names and addresses of the committee members are given at the end of this introductory section. Their role as members of the committee is seen as the following:-

- to give advice as to the form and content of the news and information service.
- to write a general article for the first issue of the newsletter.
- to provide names of those in their geographical area who should be sent copies of the newsletter.
- to provide names of those who they think might be suitable as authors of future articles.

This Issue

This first issue of the newsletter is intended to give a general introduction to faba bean research throughout the world as well as having a section devoted to Short Communications. The General Articles written by members of the Co-ordinating Committee highlight some of the major aspects of faba bean research in the different countries and regions of the world. Details of the form and style for FABIS contributions are given at the start of the General Articles Section.

Considering that Vicia faba researchers were only approached in January this year, the fact that this first issue contains over thirty Short Communications is very encouraging. The Short Communications are followed by a list of the names and addresses of all the institutions known to us where practically orientated Vicia faba research is being conducted. This is followed by a list of all the people known to us who are involved or interested in Vicia faba research together with their addresses and, where possible, details of their research fields.

We hope that you will inform us of any mistakes or omissions with respect to these lists. These will then be published in the second issue of the newsletter or, if we receive sufficient additional information about the research work being carried out at the different institutions throughout the world, in a separate publication in 1980. In particular we would like to stress the need for the names of researchers in developing countries and for details and names of firms involved in faba bean processing, private seed companies etc..

Future Issues

It is intended to publish the second issue of this annual newsletter in March 1980. This should enable researchers working with winter sown crops to make April or May selections in the field based on the results of others from the previous summer season, and those working with spring sown crops to select lines for planting based on results of the previous year. Accordingly the deadline for submission of articles for the March 1980 issue will be December 1st. Any contributions received after this date are liable to be deferred until the 1981 issue, although every effort will be made to include them as soon as possible.

We hope that everyone will feel free to make suggestions as to the content of future issues. At present we think that future newsletters would benefit by focusing on specific problem areas in the 'General Articles' section, but that the Short Communications would best be left open to all subject areas. We would also like to publish readers' letters if space permits.

Subscriptions

It is not proposed to ask for a subscription for the first two issues, but the second issue will contain a reply slip which readers will be asked to return together with a nominal fee so that they may receive future issues. If anyone has any strong views on this subject please let us know.

ICARDA

Finally perhaps we ought to say a little about the International Center for Agricultural Research in the Dry Areas (ICARDA) and its own involvement in *Vicia faba* research. ICARDA began in January 1977 and is one of twelve international centers whose work is coordinated by the Consultative Group on International Agricultural Research (CGIAR). Part of ICARDA's mandate is to serve as an international center for research into and improvement of barley, lentils and faba beans (*Vicia faba*). It is hoped that FABIS will help in the fulfilment of this role.

Vicia faba research at ICARDA is one of the activities of the Food Legume Improvement Program and the research objectives are outlined in the General Article by Hawtin and Stewart.

Finally, we hope to receive your views and comments on all aspects of FABIS so that the Service can concentrate on the areas of greatest need.

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Style and Form for FABIS Contributions

All contributions should be submitted if possible before December 1st for inclusion in the March issue of the newsletter. When writing articles it is hoped that the following points will be borne in mind:-

General Articles

- should be approximately 1500 words
- edited articles will be returned to authors for approval if the originals were submitted before December 1st.

Short Communications

- approximately 500 words, and may in addition include one Table or one Diagram/Figure/ Photograph.
- should contain a single theme, even if this means more than one article is submitted by the same author.

In addition the following general guidelines may be noted :-

- contributions should not constitute a summary of the research carried out at a particular institution.
- all references cited should be directly relevant to the content of the article. Additional references will be welcomed but not included in the newsletter (they may be published in future bibliographies).
- contributions should be typed double-spaced.
- the species should be referred to as Vicia faba or faba bean or preferably both.
- sub-classes should be referred to as Vicia faba minor etc.
- numbers in the text less than 10 (except for measurements) should be written one, two, three etc. unless they form part of a series containing numbers greater than 10 or appear at the beginning of a sentence.
- yields should be expressed in t/ha or kg/ha.

General Articles

The articles in this section have been written by members of the Coordinating Committee who were asked to write about *Vicia faba* research in their own geographical or subject area. They are intended to highlight some major aspects of faba bean research in the different areas of the world.

For future issues General Articles will be commissioned by the Editors based on the advice of members of the Coordinating Committee.

Breeding work on *Vicia faba* in the U.K.

D.A. Bond
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The cultivation of *Vicia faba* in the UK.

Vicia faba has been grown in the UK for at least 2000 years and in the 19th century almost equalled wheat in terms of the area cultivated. Cheaper imported protein feed and a reduction in the number of farm horses caused a decline to about 40,000 hectares by 1977. However, the crop is still popular as a break from cereals on heavy soils and on farms where it can be used directly for livestock feed. About half of the UK production is exported (to the continent of Europe mainly for animal feed and to the Middle East mainly for human consumption) and about 10% is sold, usually at a premium, as feed for domestic pigeons.

At present 25% of the crop is autumn-sown with varieties having some winter hardiness, and of the spring beans (75% of the crop) the small-seeded varieties (*V. faba minor*) are far more popular than the medium-seeded ones (*equina*). However, there used to be more winter beans than spring beans prior to 1950, and the relative popularity of ticks (*V. faba minor*) was not evident until the post-war period. As winter beans are on average 30% higher yielding than spring beans, and spring horse beans (*V. faba equina*) about 10% higher yielding than tick beans (*V. faba minor*), it could be said that farmers have opted for lower yielding types for the sake of convenience in handling grain and the reduced risks from frost and disease.

Large-seeded varieties (*V. faba major*) have been grown for many years on a small scale in gardens, but with the recent development of the vegetable-processing industry and of varieties which are free from leucoanthocyanidins and suitable for canning, the area given over to broadbeans (*V. faba major*) on an agricultural scale has risen to 3000 ha.

The average yield of field beans (*V. faba minor* and *equina*) harvested dry in the UK is 2.7 t/ha (as compared to the world average of about 1.1 t/ha), but average annual yields in the UK fluctuate widely. For example, the annual yield has varied from 3.2 t/ha in 1972 to 1.6 t/ha in 1976 and the yield of individual crops from 0.5 to 6.0 t/ha. The average annual yields of field beans are less stable than wheat and barley in the UK (Hebblethwaite *et al*, 1977), and it is this lack of reliable production which is thought to have prevented the expansion of the crop into a substantial import-saver. This, therefore, is the main problem associated with *Vicia faba* to which UK research workers are addressing themselves. This article, however, deals only with the way in which the problem is being approached through breeding.

Breeding methods and objectives 1960-1975.

The breeding work at the Plant Breeding Institute, Cambridge from 1948 to 1960 was reviewed by Bond and Fyfe (1961). Up until that time, many farmers had maintained their own stocks and seed merchants had made mass selections within these stocks and produced named varieties. Now few farmers maintain their own distinct stocks, and not many private firms in the UK conduct their own breeding programmes on *Vicia faba*. Instead, a better understanding of the mating system and of genetic variation within the species has led to some defined breeding strategies at the State breeding stations and Universities.

The traditional objectives of such programmes were improved yield together with the desired seed size and shape, and earlier maturity especially for spring beans grown in the north of England and in Scotland. However, it was thought that one factor which may be contributing to yield instability was the partial dependence of *Vicia faba* on insects for pollination. Attempts were made therefore to improve self-pollinating ability (autofertility).

During the 1960's work at the PBI in Cambridge attempted to exploit the self-pollinating ability of F_1 hybrids, and has since involved cytoplasmic male sterility, restorer genes and tests of insect pollination at the seed production phase. Other work at WPBS in Aberystwyth has utilised the self-pollinating ability of exotic genotypes from Africa and India. This work has led to the varieties 'Dacre', 'Danas', and 'Deiniol'.

The present breeding methods being employed in the UK include the production of synthetic varieties from inbred components, recurrent selection with S_1 testing and mass selection. Most synthetic varieties are tested and grown commercially in the syn-4 to syn-7 generations; some are reconstituted periodically from their component inbreds and others from syn-1 and syn-2 populations. Examples of synthetic varieties are the winter beans 'Maris Beagle', 'Bulldog', 'Banner' and 'Buccaneer'. 'Maris Bead', the most popular spring bean variety in the UK for several years, was first constituted from selected components but maintained as a population. 'Blaze' resulted from mass selection under open pollination in isolation after some crossing between selected parents. The other UK-bred varieties of *Vicia faba equina* which are currently being grown in the UK, 'Cockfield' and 'Stella', were probably developed by mass selection with some progeny testing.

Recent developments

Lawes (1979) has reviewed developments in the understanding, genetic improvement and uses of *Vicia faba*.

The over-riding objective of the research in the UK is improved yield stability. Work at the PBI has studied yield stability in different environments, the main finding so far being that inbred lines interact with environments (e.g. locations) within years but synthetics interact only with the more contrasting environments of different years. Collaboration with other EEC countries has allowed the use of a wider range of environments within any one year, and in these trials the best combination of mean yield and yield stability was shown by the fast-growing, large-seeded Dutch variety 'Weirboon'.

The major individual factors limiting yield in the UK are Botrytis fabae and frost damage on winter beans and Aphis fabae, viruses and drought on spring beans. High levels of resistance to these factors are lacking, largely due to the inability of Vicia faba to cross with related species where resistance is to be found. However, it is hoped that in the future with the improvement of control measures for these and other pathogens, varieties can be bred for performance in more favourable environments. Pod shattering is not common in the UK, but such losses as do occur could be much reduced by use of the gene for indehiscent pods which is found in many varieties of the arid regions of the world. Rhizobium is present in UK soils, but Mytton et al (1977) have shown a specific relationship between Rhizobium strain and V. faba genotype, and there is promise that improved associations can result in marked yield improvement especially on soils where relatively ineffective strains of Rhizobium are present.

Even when none of the above factors is limiting yield there is often considerable flower- and/or pod-drop, especially in conditions favouring vegetative growth. The indeterminate growth habit and apical dominance are thought to be responsible for the poor seed-set especially on lower flowering nodes. As a result plant models have been proposed by Lawes (1979), Poulsen (1977a) and Thompson (1977) which should minimise this effect. Such models include good pod-set on lower flowering nodes, high number of seeds per node on the first few flowering nodes and a high number of nodes before the first flowering node. The induction of mutants with a terminal inflorescence (Sjodin, 1971; Nagl, 1979), and the selection of recombinants when these are crossed with dwarf genotypes (Chapman and Peat, 1978) has widened the range of plant architecture available for the study of yield stability relationships.

The discovery by Poulsen (1977b) of a closed-flower gene has opened up the possibility of changing the species to almost complete autogamy. If the cleistogamous habit and self-pollinating ability can be combined, populations could be screened and segregants multiplied under open pollination, thus greatly increasing the scale of breeding operations and selection pressure which could be applied.

Seed composition.

There has been recent evidence of genetic variation in composition of the seeds of Vicia faba. The range in protein content of the dry seed is almost from 20 to 40 per cent (Griffiths and Lawes, 1978; Chapman and Peat, 1978), and this is not often found to be negatively correlated with yield as it is with some other crops. However, the amino acid balance may change with total protein content. There is uncertainty as to the changes in chemical composition which are most urgently required in the UK. A trend is expected toward greater use of Vicia faba for direct human consumption both as a vegetable and processed from dry beans, while at the same time the crop may be needed to increase the self-sufficiency of the EEC in animal protein.

The future.

There is now the possibility of a radical change in the Vicia faba crop in the UK. It might, in the future, be self-pollinating, semi-dwarf and uniform, and have a terminal inflorescence, white flowers and a tannin-free testa. However, it is important that breeding towards such a type, or any other model, should be accompanied by improved yield stability and should not be at the expense of the potential yield of the present traditional types.

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The development, production and problems of faba beans (Vicia faba) in West Asia and North Africa

Geoff Hawtin and Richard Stewart,
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Origin, Development and Early Uses:

The origin of Vicia faba has been discussed by a number of authors, including de Candolle (1886), Renfrew (1973) and Bertsch and Bertsch (1949).

Vicia faba was clearly not one of the first plants to be domesticated; its cultivation is relatively recent compared, for example, to that of wheat or lentils. Hector (1936) thought that Vicia faba derived from a special branch of the primary V. narbonensis, the earliest findings of which were made in a neolithic village at Beidha in Southern Jordan and at another neolithic site at Jericho. The similarity between the chromosomes of Vicia faba and those of V. narbonensis and V. serratifolia suggest that these two latter species are closely related to the crop plant, as is V. gallilea. The distribution range of these species put the probable place of origin of Vicia faba in the Near East and Mediterranean region. It is interesting to note that in his book 'Origin of Cultivated Plants' de Candolle (1886), writing about Vicia faba, states that "Its wild habitat was probably two-fold some thousands of years ago, one of the centers being to the south of the Caspian, the other in the North of Africa".

Mention of the early history of Vicia faba has recently been made by Bond (1976) and Renfrew (1973). Schultze-Motel (1972) has concluded that Vicia faba was introduced into agriculture in the late neolithic period based on the available archeological evidence. The first findings of Vicia faba date from the early bronze age (c. 3000 BC) and were made in the Eastern Mediterranean region. Hanelt et al (1972) point out that there have been no prehistoric finds of Vicia faba east of a line from Palestine to Turkey. Such observations also indicate a Near East or Mediterranean origin.

Cubero (1974) has summed up the early development of Vicia faba from its Near East origin as a four-way radiation of the species: to Europe, along the North African coast to Spain, along the Nile to Ethiopia and from Mesopotamia to India.

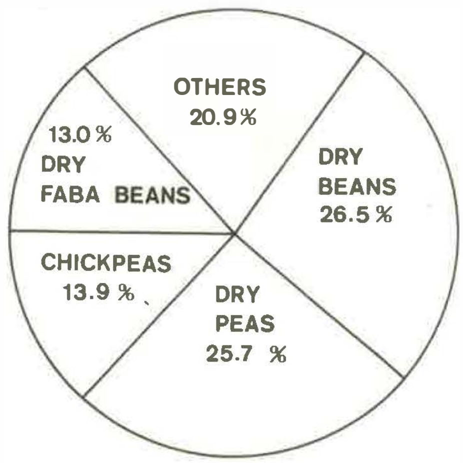
The cultivation of Vicia faba spread during the late neolithic period to Spain, Portugal and Eastern Europe (Renfrew, 1973). Faba beans have been found at many of the bronze age lake-side dwellings in Switzerland and there is some evidence that they were cultivated in Northern Italy before the end of the bronze age. Faba beans do not appear to have reached Britain until the iron age.

Reference to faba beans is made in the Old Testament. The word 'pol' appears twice (de Candole, 1886) and was used to describe the seed; it is closely related to 'fol', 'ful' or 'foul', the Arabic name for the bean. This gives clear evidence that the Hebrews were acquainted with the bean a thousand years before Christ. The ancient Greeks knew Vicia faba as 'kuamos'. The 'Iliad' mentions the bean as a cultivated plant. The early Romans called the bean 'faba'. Pliny describes how beanmeal was used in breadmaking by the Romans; it was added to the wheat or millet flour to increase the weight of the loaves intended for sale. Faba beans were also used by the Romans for making porridge and as an addition to sacrifices to the goddess Carna. However, the Romans also considered the beans to have "dulling effect on the senses and to cause sleeplessness" (Renfrew, 1973). They did however make a special purée out of bean meal, fish stock, a little oil, and herbs such as cumin and corriander (Andre, 1961).

Production and Uses:

Faba beans (Vicia faba) are the fourth most important pulse crop in the world after dry beans, dry peas, and chickpeas.

Fig.1. World Pulse Production



Based on mean values from 1975, 1976 and 1977.

Mean annual world pulse production:
47,379,000 tons

Mean annual world faba bean production:
6,174,000 tons

(Source: FAO Production yearbook 1977)

China produces about two-thirds of the world's faba beans while 10 to 15% are grown in the West Asia and North Africa region. In this region faba beans exceed both chickpeas and lentils in terms of area and production, and Table 1 shows recent figures for the production of the crop in 12 of the region's countries. It can be seen that the North African countries account for 90% of the region's output.

Table 1. Dry faba bean production in West Asia and North Africa*.

Country	Area (ha)	% of Regional Total	Production (tons)	% of Regional Total
Morocco	200,000	28.3%	179,000	21.7%
Tunisia	62,700	8.9%	51,000	6.2%
Algeria	33,300	4.7%	26,300	3.2%
Libya	5,000	0.7%	5,000	0.6%
Egypt	104,700	14.8%	236,000	28.7%
Sudan	15,300	2.2%	19,000	2.3%
Ethiopia	220,300	31.2%	220,300	26.8%
NORTH AFRICA	641,300	90.8%	736,600	89.5%
Turkey	32,000	4.5%	51,000	6.2%
Iraq	22,300	3.2%	22,300	2.7%
Syria	7,000	1.0%	10,300	1.3%
Cyprus	2,300	0.3%	1,700	0.2%
Lebanon	1,000	0.1%	1.000	0.1%
REGIONAL TOTAL	705,900	100.0%	822,900	100.0%

* All values are means taken from the 1975, 1976 and 1977 figures in the FAO Production yearbook 1977.

Faba beans are an important source of dietary protein, particularly throughout Egypt, Northern Sudan, the highland areas of Ethiopia and among certain rural communities in the Maghreb. Most of the faba bean production in North Africa is carried out in three areas. In Ethiopia the production is characterised by highland rainfed cultivation, with the crop being planted in July at the beginning of the summer rains. Only the small-seeded types (Vicia faba minor) are grown and almost all the crop is harvested as dry seed for human consumption. In the countries of the Maghreb (Algeria, Morocco, and Tunisia) faba beans are grown primarily as a rainfed winter crop. The large seeded types (Vicia faba major) account for most of the production and are harvested both as seed and for use as a vegetable. Most of the small amount of V. faba minor grown is used as animal feed. In Egypt and the Sudan faba beans constitute an irrigated winter crop with small and medium seeded types (equina and minor) being preferred. They are grown mainly for human consumption and are harvested dry.

In most of the countries in West Asia where the crop is grown (Cyprus, Iraq, Jordan, Lebanon, Syria and Turkey) faba beans are a rainfed winter crop and are grown mainly in the coastal zones. Some supplementary irrigation may be applied especially inland. The most common types are the large seeded varieties (V. faba major) which are harvested mainly for human consumption. It has been estimated that about two-thirds of the crop is harvested for the green vegetable while about one-third as the dry seed. In some areas it is grown as a dual purpose crop - the early pods are harvested green, the later ones dry. In Afghanistan, the crop is spring planted and the small seeded types harvested both as dry seed and as green vegetables.

Problems faced by faba beans in West Asia and North Africa:

The problems are many and varied. Throughout the region there is a steady population increase which itself demands higher yields from the crop. In common with the European experience faba beans exhibit a high yield potential but a low yield stability. Diseases and pests are major contributory factors as regards this low stability.

The most troublesome fungal diseases are ascochyta blight (Ascochyta fabae) and chocolate spot (Botrytis fabae) which are particularly severe in the Mediterranean coastal regions and in the highlands of Ethiopia. Epiphytotics of these diseases can lead to total destruction of the crop in certain years, this ocurring for example in 1976-77 in the Syrian coastal region. Root rot and wilt pathogens, especially Fusarium spp. and Rhizoctonia spp., are a major problem, as is stem rot (Sclerotinia). These pathogens are widespread throughout the region. The rust disease Uromyces fabae is also very common and can be severe on occasions. Brown spot (Alternaria sp.) has been widely reported throughout the West Asia region and leaf spot (Circospora sp.) has been reported in some North African countries, especially Morocco. Two species of powdery mildew, Erysiphe polygoni and Leveillula taurica, can be very damaging in some locations particularly in inland areas of low humidity. Viruses such as broadbean mosaic virus (BBMV), bean yellow mosaic virus (BYMN) and bean wilt virus (BWV) can cause problems in the region. BBMV and pea mosaic virus (PMV) are especially severe in the Sudan (see Short Communication by Hussein).

Broomrape (Orobanche sp.) probably constitutes the major single problem encountered by faba beans in the region. The two most troublesome species of this obligatory parasitic angiosperm are Orobanche crenata and O. aegyptiaca. In certain areas of the region the production of faba beans is no longer possible because of broomrape infestation.

There are several important insect pests in the region. The major threat is posed anually by aphids; several species have been reported, including Aphis fabae, Aphis craccivora and Acyrthosiphon. Army worms (Spodoptera exigua) are also a problem, as are leaf weevils, and in particular Sitona lineatus as well as other Sitona and Apion species. The larvae of stem borers (Lixus spp.) have been observed to cause losses of up to 30%, and damage can also result from leaf miners (Liriomysa spp.) and leaf hoppers (Empoasca spp.). There are one or two storage pests, the most widespread being Bruchus rufimanus. There have been few nematodes reported other than Ditylenchus dipsaci which occurs in Morocco and which can be seed borne.

Weeds constitute a major problem for many of the crops of the region. They are especially troublesome in the higher rainfall zones, areas where most of the faba beans are grown. In some areas particularly in North Africa, the crop is grown in rows of up to two metres apart so that weeds can be controlled by between-row cultivation using a tractor and cultivator.

There are several other problems to be faced by faba beans in the West Asia and North Africa region. The region as a whole is characterised by a relatively low rainfall and drought can be a problem - in areas of marginal rainfall annual fluctuations can have a marked effect on faba bean production. The growing season in the region is normally limited by high temperatures at both the beginning and the end. Planting too early can result in severe root/wilt diseases at the seedling stage and the early onset of high temperatures in spring and summer can lead to excessive flower and pod drop and subsequent low yields.

Faba beans are grown as a winter crop in most of the region, but generally at low or medium elevations. The crop can be damaged in inland areas in unusually severe winters. If winter-hardy types could be developed the plant could be grown as a winter crop at higher elevations giving better use of the growing season and the possibility of higher yields.

Salinity also constitutes a problem particularly with irrigated crops and on certain of the recently reclaimed lands in North Sudan and Egypt. Lodging can also cause significant yield reductions, especially under high fertility and high rainfall/irrigated conditions. Populations of pollinating insects (both wild bees and honeybees) appear to be very variable, from year to year and from location to location. In general, however, it appears that the tripping requirement of many of the local landraces is less than that for most cultivars originating in Northern Europe. Studies have shown that although the extent of nodulation varies considerably within the region it is generally good. However, positive responses to added Rhizobium bacteria have already been obtained (see Short Communication by Islam).

Seed quality is an important consideration in that a higher protein quantity and/or quality is needed to provide better nutrition for those people who are dependent on faba beans for a significant proportion of their dietary protein. The role of anti-nutritional factors, especially the polyphenolic compounds, in human nutrition also requires further study. Favism is endemic to the region; genes for susceptibility to the disease are found in human populations surrounding the Mediterranean (see Short Communication by Rivoira et al). The disease is fairly widespread and can result in the death of small children; many parents therefore refuse to feed their children faba beans.

Vicia faba research in the West Asia and North Africa region.

Research on faba beans at the national level is being undertaken in most of the faba bean growing countries of the region, and is most advanced in those countries where the crop is of prime importance i.e. Egypt, the Sudan and to a lesser extent Ethiopia, Turkey and the countries of the Maghreb. Research efforts reflect many of the problems outlined above, as do those of the international research program for the region at ICARDA. Current work at ICARDA focuses on several different areas which can be outlined as follows.

ICARDA is involved in training and communication work with respect to Vicia faba. This year has seen the successful completion of the second residential training course in food legume improvement which involved 14 participants from 12 countries in the region, 7 of whom specialised in faba bean breeding, selection, agronomy and physiology work. This newsletter is one of a number of efforts ICARDA is making to improve communications among faba bean researchers in the region and between them and other interested parties.

At present two germplasm collections are being maintained. One is a collection of populations from throughout the world standing at nearly 1,800 accessions, and the other a collection of pure lines selected from the populations by single plant selection under conditions of strict selfing. This pure line collection contains over 2,500 entries. Small samples from either collection are available on request subject to seed availability.

The breeding work at ICARDA is aimed at the development of cultivars and genetic stocks suitable for both green and dry seed use and having high and stable yields, resistance to Botrytis and Ascochyta, and resistance to Orobanche (see Short Communication by Basler), aphids and drought. Screening for resistance to root rot diseases will begin next year. The determinate growth habit is also under investigation and other studies are underway on autofertility, outcrossing and breeding methodology. Elite genetic materials, lines exhibiting particular characteristics (e.g. disease resistance) and early generation segregating populations are distributed to co-operating institutions primarily, but not exclusively, in the region.

Agronomy work involves studies of cultural practices for existing and improved cultivars. Physiological studies on such factors as growth habit, flower drop and symbiotic nitrogen fixation are also being carried out. Finally, economic and general farming studies and surveys ensure that the research carried out is done so in the context of government pricing policies and the needs and resources of the general population of the region.

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Vicia faba in Spain

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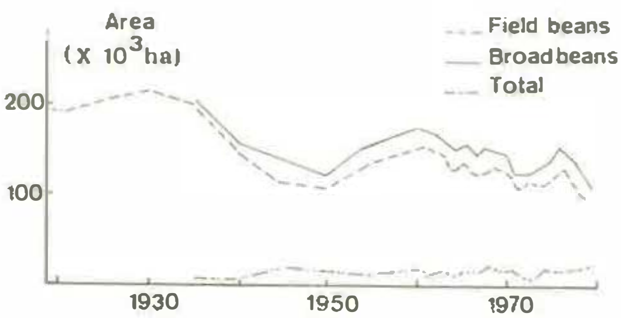
"Bean – Botanically, Faba. A well known cultivated plant of the vetch division of the leguminous family. It is cultivated in both the garden and the field, for the sake of its large, nutritious, dicotyledonous seeds; and is so universally well known to our population, both urban and rural, as not to require any description".

These words, written in 1852 by the Rev. John M. Wilson in his 'Rural Cyclopaedia' could have been applied to Spain up until recently, but the popularity of the crop, together with its production, has decreased steadily over the last fifty years, as shown by Fig. 1. The situation in Spain is similar to that in most other western countries, and this is the case not only with Vicia faba but also with most of the other pulse crops.

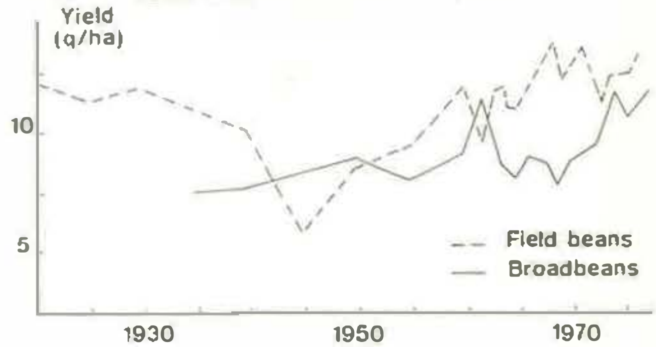
Fig.1. Vicia faba Area in Spain



There are several reasons for the decline in the importance of the crop in Spain which can be listed as follows:

1. Migrations from rural to urban areas, which have taken place mainly from the dry areas where pulse crops are very important. In fact this decrease has affected field beans (V. faba minor) rather than broadbeans (V. faba major), the latter being a horticultural crop which has increased in importance over the same period. The farmers of the richest dry lands have planted more valuable cash crops (usually officially subsidised) in preference to field beans.
2. Animal production has over the past 25 years been developed almost independently of plant production. Animal feed has thus been largely imported, at least in the form of soybean and maize seeds. As more animal feed has been produced by industrial methods less area has been devoted to pulse crops. There is the possibility of including autochthonous pulses in feed formulations but this cannot be simply achieved due to the lack of active research on the subject and to commercial interests favouring importations. These two reasons are not unrelated.
3. The mechanisation of Spanish agriculture did not begin until after the Second World War, but since then farmers have favoured the larger income obtained from mechanically-harvested crops. There has been no work aimed at identifying Vicia faba varieties suitable for mechanical harvesting, even though this would be a relatively simple task in Spain due to the great variability found in Spanish beans. Farmers have been given no recommendations concerning the benefits of suitable rotations with pulses, thereby maintaining good fertility levels in the soil. In general there has been a preference for rapid earnings over long-term foresight.
4. The yields of the pulses (see Fig. 2 for field and broad bean yields) have been found on average to be low. Compared to other important crops there are very few new varieties of pulses, due to the lack of research not only in Spain but in most countries. This in turn is thought to be due to the fact that most pulses are cultivated in underdeveloped regions, the environmental conditions of most of the developed areas being found to be unsuitable. However, the interest recently shown in Vicia faba by the EEC may herald a change in attitude in the developed countries.

Fig.2. Vicia faba Yield in Spain



5. Both garden peas and French beans have overtaken broadbeans in terms of cultivated area, production and popularity. Two early English agricultural cyclopedias (The Complete Farmer, 1766 and Rural Cyclopedia, 1852) devoted the same amount of space to the sections on 'pea' and 'bean' (Vicia faba) and only a small amount to 'kidney beans'. The same was the case in some Spanish agricultural books written during the same period. It is likely that the decline in 'bean' popularity in Western Europe is connected with the availability of new varieties of peas and kidney beans suitable for canning and, more recently, freezing. The development of suitable machines has resulted in the mechanical harvesting of both garden peas and French beans thus transforming them from garden crops into field crops and leading to a rapid increase in cultivated area, production and popularity.

Points 4 and 5 are clearly related to the fact that the country leading the world agricultural research, the USA, does not know Vicia faba as a useful crop.

6. In Spain and in other Mediterranean regions broomrape (Orobanche crenata) is an important limiting factor. Farmers in Andalucia (the southernmost Spanish region) have always been interested in faba beans; they have benefitted by harvesting the seed and from the good quality of the soil following faba bean cultivation. However, broomrape attacks have now discouraged these farmers from sowing Vicia faba.

The most important single reason for the decline in V. faba in Spain is thought to be the lack of research on the crop. The pulses in general are commonly considered as being of limited interest based on yield and production, but this neglects the fact that there are very few researchers concerned with these crops compared to others. The output of research is dependent on the input, and although the present performance of the crop limits its widespread cultivation its potential may be very great. It is necessary to wait for the research results of the EEC group, ICARDA and countries such as Canada, Mexico, Spain, Egypt and Sudan before it can be decided whether or not Vicia faba will be a valuable crop in the future.

The first National Program for Pulses in Spain has recently been initiated and places its greatest emphasis on Vicia faba. The work of this program has encouraged some private firms to carry out their own research and a second group has been formed by some researchers at the National Institute for Agronomic Research (INIA) in Madrid, this group concentrating on the agronomy of the crop. When the first group was formed the main problems were identified as being the lack of suitable varieties, the need for mechanical harvesting, and a number of diseases (as well as broomrapes in the hot and dry regions). Soon another problem arose due to the decision to develop livestock based on the importation of soybean and maize. This could well be the main reason why the number of researchers working on pulses has been so small in recent years.

It is considered that Vicia faba has a good future in Spain. However, it is very important to realise that agriculture in Spain is no longer underdeveloped and that the Spanish way of life has changed very rapidly during the past 20 years. For example, canned and frozen goods are now replacing fresh products.

The future for Vicia faba in Spain will be good if

1. cultivars suitable for mechanical harvesting are obtained, and if these cultivars are more productive than existing land races.
2. the ability to resist, tolerate or escape broomrape infestation is introduced into varieties, particularly those grown in the south and the center of the country.
3. Vicia faba seeds are used in industrial formulations of animal feed.
4. 'garden faba beans' can be transformed into a field crop in a similar way to peas and French beans. This means that problems concerning canning, freezing, mechanical harvesting (including the identification of suitable cultivars) need to be solved.

From the above it can be seen that perhaps the most important factors that need to be studied are not in the hands of the plant breeders.

Details of the work being carried out in Spain and the institutions and researchers involved are given in the later sections of this newsletter, as well as in two short communications contributed by Moreno and Martin. This article concludes with a list of some of our articles concerning Vicia faba.

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Broadbeans in Japan : origin and development

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It appears that the cultivation of most of the pulses in the Old World began at about the same time as that of cereal crops. However, for broadbeans (Vicia faba) the answer to the question of when and where they were first domesticated is still far from clear (Hanelt, 1972; Zohary and Hopf, 1973). In fact Plitmann (1967) has said that out of many cultivated crops the problem of the origin of Vicia faba is the most difficult. There is some evidence for the existance of broadbeans in the early Neolithic Age (ca. 5000 BC) in the Near East region but this has not yet been fully substantiated. Evidence from the Bronze Age, however, shows that by 2000 BC Vicia faba was already cultivated throughout the entire Mediterranean Basin, from Spain in the west to the Levant in the east. All the beans unearthed from this period have been of the small-seeded type (V. faba minor).

Zohary and Hopf (1973) and Plitmann (1967) considered the ancestor of Vicia faba to be V. galilea Plitm. et Zoh and this may help in predicting the place of origin of the crop. There is only scanty written evidence for the early cultivation of broadbeans in the East Asia region. Folk tales mention broadbeans in China about 100 BC and in Japan about 700 AD, but the first written description of Vicia faba in China is not found until 1313. Other documents show that the cultivation spread over the whole country in the early 15th century and that the large seeded types appeared by the end of the 16th century. However in India, which is en route from the Near East to the Far East, there are no written descriptions of the early cultivation of Vicia faba despite the existance of old names for the crop in the Kashmir and Punjab regions (Maeda, 1977).

The first description of broadbeans in Japan comes from 'Tashiki-Hen', a dictionary of plants published in 1631. The development of the crop in Japan took place in two or three stages. First to appear were the small-seeded (V. faba minor) followed by large-seeded types (V. faba major) both of which came from China in the 16th century. Many new varieties of long pod and medium-sized beans (V. faba major and equina) came from England, France and Spain in the late 1800's. This explains both the present existance of three types of Vicia faba in Japan and the problems encountered with seed contamination.

The encyclopedia 'Nogyo-Zensho' was published in 1697 and gave the first regular description of agriculture in Japan. The author, Yasusada Miyazaki, travelled throughout the country investigating the characteristics and peculiarities of many of the crops. The book is shown in Plate 1, opened at the pages describing broadbeans. Miyazaki pointed out that broadbeans were grown as a winter crop in rotation with rice as summer crop, that they liked a moist and fertile soil, that there were both small and large-seeded types and that the crop was used for human consumption, its maturing time being earlier than wheat or barley.

Most of the above observations could be applied to present day broadbean cultivation in Japan. In fact the cultural practices used by farmers up to the end of the First World War were essentially based on this book. Since then, however,

Plate 1. "Nōgyō-Zensho", the first encyclopedia of agriculture in Japan.

many studies have been made on the characteristics and adaptability of the crop. These studies were carried out by autoecological analysis of the relationship between plant growth and natural and artificial environmental conditions.

Small and medium seeded types have been studied with respect to dry seed production and large seeded types with respect to green seed production. Within the last 20 years studies on photosynthesis and respiration, dry matter production and plant populations have been carried out by a variety of researchers (Fukuyama et al, 1978; 1979; Inako and Sakai, 1965; Kogure et al, 1977; 1978; Nishimura and Nishio, 1967; Tamaki and Naka, 1972; Tamaki et al, 1971; 1972; 1973; 1974).

Vicia faba has been grown as a winter crop in the multiple cropping of paddy field system (Fig. 1). The development of this system as a whole has produced many local varieties as well as involving studies of nursery management and seedling transplantation techniques. Experience gathered over a long period of time has taught us that although broadbean is a good crop for fertilising the soil and for improving other soil properties during the season of its cultivation, it can only be grown once every four or five years if 'sick soil' is to be avoided. The most suitable crops for the intervening years are gramineous crops or rape. The ideal summer crop to follow broadbeans is late-maturing rice; other rice varieties are suitable as crops preceeding broadbeans.

The multiple cropping system enables full use to be made of both the soil and the sun. For example, in Kagawa prefecture one field can produce good yields of broadbean grain and hulled rice in the same year (Fig.1, system 2). Multiple cropping systems incorporating broadbeans seem to constitute profitable agricultural practice in the temperate and subtropical zones. However, one problem associated with this system is that of soil moisture. Iinuma (1968) has pointed out that seasonal fluctuations in rainfall result in Japan's agriculture being divided into humid zone and arid zone farming. The date of planting or cultivation is heavily dependent on the amount of rain falling within the summer and/or winter season. In view of the requirement for high soil moisture it is difficult to envisage the route taken by broadbeans from their place of origin to the Far East. Since much of central Asia is too dry to allow their cultivation. This is also true for the related species in the section Faba of the genus which also require high moisture, unlike certain other Vicia species in other sections such as euvicia, cracca and ervum.

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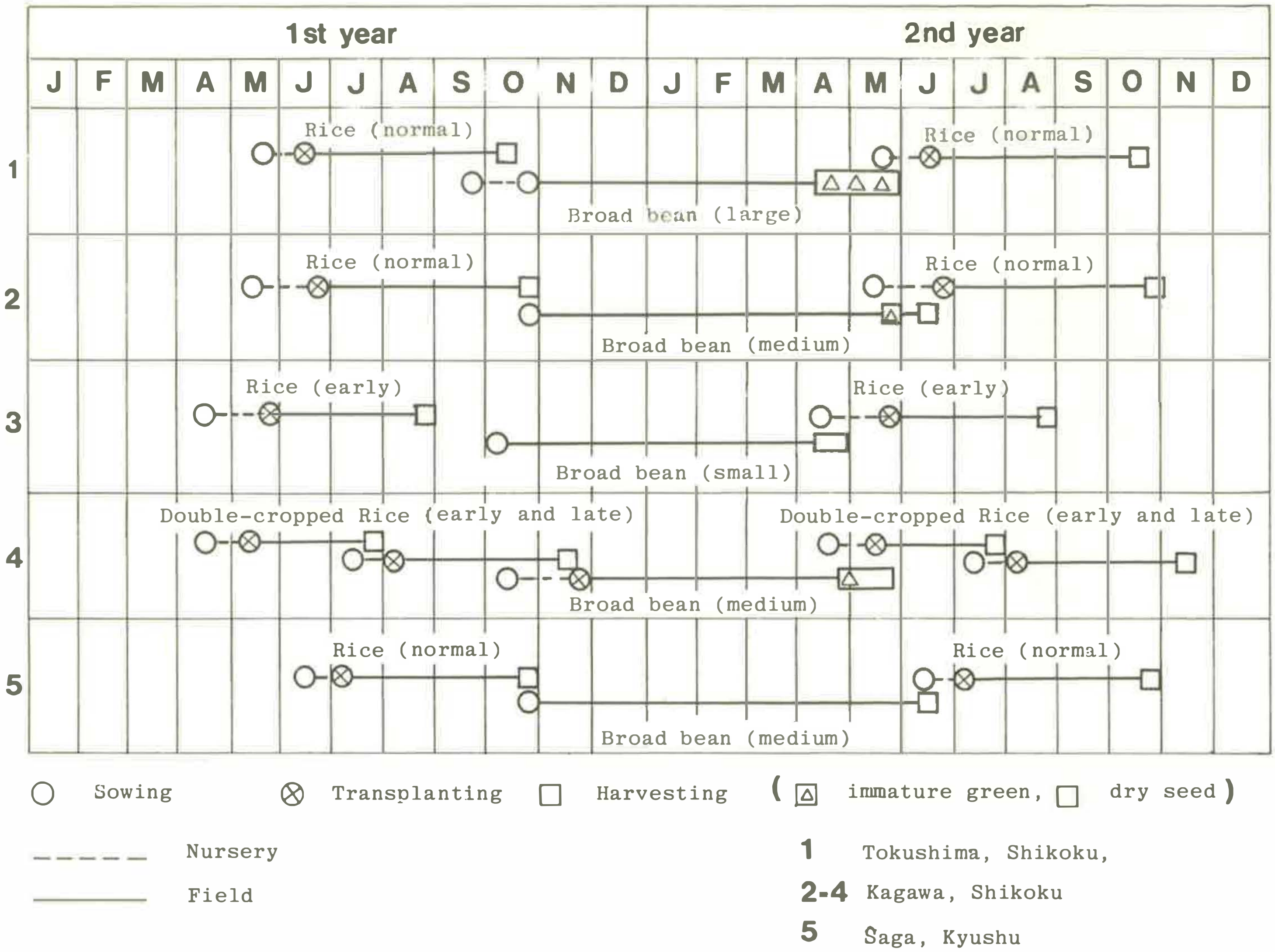
Fig. 1 Multiple cropping systems of paddy fields in Japan



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Vicia faba breeding in France

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Vicia faba has been grown in France for a long time, V. faba major for human consumption and V. faba equina and minor for animal feed. Equina and minor covered an area of 100,000 ha at the end of the last century, most of the seeds being used as feed for horses. Some of the local populations of these two types which have developed in different areas are:

Picardie (3 types), Lorraine	spring sown
Vendee, Sud-Ouest	spring and autumn sown
Cote d'Or(high level of winter hardiness)	autumn sown

The area of Vicia faba grown for feed has now decreased to between 15,000 and 20,000 ha.

The major types grown for human consumption are scattered around the country with a small concentration in the South. A small-grain type of V. faba major was developed in the South-West as 'Feve d'Aquitaine'. Attempts have also been made to incorporate equina and minor bean flour into bread. Specialised mills are also trying to develop other new products for human consumption, particularly in light of the decision to encourage the development of France's own protein sources.

There are several institutions carrying out V. faba minor and equina breeding in France and these are listed later in this newsletter. Breeding work is clearly underdeveloped, a fact witnessed by the small increase in the mean yield of beans over the past 30 years:-

	National Mean Yield (q/ha)	
Year	Wheat	Beans
1945	20	20
1975	45	25

In fact it can be said that there was no breeding work of significance on field beans prior to 1964.

The problems to which breeders are addressing themselves are primarily those of yield and yield stability. Following work by Bond in England yield improvements were started by INRA through hybrid varieties using cytoplasmic male sterility. Single crosses and three way hybrids have shown a high yielding capacity, a high level of self fertility and quite good homeostasis. The problems encountered with male sterility have been largely due to phenotypic instability. Work is now being carried out to find the origin of this instability and to obtain more stable material, either through the improvement of cytoplasm x genotype interaction or through the use of alternative cytoplasmic sources, for example through mutagenesis.

The yield instability can be attributed in part to the plant itself and in part to external factors. To improve the former very diverse types are being introduced into the breeding pool; external factors affecting stability include drought, diseases and pests. Winter types have been developed to escape drought, but these have been affected by heavy attacks of Botrytis fabae.

Breeding work has also been concerned with seed quality. It has been found that protein content of the seed can be improved without losing yield ability, and that it is linked to lateness. The chief problem concerning protein availability is the high level of condensed tannins in the seed coat which interacts strongly with protein digestibility in monogastric animals. In order to improve protein quality attempts are being made to increase the lysine content. The low sulphur-containing amino acid content has not until now been taken into account owing to the availability of synthetic methionine used as a supplement.

Two problems associated with the winter types are winter hardiness and chocolate spot (Botrytis fabae) attacks. Winter hardiness is a major problem, as winter beans have up until now only been grown in France, Great Britain and the Mediterranean countries where crosses aimed at improving yielding ability have been made with spring types. Chocolate spot can reduce yields almost to zero and good routine screening techniques are not yet available for plant resistance testing.

The major problem associated with growing spring types of Vicia faba is drought. To avoid drought it is necessary to increase earliness without losing yielding ability, an improvement which helps the crop escape aphid damage, another problem encountered with spring types.

One can be optimistic about the fact that the different varieties and cultivars of Vicia faba exhibit a wide variation for a number of the problems mentioned above. For others, for example resistance to Botrytis, a lot of co-operative work between the different disciplines is required in order to make good progress. In this way plant breeders can benefit from specialised work in areas such as tissue culture and protoplast fusion. As regards this approach, we can again speak of underdevelopment for all the legume species.

Short Communications

General

English names of Vicia faba : broadbean, field bean or faba bean ?

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It is clear what is meant when Latin is used to name the species Vicia faba L. and its subspecies or botanical varieties major, equina, minor and paucijuga, but the commonly used English words can be confusing.

In the UK and where English is spoken in Europe, V. faba equina and minor are usually referred to as field beans and major as broadbeans. Within this there is the subdivision of field beans into horse beans (equina), which may be either winter- or spring-sown types, and tick beans (minor). Broadbeans are often classified as either long-pod or Windsor types.

In the USA, and in some international literature including that of ICARDA, the whole species Vicia faba has been known as broadbeans. This is thought to have arisen because of the need to distinguish it from Phaseolus vulgaris, which in the USA is known as field beans.

In Canada the term faba beans has recently come into general use. This has also been used on occasions in Europe, but there has been no general attempt to adopt it. Faba beans in Canada usually refer to V. faba equina or minor but in Europe the term can refer to the whole species Vicia faba and is a means of distinguishing it from Phaseolus beans. Thus both faba beans and broadbeans are sometimes used to refer to the whole species but they have more limited definitions in other contexts. Now that the uses of the horticultural V. faba major and the agricultural V. faba equina/minor are becoming less distinct and also that new varieties can result from crosses between any of the three subspecies there may be a case for reviewing the definitions.

However, the English word field bean (or German 'feldbohne') for Vicia faba equina and minor in Europe is of much longer standing than field beans for Phaseolus vulgaris in the USA. Therefore 'field beans' is likely to continue to be used for V. faba equina/minor in the UK unless there is a recognised agreement as to the precise meanings of faba beans and broadbeans. Phaseolus vulgaris is not called 'field beans' in the UK but is distinguished from Vicia faba by some prefix such as 'French', 'Kidney', 'haricot' or 'navy'. 'Vicia beans' is another term occasionally used, but can include narbonensis beans.

In all cases of doubt, of course, the botanical names are preferable, and we clearly have a greater need than people working with other species to make sure that botanical names are given along with the common names.

A note on systematics and evolution of broadbean (Vicia faba)

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Studies on quantitative genetics have been carried out using the diallel analysis of Hayman-Jinks and the analysis of Cavalli-Sforza. So far almost thirty characteristics have been studied within the botanical groups major and paucijuga. Approximately one third of the characteristics have exhibited heterosis, suggesting that the original V. faba must have been an allogamous species.

Some of the morphological characteristics used in systematics are purely quantitative ones, namely the number of leaflets per leaf and the coefficient of thickness per length of the seed. This fact together with results obtained using multivariant analysis show that to split V. faba into several sub-species does not seem to be a natural system, that is if the distinction is to be based only on morphological characters and on barriers to crossability. Following the proposal of Harlan and De Wet it is considered that all the cultivated forms belong to just one sub-species; a second sub-species is formed by any wild forms. The primitive wild form must, it thought, have been closely related to the botanical group paucijuga but was allogamous and dehiscent.

The group with the higher potential to evolve, therefore answerable to both natural and artificial selection, seems to be suitably placed on the border of equina and major. Studies will be continued using polyacrilamide gel electrophoresis.

A suggestion for classification of Vicia faba growth stages

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A problem in trying to describe the growth stages of field bean is the absence of a recognised stage scale. This could be provided by the following letter and numeral system:

V = vegetative
F = flowering
P = pod-bearing

Plant size differences are indicated by the numbers of the different nodes.
For example:

V9	represents a non-flowering plant with the ninth leaf infolded or 9 vegetative nodes
F11.7	represents a flowering plant with 11 vegetative nodes and 7 flowering nodes
P11.2.5.	represents a pod-bearing plant with 11 vegetative nodes, 2 flowering nodes and 5 pod-bearing nodes.
P11.0.7.4.	represents a pod-bearing plant with 11 basal vegetative nodes, 0 flowering nodes, 7 pod-bearing nodes and 4 terminal vegetative nodes.

It may be simpler to always use zero's for absent stages to make system fully consistent. The above examples would then become:

V 9.0.0.0
F11.7.0.0
P11.2.5.0
P11.0.7.4

Branching of the plants could also be allowed for by bracketed additions.

Comments and criticisms of this system will be welcomed by both the author and the editors.

The classification of local broadbeans (Vicia faba)

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In Syria the local populations of broadbeans are highly heterogeneous for many characters. Farmers therefore prefer to import pure seed stocks at an annual cost of nearly $100,000. In a study carried out from 1970 to 1976 a number of morphological characteristics were recorded on lines selected from 1.5 kg samples of seeds from the Hama area. The seeds were divided into 12 categories depending on their size (large greater than 2.6 x 1.7 x 0.5cm, medium 2.1 -2.6 x 1.2 - 1.7 x 0.4 - 0.5cm, small less than 2.1 x 1.2 x 0.4cm), shape (long, medium or short), seed filling character (full or semi-full), the testa characteristics (smooth, semi-wrinkled and wrinkled) and testa colour (rose, violet, green or yellow).

The seeds in each category were planted out and at maturity the plants were further classified according to pod size (long more than 3 seeds per pod, medium 2 to 3 seeds per pod or short 1 to 2 seed per pod).

Using this procedure 116 classes of plants were identified and representative samples were taken of each. These were then planted out in isolation and those plants which had the same characteristics as their parents were harvested. This gave 114 lines which were again planted out, the procedure being repeated during subsequent years until 18 pure lines were selected which had stable and agronomically desirable characteristics. These lines are listed in Table 1.

A small pollinating honey-bee hive for population improvement in broadbean (Vicia faba)

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The presence of active honey-bee workers (pollinators) throughout the flowering season (60 days) was a major factor in increasing random mating in the recombination stage of a population improvement program for broadbeans. The use of five comb pollinating hives of dimensions 60 x 45 x 35 cm inside Sara screen cages of size 7.20 x 3.60 1.80 m resulted in 79.9% cross-pollination of the beans within the cage (Nassib et al. 1978). However, with this arrangement it was found necessary to activate the hives by frequent provision of brood in order to produce worker bees emergent in, and adapted to, these small compartments. Production of the necessary brood constituted a heavy burden on the parent hives especially with the large numbers of bean populations involved. Accordingly a smaller four comb hive of dimensions 26 x 26 x 16 cm was developed and was found to increase the efficiency of the parent hives by 50 - 60% in providing brood readily and frequently during the breeding season. Cross-pollination using the new hives will be investigated next season.

Reference:

Nassib, A.M., Ibrahim, A.A. and Khalil, S.A. (1978). 'Methods of population improvement in broadbean (Vicia faba) breeding'. A paper presented at the Food Legume Improvement and Development Workshop held at ICARDA, Aleppo, Syria. (In press).

Table 1. The characteristics of eighteen pure lines of Vicia faba with stable characteristics.

Line	Seed Size	Pod Shape	Seed Shape	Seed Filling	Testa Type	Testa Colour	Yield (kg/ha)
W	large	short	medium	semi-full	semi-wr.	violet	5700
4 M_{b3}	large	medium	medium	semi-full	semi-wr.	green	5990
10 M_{b4}	large	long	medium	semi-full	semi-wr.	green	6000
S_4	large	short	medium	semi-full	semi-wr.	violet	5470
K	large	short	medium	semi-full	semi-wr.	green	6210
K_s	large	medium	medium	semi-full	semi-wr.	green	6730
39 M_b	large	medium	medium	semi-full	semi-wr.	rose	5620
3 M_{a1}	large	medium	long	semi-full	semi-wr.	violet	5920
8 M_{a1}	large	medium	long	semi-full	semi-wr.	rose	5980
6 M_{b1}	large	long	medium	semi-full	semi-wr.	violet	5500
10 M_{b5}	medium	long	medium	full	smooth	rose	5670
47 M_{b1}	medium	medium	long	semi-full	semi-wr.	green	5110
5 M_{c1}	medium	long	long	full	smooth	rose	5750
8 M_{c1}	medium	medium	medium	semi-full	semi-wr.	rose	4740
6 M_{c2}	small	medium	medium	semi-full	semi-wr.	green	4950
15 M_{c2}	small	medium	long	full	smooth	rose	5750
9 M_{a2}	small	medium	medium	full	smooth	rose	5730
T. W.	small	long	short	semi-full	semi-wr.	yellow	1010

* Semi-wr. = semi-wrinkled.

Approaches to field bean (Vicia faba) improvement in Egypt

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Field bean is the most important pulse crop grown in Egypt and is used mainly for human consumption. Research on field beans has centered around the exploitation of local and exotic variability, mutation induction and the induction of variability through cross breeding.

In general higher autofertile stocks responded better to selection. The highest phenotypic correlation coefficients were found between yield per plant and both number of pods and number of seeds per plant. Studies in controlled growth chambers showed that high temperatures (30°C day, 23°C night) resulted in poor pod and seed set (Abdalla and Fischebeck, 1978). Low temperatures (15°C day, 11°C night) resulted in good but slow growth and pod set. Studies on some of the quality characters showed that protein, starch, fat and ash had no significant association with seed size. Canning trials have indicated that local stocks have high consumer acceptability characteristics.

Some of the local varieties were treated with gamma rays, EMS or a combination of both mutagens (Abdalla and Hussein, 1977; Hussein and Abdalla, 1978). The materials were then tested for qualitative and quantitative variability and for high protein content. It was found that the combined treatments almost doubled the mutation frequency compared to EMS. Gamma-rays showed the lowest effect on mutation frequency and no relation was found between seed yield and protein content of the seeds.

Hybrids have been made between the sub-species paucijuga and the minor, equina and major types of the sub-species eu-faba (Abdalla, 1974; 1977a; 1977c). Hybrids between local and exotic stocks are more promising than those between locals. In some cases crossing succeeded in only one direction i.e. there was unilateral incompatibility (Abdalla, 1977b). The results obtained so far indicate that the equina type may have great potential for field bean improvement, this type possessing reasonable fertility and intermediate seed size. The major problems connected with bean improvement may be

- a lack of useful variability and reasonable level of pest resistance.
- sensitivity of the plant to environmental conditions.
- a lack of detailed knowledge on autofertility.
- low pod set compared to flower production.

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Abdalla, M.M.F. (1974). 'Unilateral incompatibility in field beans (Vicia faba L.)'. Incompatibility News Letter, 4, 16.

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Abdalla, M.M.F. and Hussein, H.A.S. (1977). 'Effects of single and combined treatments of gamma-rays and EMS on M_2 quantitative variation in Vicia faba'. Z. Pflanzenzuchtg. 77, 72-79.

Hussein, H.A.S. and Abdalla, M.M.F. (1978). 'Gamma-rays and EMS induced mutations in Vicia faba L. Evaluation of yield and protein traits in M_4 and M_5 generations.' In Proc. of the Intern. Symp. on Seed Protein improvement in Cereals and Grain Legumes, at IAEA, 4th-8th Sept., 1978.

Breeding and Genetics

Aneuploidy and tetraploidy in Vicia faba

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The first fertile tetraploid of Vicia faba as well as the first aneuploids have recently been described (Poulsen and Martin, 1977; Martin, 1977). Further work has shown that as expected the tetraploids exhibit agronomic disadvantages such as late development, low tillering ability and poor growth under artificial conditions compared to the original diploids. However, the major problem in the breeding of auto-tetraploids, and the main limitation concerning their practical use as a crop, is partial sterility.

Initial data show a strong environmental influence on both the fertility and the meiotic behaviour of the tetraploid. It was observed that there was a rather high heterogeneity in the mean number of bivalents in the meiosis of different tetraploid plants. This observation has initiated a long-term program aimed at increasing the fertility of the tetraploid. It is also intended to use γ-rays in order to induce structural changes and to increase the variability in such a way as to get a higher number of bivalents per cell.

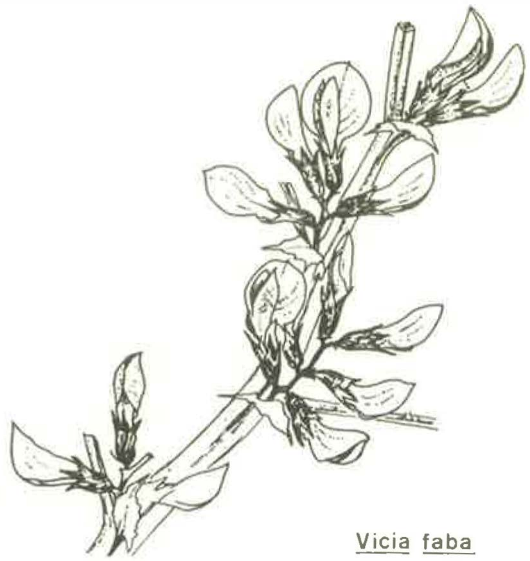
It would be very interesting to make a cross between tetraploids and diploids although this has not been achieved to date. It is also intended to try crosses between tetraploid plants and other Vicia spp. in order to obtain interspecific materials.

Attempts are being made to identify the extra chromosomes in aneuploids using both G and C banding. Studies of the morphology and fertility, as well as those of the transmission of the aneuploidy, suggest that there are at least two trisomic lines. It is necessary to confirm this, however, through identification of the chromosomes involved. A crossing program using marker genes has been initiated in an attempt to identify linkage groups and to build up a chromosome map.

References:

Martin, A. (1979). 'Aneuploidy in Vicia faba L.' The Journal of Heredity 69, 421-423.

Poulsen, M.H. and Martin, A. (1977). 'A reproductive tetraploid Vicia faba.' Hereditas 87, 123-126.



Vicia faba

The use of isoenzymes as an aid to the breeding of field beans (Vicia faba)

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A simple, rapid technique has been developed for identifying inbred lines of Vicia faba L. and measuring crossing between them, using vertical polyacrylamide slab gel electrophoresis of isoenzymes isolated from pollen and cotyledons. Six isoenzyme systems were evaluated, and two of these, non-specific esterase (EST) and glutamate oxaloacetate transaminase (GOT), were selected for use in screening genotypes. Neither of these isoenzyme systems, from seed or pollen, was found to be affected by environmental variables which included contrasting nitrogen regimes and plant growing conditions. Tissue specificity for EST isoenzymes was found between leaves, pollen, seed cotyledons, and embryos.

It was found that by using EST isoenzymes, a large number of inbred lines could be positively identified by seed or pollen zymograms and their F_1 hybrids could be detected. Because only small quantities of cotyledon or pollen were required for extraction, the method allowed seeds to be germinated after sampling, and the reproductive capacity of plants was not seriously impaired.

The method was successfully used for measuring the contamination of inbred lines and F_1 hybrid seed, and outcrossing was measured in the first synthetic generation of two commercial synthetic varieties. Within these, individual components and their different F_1 hybrids could be identified, thus testing was carried out for random intercrossing between the syn-0 inbreds.

The system was also tested on a diverse range of taxa, and found to be widely applicable, especially to crop breeding programmes where inbred lines form an integral part.

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Gates P. (1978). 'The use of isoenzymes as an aid to the breeding of field beans (Vicia faba L.).' Ph.D. Thesis, University of Durham.

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Concerning the instability of "447" male sterile cytoplasm

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It has been hoped that the discovery by Bond in 1957 of a male sterile cytoplasm will lead to hybrid varieties of Vicia faba. However, the cytoplasm is of limited use at present due to the following factors:

1. Instability - male fertile plants and plants with fertile tillers appear during the back-crosses with the male (maintainer) parent.
2. Permanent restoration - the hybrid between male sterile and restorer lines (self pollinated) give a progeny which is almost entirely male fertile.

It has been shown that the pollen from the male fertile plants described in 1 and that from about a quarter of the F_2 plants described in 2 give the same progeny as maintainer pollen, excluding the possibility of a nuclear mutation and suggesting a cytoplasmic change.

The pollen phenotypes (where S is male sterile, F is male fertile and I is intermediate) of a sterile line (BC9 of Ad23, a spring type of field bean obtained from M. Berthelem, INRA, Rennes, on the '447' cytoplasm) have been studied under greenhouse conditions. Observations made throughout the flowering period revealed a large heterogeneity between and within plants. S, I and F plants were found, as were 'SvI' and 'IvF' plants which showed phenotypic modification from S to I and I to F respectively on the different tillers of each plant. Individual plants have been found with different phenotypes on different tillers (Thiellement, 1977b).

In the F_{10} generation following free pollination in isolation, the phenotypically different mother plants gave different proportions of phenotypes, suggesting that the heterogeneity observed in the BC9 reflects some change in the hereditary material. For example, S and I sectors of the same mother plants gave different progenies (Thiellement, 1977c).

In the F_{11} generation it was found that the F_{10} S plants gave the same progeny whether freepollinated or crossed with F sister plants, suggesting that nuclear restoration is not involved. The F_{10} I plants also gave the same progeny whether free pollinated or self pollinated, suggesting that the I pollen is equivalent to the free (mainly F) one. However, the proportions of phenotypes were found to be different between the F_{10} I plants from the BC9 I plants and the F_{10} I from the BC9 'SvI' plants. This 'grandmother' effect has been confirmed by the offspring analysis of plants which showed F and I phenotypes on different tillers. 'F&I' plants derived from S plants gave homogeneous progeny, entirely F, whereas 'F&I' plants from an I phenotype gave different progenies according to the phenotype of the tillers from which they originated (Thiellement, 1979).

All the reported results fit with the working hypothesis previously suggested (Thiellement, 1977a) which considered the pollen phenotype to be dependent on the nuclear genome and that there is an equilibrium between two kinds of plasmons, one kind leading to pollen fertility the other to pollen abortion. Conclusive evidence is still lacking, although biochemical investigations of the cytoplasmic fractions (DNA, proteins) are at present in progress.

The aim of the work was to obtain by maternal selection within a fixed line a stable S cytoplasm, but under the greenhouse conditions used no further S plants were found in F_{11} even when derived from S plants. However, the effect of temperature on the pollen phenotype should be noted (Le Guen et al, 1979; Duc, 1978). It has been shown that the I phenotype, a heterogeneous class by definition, has an interesting behaviour shifting more slowly that the S phenotype towards male fertility.

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Interspecific hybridization in Vicia spp.

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Very limited genetic variability has been found within Vicia faba for many important characters such as disease resistance, insect pest resistance, protein quality and environmental adaptation. In such circumstances plant breeders often look for genetic variation within closely related primitive and wild species (Hawkes, 1977). Few attempts have been made in this respect for Vicia faba largely due to the limited information on such aspects as morphology and chromosome number of related species and the difficulty in manipulating them.

Vicia narbonensis is closely related to Vicia faba and is known to be highly resistant to diseases and insects. A preliminary interspecific crossing program has been initiated to study the possibilities for gene exchange between V. faba and V. narbonensis. Twenty five crosses between V. faba (vars. Aquadulce Claudia and Bunyards Exhibition) and V. narbonensis materials obtained from USSR, Tunisia and Germany have been attempted but with no success. It is intended in the future to test other V. faba related species such as V. hyaeniscyamus, V. galilaea and V. bithnica.

Reference:

Hawkes, J.G. (1977). 'The importance of wild germplasm in plant breeding.' Euphytica 26, 615-621.

Mutation and breeding work on Vicia faba in Austria

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The field bean (Vicia faba minor) is grown as a spring sown crop in the cooler and more moist regions of Austria. It is used as a source of protein and energy for use in livestock feeding. Recently the broad bean (Vicia faba major), in particular the shorter types, has been used in breeding programs and in yield performance trials where it can be compared to the field bean. Such trials have been carried out both in regions where field beans are grown commercially and in the drier regions under irrigation. Broadbeans are not generally used for human consumption in Austria.

The principal breeding objectives are to minimize yield instability in field beans and to increase earliness at the same time as improving yield capacity. It is also hoped to improve grain quality by enhancing protein quality and quantity and by reducing antinutritional factors. At present disease resistance is considered as of secondary importance. Mutations have been induced using gamma (3,5,7 Krad) and fast neutron irradiation (200, 300 rad) on seed material of cv. Kornberger Kleinkornige. This has resulted in a remarkable increase in genetic variability and screening is being carried out to identify mutants which will be of value as breeding material.

Mutations have been identified for the following characteristics: altered plant type (determinate), leaf shape and size, flower morphology and pigmentation including white flowering types which may correspond to tannin content differences in the seed coat. Differences in grain size of mutants up to the medium-large horse bean size may affect the proportion of seed coat and the content of the different antinutritional factors. Resistance to pod shattering is especially important for the dry growing regions. Positive and negative selections for protein content resulted in high and low protein lines with different amino acid profiles. It was found that most of the essential amino acids showed a negative correlation to protein content. High protein mutants are maintained under bee-proof isolation.

In the cross-breeding program broadbeans are used as a gene source for earliness, high number of grains per pod, high grain weight and short growth habit. Field bean mutants are also included in this program and differences in response to irrigation are also being studied.

Aspects of broadbean and field bean breeding

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Recent research has involved a continuation of the work on agronomic selection and evaluation of field bean (Vicia faba equina and minor) progenies found in Sicilian populations and the enlargement of the broadbean and field bean collections, with analysis of characteristics and relative variability. A cross-breeding program has also been carried out together with studies of the following agronomic factors:

- relationships between yield, plant density and time of seeding.
- relative agronomic value of major, equina, and minor.
- influence of environmental factors on setting, fructification, Single seed weight, yield per plant and protein content.
- evaluation of fertilizing capacity of broadbeans.

The current breeding program has led to the identification of numerous lines of field beans which are of particular interest as regards the bioagronomic characteristics of earliness, time between anthesis and maturity, productive capacity and protein content. Ten of these lines have been taken for agronomic evaluation. Results have shown that there is a relationship between productive capacity and yield components (number of pods and seeds and 1000 seed weight).

The observed variability in the collection of over 100 populations available has made it possible to select material which may lead to the constitution of broadbean varieties for the production of dry grain for human consumption and animal feed. From the population collection a variability range of 15 - 29% has been observed for protein content and 250-3000 g for 1000 seed weight.

Physiology and Microbiology

A preliminary study of the response of some faba bean (Vicia faba) genotypes to vernalisation

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Studies were carried out on the response of several faba bean genotypes to dates of planting ranging from early winter to early spring, under field conditions in Northern Syria (36°N, 392 m above sea level) during the 1977-78 season. The studies revealed that many genotypes failed to give satisfactory reproductive growth when planted in early spring. It was suspected that these genotypes might have a chilling requirement which was not being met when the crop was planted late in the season. In order to test this a preliminary study on vernalisation was carried out during the 1978-79 season using seven diverse genotypes of faba bean collected from within ICARDA's region (The Near East and North Africa).

Selected seeds were treated with thiram and benlate fungicides and then soaked in water for 24 hours, with occasional stirring, to initiate the process of germination. After soaking, the seeds were planted in moist sand troughs which were transferred to a refrigerator and kept within a temperature range of 1 to 5°C for 38 days. Vernalised seeds (V) were planted in 20 cm plastic pots containing a soil + sand medium and the plots were kept in an unheated plastic house and were well supplied with nutrients and water. Unvernalised seeds of the same genotypes were planted at the same time, these being pre-soaked for 24 hours and handled in the same way as the vernalised seeds in order to act as a control (C). Five plants were grown in each pot and there were four replications. The temperature in the plastic house ranged from 5°C to 32°C during the growth period until 100% flowering (i.e. all plants in the pot had at least one flower) had been obtained in all the treatments. Temperatures lower than 10°C were reached only for short periods on some days during the growth period.

It was found that vernalisation hastened the flowering process in all genotypes (Table 1), although the magnitude of this effect varied considerably. Plants were sampled from each pot at the 100% flowering stage in order to determine the effect of the treatments on the development of the the reproductive structures (flower buds, flowers and young pods) per plant. A positive effect of the treatment was observed in all the genotypes (Table 2). It would be safe to infer that the genotypes tested have a facultative vernalisation requirement in view of the fact that flowering occurred even in unvernalised plants and that vernalisation hastened and encouraged reproductive growth.

Although this study was very preliminary it has generated interest for more intensive investigations into the genotypic differences in vernalisation requirement as these could be of considerable significance for breeding varieties with wider adaptability.

Table 1. Effect of vernalisation on time taken for 100% flowering and the position of first flowering axis in seven genotypes of faba bean.

Genotype	Days from Planting to Flowering		Position of First Inflorescence (1=1st node etc.)	
	C*	V*	C	V
Cyprus Local	60	55	5.7	5.7
Giza-3	63	62	6.5	5.7
Jordanian Local	68	62	5.7	4.5
Giza-2	70	62	7.7	6.0
Giza-4	70	57	6.7	5.2
Lattakia Local	70	62	6.0	6.2
Lebanese Local	72	67	7.2	6.7

*C = Control
*V = Vernalised

Table 2. Effect of vernalisation on the development of reproductive structures of faba beans*.

Genotype	No. of Inflorescences per Plant		Totals No. of Flowers per Plant		Total No. of Flower Buds per Plant		Dry Weight of Reproductive Structures (mg/plant)	
	C	V	C	V	C	V	C	V
Cyprus Local	5.25	6.25	12.00	14.00	0.00	0.75	430	690
Giza-3	5.00	5.25	9.75	14.25	11.50	0.00	430	470
Jordanian Local	6.25	6.75	13.50	15.50	15.25	6.75	510	670
Giza-2	3.75	4.50	6.25	8.75	3.25	4.25	280	390
Giza-4	5.75	6.25	10.25	19.00	11.75	2.75	550	350
Lattakia Local	6.25	7.75	11.75	17.25	17.50	10.00	520	550
Lebanese Local	5.50	5.75	4.50	12.00	20.25	10.75	470	390

C = Control
V = Vernalised
* = All measurements were made when 100% flowering had been attained in all the treatments.

Scanning electron microscope studies of Vicia faba stigmatic exudates

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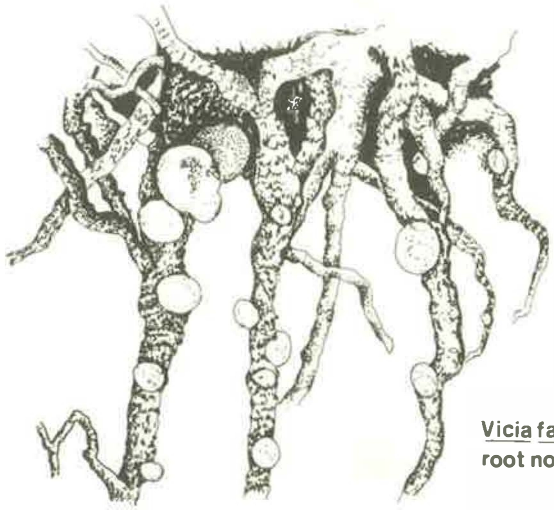
A scanning electron microscope was used to study the stigmas of inbred lines of field bean (Vicia faba minor). The ability of flowers to set seeds in the absence of 'bee-tripping' (or autofertility) has been shown to be dependent on the secretion of a stigmatic exudate which occurs before anther dehiscence. If they were left 'untripped' autosterile inbred lines did not secrete an exudate until late in flower development. However, manual tripping or emasculation of flowers increased stigma exudation.

Anther dihiscence occurs one or two days before opening; by freezing flowers in liquid nitrogen vapour to prevent disturbance of pollen during dissection, it was shown that autosterile lines always had pollen grains on their stigmas before flower opening. Self-pollen therefore has a temporal advantage over cross-pollen, but it does not germinate until the stigmatic exudate accumulates, thereby allowing the possibility of cross-pollination. Lines which have previously been termed autosterile can therefore be classed as protandrous while autofertile lines are protogynous.

Present work is aimed at determining the role of the stigmatic exudate in pollen germination. Aspects of pollination and fertilisation relative to the physiological development of the flower are also being examined.

Reference:

Paul C., Gates P., Harris N., and Boulter D. (1978). 'Asynchronous sexual development determines the breeding system in field bean.' Nature 275, No. 5675, 54-55.



Vicia faba root nodules

Improved nitrogen fixation in faba beans (Vicia faba)

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Limited surveys carried out in farmers' fields in the Near East and North Africa region have indicated that Vicia faba usually nodulates well with the naturally occurring Rhizobia. However, within any one area the nodule development varies from field to field and this is seen primarily as a result of variations in management practices. For example, it has been observed that plants in irrigated fields invariably had more nodules than plants in neighbouring unirrigated fields. These surveys have helped to identify several problems associated with nitrogen fixation in broadbeans in the region. As a result a series of studies at Aleppo have been initiated to investigate these problems and to improve nitrogen fixation in Vicia faba in the region.

Studies have been made on five Rhizobium strains (BB 10C, BB 14C, BB 21B, BB 22B and IC 9253) all of which were isolated from the West Asia region and were found to be highly effective under greenhouse conditions. The inoculation responses of these strains on nodulation and growth of three faba bean cultivars (Local Large, Giza-2 and Local Small) were measured. The aim of the experiment was to determine the feasibility of introducing highly effective Rhizobium strains into a soil already containing faba bean Rhizobia. It was found that inoculation with some Rhizobium strains gave large increases in the number of nodules (Table 1). There was also a positive interaction between cultivars and Rhizobium strain.

The nodule development of 23 faba bean cultivars obtained from different countries was examined in a replicated trial with and without inoculation. It was found that the cultivars varied considerably in their nodule production whether inoculated or not. For example, one cultivar (green Windsor from the UK) formed on average 170 nodules per plant whereas another (Hudeiba-72 from the Sudan) formed only 35. Rhizobium inoculation increased nodule production in 14 of the cultivars tested, the percentage increase ranging from 7.6% to 92.5%. It was also found that the dry matter production of the cultivars increased along with this increased nodulation.

About 100 different Rhizobium strains have recently been isolated from nodules collected in Syria, Jordan, Lebanon, Egypt, Sudan, Morocco and Lybia. At present these strains are being authenticated and evaluated under glasshouse conditions to determine their suitability for use in field trials. The most effective strains will be multiplied for regional testing, and will be supplied to any interested scientists.

Table 1. The effect of Rhizobium Inoculation on Nodule Production in Three faba bean Cultivars.

Cultivar	Treatment	Number of Nodules Per Plant*
Local Large	none	49.4 ± 5.2
	BB-21B	104 ± 9.5
Giza-2	none	33.1 ± 1.2
	BB-14C	69.1 ± 7.6
Local Small	none	51.4 ± 7.7
	IC-9253	91.5 ± 10.5

* Nodules were counted 118 days after germination.

Waterlogging and drought effects in field bean (Vicia faba minor)

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Using in most cases the cultivar Vicia faba minor var. 'Maris Bead' it was found that field beans suffered less from equal durations of waterlogging than did a cultivar of garden pea. However both plants were seriously affected by water shortages resulting in incipient wilting. The observed waterlogging effects were approximately the same when plants were grown in the field, in pots containing various soil types in the glasshouse and in sand and culture solutions.

Aeration studies showed that oxygen deficiency was the main cause of waterlogging. Ten to 12 days of waterlogging produced substantial damage at all growth stages but waterlogging during the early to mid flowering stages was the most effective in reducing yields. The loss of yield was associated with pod-setting failure.

The morphological effects of waterlogging and drought were often similar and included:

- smaller size of expanding leaves
- early senescence of older leaves
- shorter internodes
- suppression of root growth

Tap root death in plants grown in waterlogged soils occurred frequently.

The physiological effects of waterlogging included:

- low levels of cytokinins in the exudates collected from stems cut near ground level
- high levels of abscisic acid especially in the pods of plants waterlogged around early pod formation stages.
- reduction in nutrient uptake and in subsequent distribution patterns of nitrogen and phosphorus.

Plants under drought conditions also showed high levels of abscisic acid, (ABA), particularly in the older leaves. Recovery of the plants and reduction in the level of ABA in the younger leaves occured more rapidly following drought as opposed to waterlogging.

Agronomy and Mechanisation

The effect of sowing date and watering interval on the grain yield of broadbean

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Broadbean is the most important food grain legume in the Sudan. The effect of sowing date on the grain yield of the crop has been studied by Heipko (1965) and Abu Salih et al, (1973) who found the optimum sowing date to be around mid October. However there has lately been a large increase in the incidence of wilt disease complex in plants sown in October with the result that farmers have delayed their sowing until November. The disease was first reported by Ibrahim (1972) who ascribed it to F. solani F. sp. fabae. Work has therefore been carried out to reassess the effect of sowing date on plant survival and on the grain yield of broadbean, and to determine whether the wilt disease incidence could be influenced by varying the soil moisture regime.

An improved local variety (BF2/2) was grown on a heavy clay vertisol soil, treatments consisting of 13 sowing dates at weekly intervals from October 4th to December 27th . The treatments were factorially combined with three watering intervals of 7, 14 and 21 days, and the plots were laid out in split plot randomized blocks with five replicates . The sub-plot size was 8.6 m x 3.0 m of which 7 m x 1.8 m was harvested for yield .

Sowing date, watering interval and their interaction had a highly significant effect on grain yield. The effect of the wilt disease complex on grain yield was more pronounced than that observed by Abu Salih et al, (1973) which may explain why the optimum sowing time was significantly affected by the watering treatments. The optimum sowing date lay between October 18th and 25th when the crop was watered weekly, and during the first eight days of November when the crop was watered every two or three weeks. The watering treatments were probably acting in two ways, the first indirectly through their effect on the microclimate and therefore on the incidence of the wilt disease and the second directly affecting the plant vigour and the susceptibility of the roots to wilt attack.

On average it was found that increasing the watering interval from one to two or three weeks resulted in grain yield reductions of 56 or 133% respectively, reflecting the highly arid nature of this agro-ecological zone.

When the plant height and the components of yield were studied it was observed that both sowing date (Table 1) and watering interval (Table 2) had a highly significant effect on the number of plants per unit area and the number of pods per plant as well as plant height and the 100 seed weight. The number of seeds per pod was also slightly affected, the average value being 2.4. Plant height varied with sowing date in a parabolic manner, and it may be that there were fewer sites available for pod development at either end of the parabola. Plant height was also decreased by delaying the watering from 7 to 21 days intervals.

There were significant reductions in plant stand in plots sown during the early part of October (Table 1) due to the high incidence of wilt disease complex. The effect of the disease was significantly less when the plots were watered weekly. The number of pods per plant was highest for the October sown plants due to the low plant stand and the high degree of branching, but it decreased with delayed sowing, reaching very low levels with the December sowings (Table 2). Significantly more pods were found on watered plants.

Seed size decreased with both delayed sowings and with moisture stress, but the effect of sowing date was more pronounced. Delaying the sowing until after the optimum date exposed the plants to unfavourable environmental conditions (disease and heat stress) thereby limiting their photosynthetic capacities and grain filling.

This study clearly showed that the sowing date of broadbeans under the prevalent agroclimatic conditions is very critical. The growing season is short and limited at the beginning and the end by heat and disease stress. Soil moisture significantly affects the prevalence and severity of wilt disease complex.

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Table 1. The Effect of Sowing Date on the Number of Field Bean Plants per m^2 and on the Number of Pods per Plant.

	Sowing Date												
	October				November					December			
	4	11	18	25	1	8	15	22	29	6	13	20	27
No. of Plants per m^2* $\pm$ 0.7	3	9	16	19	21	22	22	23	25	23	24	27	25
No. of Pods per Plant $\pm$ 1.1	34	26	19	14	13	11	10	12	10	8	8	5	5

* Figures given are means of three values taken at watering intervals of 7, 14 and 21 days.

Table 2. The Effect of Watering Interval on the Number of Field Bean Plants per m^2 and the Number of Pods per Plant.

	Watering Interval		
	7	14	21 days
No. of Plants per m^2* SE $\pm$ 0.4	20	20	20
No. of Pods per Plant* SE $\pm$ 0.5	17	13	10

* Figures given are means of values taken from 13 sowing dates.

Estimates of the growth potential of field beans (Vicia faba minor)

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Yields of field beans in the UK are somewhat variable and this may be a major constraint on expansion of the acreage. Much emphasis is placed on discovering the sources of variation in yield in Vicia faba; additional understanding will perhaps lead to improved yield as well as more consistent performance. When considering year to year differences or even site to site differences in yield, it would be helpful to have a yardstick for yield based on production from plots grown under defined and reproducable growing conditions. By choosing conditions that will maximise yield it is possible to use these plots for the additional objective of estimating potential productivity for any particular environment.

Such plots have been called measured-maximum yield (MM) plots (Thompson and Taylor, 1979) to distinguish the results they produce from the estimated 'potential' yields derived from mathematical models. In principle the plots are devised to provide non-limiting levels of all resources except light, temperature and CO_2. Comprehensive pest and disease control is provided though appropriate sprays, and protection from vermin by surrounding and covering with netting. The rooting medium is a specially prepared high fertility compost enclosed in 30 cm high wooden shuttering each plot covering an area of 6 m x 12m, and sited directly upon the indigenous topsoil. The topsoil is known to be substantially free of major pest and disease problems. Irrigation and nutrients are provided through a trickle irrigation system. Growth and yield of this crop are compared with a control plot grown alongside using a standard of cultural management.

Exploration of the effects of specific factors on growth and yield are made by superimposing such factors (e.g. irrigation, spacing) in a split plot fashion over the MM and control plots. In the first instance classical growth analysis was used to establish differences in growth patterns between the MM and control plots (Thompson 1978). Interestingly, although the MM plots gave 30% more total dry matter yield than the control, the increase in dry bean yield was only about 12%. These differences in growth could be attributed more to increased leaf area duration than to improved net assimilation rates or improved relative growth rates.

Subsequent experiments have examined the effects of plant density and irrigation on performance. Interactions were found between level of fertility (MM or control) and plant density or irrigation, both in respect of total dry matter production and bean yield. Factors involved in determining the ratio of beans to total plant dry weight are being sought and examined in an effort to define conditions favouring high seed yields.

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Sowing date trials for field beans (Vicia faba minor) and broadbeans (Vicia faba major)

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Spring sown Vicia faba minor cannot be easily accommodated into the normal crop rotations of Northern Italy because of its low yields. It was therefore of interest to carry out yield trials in 1976 and 1977 to determine the highest yielding spring-sown varieties and to compare the yields of spring and autumn-sown plants.

The highest yielding spring-sown field bean varieties were Ascott, Ackerperle, Maxime, Pavana and Maris Blaze which gave from 8.5 to 9.5 q protein/ha when sown at the end of February or the begining of March. For autumn sowing the average yield of the 13 V. faba ssp. minor varieties grown was 11.4 q protein/ha. The autumn sown crop can be harvested in the middle of June in Northern Italy giving the possibility of following it with a corn crop for forage.

The results showed that autumn sowing can also give increases in grain and protein yields for V. faba major, but the results for V. faba minor are seen as more significant because of the greater potential interest in this crop. There were aphid attacks in both years of the trials and treatments were made accordingly.

There have been too few experiments to date to allow any definite conclusions to be drawn, but the results obtained with V. faba minor are of interest and suggest that it may be possible to introduce the crop into Northern Italy. However, there are many problems still to be solved in order to gain a better understanding of this crop which is almost completely new to the environment of the area.

Tahle 1. The Protein Yield Obtained from 17 Field Bean (Vicia faba minor) Cultivars in Spring- and Autumn-sown trials.

Cultivar	No. of Spring-sown Trials	Protein Yield (q/ha) Spring-sown Trials	Autumn-sown Trials
Ascott	2	6.62	14.4
Pavana	2	5.86	-
Maxime	2	6.06	-
Primperle	2	4.91	12.0
L. 72	2	4.00	10.7
Manfredini	2	4.74	-
Vesuvio	3	3.95	10.9
Scladia Kleine	2	5.47	12.7
Nixe	1	6.01	10.8
Ackerperle	2	6.03	12.0
Herra	2	4.87	8.3
Diana	2	5.85	12.1
Minor	2	4.66	12.1
Maris Blaze	1	6.06	-
Maris Bead	1	4.75	10.4
Dacre	1	4.06	-
Kristall	0	-	10.8

Pests and Diseases

Screening for disease resistance in broadbeans (Vicia faba) in Egypt

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Broadbeans in Egypt are subject to attack by several different diseases, including the leaf spot diseases Botrytis fabae, B. cinerea, Alternaria tenius and Stemphylium botryosum, the rust Uromyces fabae and the root rot and wilt diseases Rhizoctonia solani, Fusarium solani, F. oxysporum and F. fabae.

Varietal evaluation under field conditions at both Sakha and Nobaria Research Stations have indicated a wide variation for leaf spot diseases, from small traces to 50% infection. Out of 4000 lines tested, 30 showed moderate resistance with rates of infection of less than 10%. The inoculation of detached leaves with a spore suspension of one isolate of Botrytis fabae indicated that leaflets from plants approaching maturity were more easily infected than those in the earlier stages of growth. It was also found that the cultivars differed widely in their infection rates: from 14% in NEB 519 to 92% in Rebaya 40. The two commercial varieties Giza 1 and Giza 3 which were recommended for disease-prevailing areas were only moderately resistant with rates of 20% and 25% respectively.

Using the same isolate, the inoculation of potted plants showed that the cultivar NEB 938 was highly resistant with an infection rate of less than 1%. The following cultivars also had infection rates of less than 10%: Giza 1, Giza 3, NEB 368, NA 67, NA 174, NA 176, Selection 23 and Selection 27. Rebaya 40 was found to be very susceptible with an infection rate of more than 60%.

Recent research on certain broadbean (Vicia faba) diseases in the Sudan

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Broadbean Mosaic.

Broadbean Mosaic is a common disease in the broadbean growing areas of the Nile and in the Northern provinces of Sudan, a country where the total area under this crop is estimated at 20,000 acres. Research at Hudeiba has shown this disease to be caused by two viruses, pea mosaic virus (PMV) and broadbean mottle virus (BBMV) which may be present under natural conditions, either separately or together. Both viruses produce similar symptoms in broadbean, these being mottling or vein clearing, and both can be carried by the plant without the symptoms being evident. Both are readily transmitted mechanically and by seed while only PMV, the more common and damaging of the two viruses, can also be transmitted by insects (aphids).

It has been shown that disease development is closely related to sowing date, the final percentage and the incidence of infection being found to increase steadily with delay in sowing. Abu Salih (1974) found that neither nitrogen application nor repeated spraying against the vectors had any effect on the disease incidence. Artificial infection with a mixture of the two viruses two weeks from sowing highly significantly reduced the height, the number of pods and the seed weight per plant.

Phyllody.

Phyllody, or green flower disease, has also been studied. Extensive surveys have shown the incidence of this disease to be fairly low and insufficient to warrant any cause for concern. No insect vector nor any indication of secondary spread is evident, but the incidence of the disease has been shown to diminish abruptly with late sowings.

Broomrape

Broomrape has not yet been recorded or observed in the field in Sudan, although it was recorded on tomatoes at Hudeiba in 1971 (Hussein, 1972). In a host range study with the same Orobanche species as that parasitising tomatoes it has been experimentally possible to make it parasitise broadbeans. Almost 100% parasitisation was achieved using the seedling inoculation method (dipping the roots of seedlings in a suspension of Orobanche seeds before planting). Lesser degrees of parasitisation were also achieved by sowing broadbean in naturally, as well as artificially, contaminated soils. Parasitised plants showed marked reductions in height, in number of basal shoots, in number of pods and in seed weight.

Leaf Rust.

Leaf rust (Uromyces fabae) has recently been observed in the Zeidab Scheme near Hudeiba, which is the largest single broadbean production area in the Sudan where up to 4000 acres are sown annually. The incidence of the disease was particularly high in plots which had received nitrogen in the form of urea which has resulted in substantial leaf shedding. Uromyces fabae was first recorded on broadbean in this province in the early 1940's (Tarr, 1955) but since then had not been reported until the recent observations.

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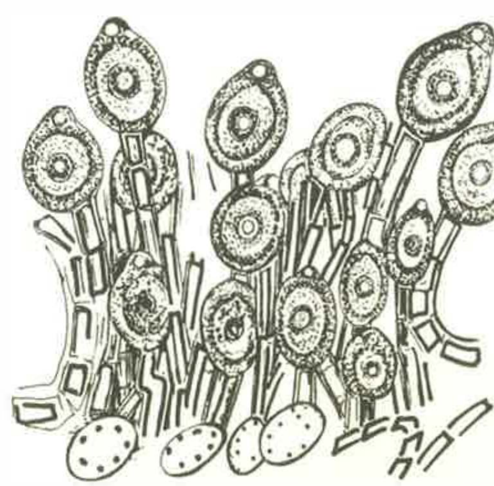

Rust disease

Studies of some viruses isolated from broadbeans (Vicia faba) in Egypt.

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Research into the viruses attacking broadbeans in Egypt began in the late 1960's. Since then several viruses such as bean yellow mosaic virus (BYMV) and pea bean true mosaic virus (BBTMV) have been isolated and identified. Of the four viruses tested only resistance to BBTMV was found among the available broadbean cultivars.

More recently five strains of BYMV have been differentiated on the basis of reaction with a specific set of French bean, cowpea, lupin and pea cultivars. Another test was conducted to evaluate the susceptibility of 91 broadbean introductions and hybrids to one of the BYMV strains. Five of this number, namely NA 52A, NA 206, 61/1311/66, 66/1887/69 and 104/3087/73, were considered to be resistant to the strain. A program was therefore initiated in order to transfer this resistance to economically valuable cultivars; crossings have now been carried out and the evaluation of the F_1 seeds is in progress. This program is being conducted in collaboration with the Food Legume Research Section at Giza.

In addition a virus new to the area has been isolated from both peas and broadbeans and has been identified as broadbean wilt virus. The status of this virus in local broadbean fields is to be evaluated. However, field and greenhouse investigations, as well as ultrastructural studies, have suggested that the strain is milder than elsewhere. BYMV is still the most destructive and widespread of all broadbean viruses under Egyptian conditions.

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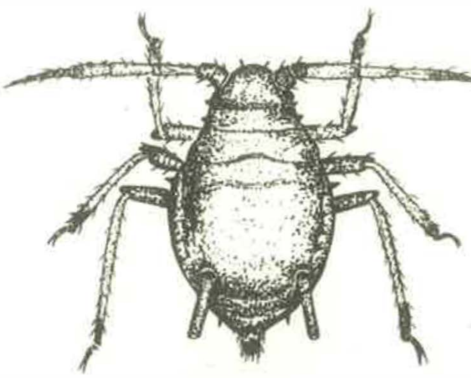

Aphis fabae

Aphid resistance in Vicia faba

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Natural resistance to aphids in Vicia faba is a factor which has played very little part in the breeding and development of new varieties. Chemical control of aphids is liable to become increasingly ineffective so there is a need to determine the distribution of the natural resistance existing within the range of Vicia faba cultivars.

The resistance of one particular cultivar (RI), and that of the lines derived from it (Bond and Lowe, 1975) has been confirmed using the black bean aphid (Aphis fabae). Aphids reared on RI showed significantly lower teneral adult weights and contained fewer large embryos than those reared on varieties commonly grown in England such as Cockfield. It is hoped to extend this aphid performance screen to include a much wider and geographically more diverse range of plants, including more primitive cultivars and landraces.

Aphid performance is assessed by caging adult apterae onto the leaves in 'clip cages' (as described by Way and Cammel, 1970) and then allowing their offspring to grow to maturity confined within the cage. The teneral adults are then weighed and dissected in order to count the number of large embryos contained in each. This is a much more rapid technique than that of monitoring the fecundity of the animals directly, but the exact relationship between weight or embryo number and fecundity is not yet known. In particular it is not clear whether these relationships are sufficiently fundamental to transcend cultivar differences, but recent work suggests that large embryo content in the teneral adult rather than weight is a more reliable measure of fecundity for between-cultivar comparisons.

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Table 1. Weights and large embryo numbers of teneral Aphis fabae adults reared on five cultivars of Vicia faba.

Cultivar	Weights	SE	No. of Large Embryos	SE
R1	430.6	22.6	7.17	0.29
Herra	737.9	32.9	8.32	0.39
R4	665.8	40.7	8.90	0.57
R7	908.3	27.7	9.50	0.27
Cockfield	938.5	24.8	10.03	0.44

Broomrape (Orobanche spp.) control in broadbeans (Vicia faba)

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Orobanche crenata Forsk. is one of the most prolific broomrape species in the world and has a host preference for faba beans (Vicia faba) surpassed only by that for peas (Pisum sativum). The parasite can produce up to a million seeds per plant which reinfest the land well before the end of the cropping season. In some regions a susceptible crop can not be grown for many years following broomrape infestation because the parasite seeds can live dormant in the soil.

In the early 1970's the control methods which were under investigation were chemical control, the use of trap crops, selection of resistant crop varieties and biological control. Since then Johnson (1976) has introduced a new approach involving the use of synthetic stimulants which cause premature germination of parasite seeds in the ground. However, recent work carried out by Saghir et al (1979) has shown that it is difficult to find practical ways of using these products in the field.

Further research on other methods of controlling broomrape has been carried out and of these the use of glyphosate appears to be the most suitable at present. Glyphosate is a systemic herbicide normally used as a total weed killer, low rates of which can be tolerated by faba beans.

Orobanche sp.

Application of the chemical at the faba bean flowering stage has resulted in almost complete prevention of Orobanche shoot emergence (Kasasian, 1973). Further research has shown that suitable rates of application of the chemical vary with both climatic conditions and growth vigour of the faba beans. Under mild Mediterranean conditions two to three applications of the chemical at two to three weekly intervals give the best results.

In Northern Syria it has been found that with the cold winters one application of 120 g acid equiv. glyphosate per ha is sufficient for control. This should be applied about two weeks after the first faba bean flowers have appeared and when the subsurface Orobanche haustorias have formed. In Morocco Schimtt et al (1978) have found that two sprayings of 60 g acid equiv. glyphosate per ha at a two-week interval and at the tubercle stage was required to get good control of the parasite and significant yield increases in the crop.

In Egypt, however, where the winters are much milder it has been found that up to three sequential treatments with 73 g acid equiv. glyphosate per ha are necessary with spraying commencing at the first appearance of faba bean flowers (Table 1.). These results also show that while in uninfested plots the chemical reduced the crop yield slightly, in heavily infested plots glyphosate increased the faba bean yield as well as preventing fresh Orobanche infestation.

Table 1. Effect of glyphosate on Orobanche crenata shoot emergence and faba bean (Vicia faba) yield in infested and uninfested soil.

Treatment	Infested Soil		Uninfested Soil	
	No. of Orobanche Shoots per ha	Green Pod yield (t/ha)	No. of Orobanche Shoots per ha	Green Pod yield (t/ha)
Glyphosate*	520	11.4	0	12.6
Control	435,200	9.7	0	13.9

* three sprays of 73 g acid equiv. glyphosate per ha at three-weekly intervals beginning with first flower appearance.

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The resistance of broadbean (Vicia faba) varieties to Orobanche crenata Forsk. and their response to chemical control

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Three varieties of broadbean (F402, Rebaya-40 and Giza-4) were tested for their resistance potential with respect to Orobanche crenata Forsk. in a naturally infested plot. F402 has been reported to be resistant (Nassib et al, 1978), while the other two are commercial varieties known to be susceptible to the parasite. The test gave the following relative values which corresponded to infection rates for the three varieties:

Variety	Relative Infection Rate	
	Without Herbicide	With Herbicide
F402	21.2	5.0
Rebaya-40	54.9	13.8
Giza-4	100	17.2

The above table also shows the relative values of infection rate for the three varieties after chemical treatment with the herbicide 'pronamide', the use of which against O. crenata in broadbeans is described by Zahran et al (1979). It was found that F402 had a low infection rate whether it was treated or not and that both the commercial varieties showed a significant response to the treatment.

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Seed Quality and Processing

Factors affecting faba bean utilisation

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Preliminary studies on the factors affecting the nutritional value of faba beans (Vicia faba) have shown that the balance of amino acids in the seeds is good except for the sulphur amino acids (in particular methionine). This deficiency can be readily made up by the addition of DL methionine to the diet.

It has also been observed that chicks fed on processed beans which had been autoclaved for 30 minutes at 121°C had 16% faster growth rates and 19% greater efficiency of utilisation than chicks fed on raw faba beans (87% of the total ingredients). This was shown to be mainly due to the effect of processing on the components of the hull or testa portion of the bean and to a smaller extent on the protein portion. It was shown that the thermolabile factor in the hull portion of the bean is not protein in nature, is not associated with lectin or trypsin inhibitor activity and does not affect pancreas size. This factor has been identified as a condensed tannin and reduces nutrient utilisation by depressing chick appetite and the availability of nutrients.

Several tannin-free cultivars of faba beans have been identified, these having a lower percentage of testa due to a much lower condensed tannin and lignin content. The testae of the tannin-free cultivars are digested in vitro by rumen micro-organisms to a much greater extent than those from other cultivars. It was also clear that the whole bean from the tannin-free cultivars is more readily digested in vitro by rumen micro-organisms and in vivo by poultry. This can be attributed to an improved retention of most nutrients, especially protein.

The elimination of condensed tannins from the common cultivars of faba beans through breeding would not only increase their nutritional value but would also eliminate those compounds responsible for seed coat darkening. The latter effect would greatly improve the organoleptic quality of faba beans, thereby further improving their value as human food.

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Preliminary studies concerning the haemolytic factor in Vicia faba

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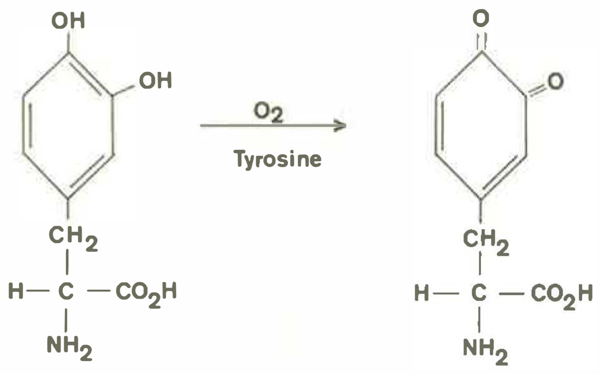
Favism is a fatal disease which is characterised by severe haemolysis following the ingestion of Vicia faba by individuals with a G-6PD deficiency who are therefore predisposed to the illness. The illness primarily affects people living throughout the Mediterranean Basin; in Italy the highest frequency of G-6PD deficient individuals is found in Sardinia. In some centres of population about 50% of the people tested have been found to have a G-6PD deficiency, and with the migrations characteristic of modern society the illness is now in the process of spreading even outside the Mediterranean Basin.

According to Beutler the major factor in Vicia faba determining the haemolysis in susceptible individuals is 3,4-dihydrophenlyalanine (L(-) Dopa). Beutler also suggests that L(-) Dopa is not directly responsible for the haemolysis but is the precursor of the haemolytic factor dopachinone. The transformation of L(-) Dopa into dopachinone is characterised by the enzyme tyrosinase in the following reaction:-



L(-) Dopa Dopachinone

On the basis of Beutler's hypothesis the seeds of 28 varieties of V. faba minor and V. faba major were analysed for L(-)Dopa content and the results are given in Table 1. The percentage L(-)Dopa content was found to vary from 2.40% in V. faba minor 'Favino Scuro Torre Lama' to 0.12% in V. faba major 'Motta' when the green seeds and pods were analysed together. In addition there was one variety V. faba major 'Troisfois Blanche' (also known as Triple White), in which L(-)Dopa was not detected.

An in vitro biochemical test was then carried out on the three varieties mentioned above. This test was based on the concentration of both oxidised and reduced glutathione (GSSG and GSH respectively) in the red blood cells of susceptible individuals who were in contact with the substances determining the haemolysis. The results, presented in Table 2, show that there was a decrease in the level of glutathione even when the extract from the variety 'Troisfois Blanche' (containing no L(-)Dopa) was used.

Table 1. The L(-)Dopa content of 28 varieties of Vicia faba.

Variety	L(-)Dopa content as Percentage of Dry Matter.
Scuro Torre Lama	2.40 %
Chiaro Torre Lama	1.12 %
368 (Prov. Algeria)	1.08 %
Torralba No. 1	0.64 %
Torralba No. 2	0.59 %
Bortigali	0.53 %
Sanluri	0.47 %
Ortacesus	0.44 %
Serrenti	0.37 %
Suelli	0.37 %
Gesturi	0.32 %
Aguadulce	0.31 %
Sassari	0.26 %
Linea 18	0.25 %
Cuglieri	0.24 %
Caltanissetta	0.20 %
Linea 86	0.17 %
Motta	0.12 %
Troisfois Blanche	absent

Table 2. In vitro concentration of glutathione in the blood of a G-6PD deficient individual .

Variety	Addition	Glutathione Concentration (nMoles per ml red blood cells)	
		at time of addition	after 160 minutes
Control	GSH + GSSG	548	567
	GSSG	21.7	22.0
	Supernatant Solution	0	0
Scuro Torre Lama 2,40% L(-)Dopa	GSH + GSSH	548	450
	GSSG	21.7	124
	Supernatant Solution	0	36
Motta (green seed, large pod) 0.12% L(-)Dopa	GSH + GSSG	548	373
	GSSG	21.7	38.0
	Supernatant Solution	0	0
Troisfois Blanche No L(-)Dopa	GSH + GSSG	503	130
	GSSG	22.0	28.0
	Supernatant Solution	0	0

Work by other researchers on susceptible individuals has suggested that there are several substances other than L(-)Dopa present in the seeds of Vicia faba which also contribute to the haemolytic process. These are:-

2,6-diamino-4,5-dihydropyrimidine

2,6-diamino-4,5-dihydropyrimidine-5-(P-D-glucopyranoside)

2,4,5-trihydro-6-aminopyrimidine

2,4,5-trihydro-6-aminopyrimidine-5-(P-D-glucopyranoside)

3,4-dihydrophenylalanine-(P-D-glucopyranoside)

On the basis of our results a program of research is being initiated with a collection of 550 varieties, lines and populations of Vicia faba which, through further chemical and biochemical tests on G-6PD deficient subjects, will enable us to select a variety devoid of haemolytic factors.

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The inhibition of digestive enzymes by field bean testa

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The presence of anti-nutritive factors in the seed coat of some varieties of field beans(Vicia faba L.) has been demonstrated by the results of several feeding experiments on both poultry(Marquandt and Campbell, 1973; Martin-Tanguy et al, 1977) and rats (Nitsan, 1971). It has been postulated that these compounds are of a phenolic nature and this has been supported by a recent experiment which compared the effects of testae from both coloured and white flowering varieties on the growth of rats. The results showed that only the tannin-containing seed coats (i.e. those of the coloured flowering variety) affected the growth of the animals (Mosely and Griffiths, unpublished). A more detailed examination of the results showed that tannin not only adversely affected the availability of dietary protein but also reduced the apparent digestibility of both soluble carbohydrates and lipids to a limited but significant degree.

Earlier work (Griffiths and Jones, 1977) had shown that water extracts of seed coats from coloured flowering varieties significantly reduced the enzymic activity of both rumen and fungal cellulases. Therefore since the role of seed coat tannins may not be solely restricted to dietary protein precipitation, their effect on three digestive enzymes, trypsin, α-amylase and lipase has been studied *in vitro*.

The results of the addition of a concentrated water extract from the testa of the coloured flowering variety, Dylan on the activity of the proteolytic enzyme trypsin are shown in Table 1. These reveal that the extract inhibits enzymic activity but this may be restored on the addition of a tannin-complexing agent polyvinyl pyrrolidone. In contrast, a similar extract prepared from the white flowering variety, Triple White, had little if any effect on enzyme activity, even in the absence of polyvinyl pyrrolidone.

Table 1. Comparison of the percentage inhibition of trypsin, α-amylase and lipase by various testa extracts.

Enzyme Studied	Extract Added (ml)	Inhibition (%) Coloured Flower Extract No PVP	+PVP	White Flower Extract
	1.0	51.2	0	6.1
	0.75	36.4	0	7.6
Trypsin	0.5	21.5	2.6	2.0
	0.25	9.1	1.1	1.7
	0.0	0	0	0
	0.8	42.9	2.3	26.2
	0.6	33.3	4.2	26.2
α-amylase	0.4	18.4	5.4	26.2
	0.2	15.5	10.5	17.3
	0.0	0.0	0.0	0.0
	0.8	68.6	32.7	10.6
	0.6	62.9	32.7	7.4
Lipase	0.4	42.9	21.2	11.3
	0.2	24.3	21.2	4.4
	0.0	0.0	0.0	0.0

In order to confirm that the inhibition of trypsin by the seedcoat extract was of a different type to that produced by the proteinic protease inhibitors known to be present in the cotyledons of both white and coloured flowering types, a more detailed kinetic study was undertaken. The results based on a Linweaver-Burk plot revealed that the proteinic protease inhibitor was a competitive inhibitor, whilst that in the seed coat had non-competitive characteristics.

The addition of testa extracts prepared from the variety Dylan inhibited the activity of both amylase and lipase and in both cases activity was largely restored on the addition of polyvinyl pyrrolidone. As can be seen from Table 1 the extract from Triple White had little effect on enzymic activity. It would appear, therefore, that field bean polyphenolics have the ability to inhibit not only proteases but also other digestive enzymes and may therefore interfere with the availability of other nutrients, although more detailed *in vivo* experimentation would be required to establish this fact.

In view of the possible significance of seed coat polyphenolics in animal nutrition more detailed examinations of their properties and reaction to various processing treatments are to be evaluated together with an assessment of the possibilities of developing high protein tannin-free varieties.

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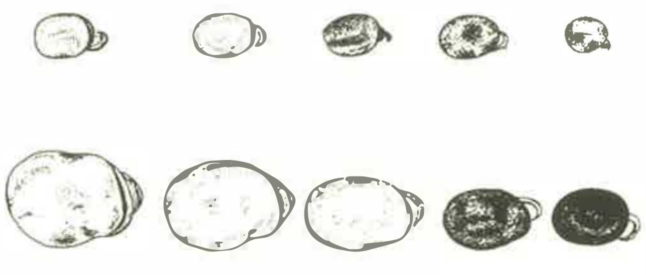

Faba beans (*Vicia faba*)

Protein and SH-amino acid content of field beans (*Vicia faba*)

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Screening with respect to the crude protein and SH-amino acid content of the seeds has been carried out on approximately 500 different strains of the Gatersleben field bean collection. None of the samples were found to be outstandingly rich in either protein or SH-amino acids but about 5% of the collection gave values which were clearly superior to those of the remainder. A considerable number of these 'plus variations' belong to the medium and large seeded botanical varieties *equina* and *faba* respectively. Only a few samples were characterised by a combination of high values of several protein and amino acid characters.

The variability of the protein concentrations appears to be preferentially induced by non-genetic environmental factors. Protein values exhibited a considerable intra-varietal variability but this varied from one variety to another. No correlation between protein or amino acid content and seed size was found.

This work is described in detail by Hanelt *et al* (1978).

Reference:

Hanelt, P., Rudolph, A., Hammer, K., Jank,H.W, Müntz, K. and Scholz, F. (1978). 'Protein screening of the Gatersleben collection of cereals and pulses 3: Protein and SH-amino contents of field beans (Vicia faba).' Kulturpflanze 26, 183-212.

Screening of broadbean varieties for higher protein content and improved amino acid composition

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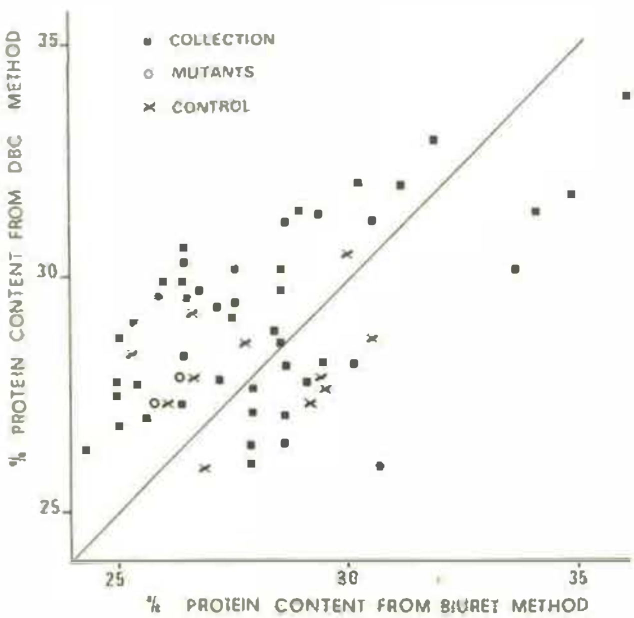
Two hundred varieties of Vicia faba were taken from the collection of the Plant Breeding Station, SHR, Szelejewo and along with 12 mutants derived from the V. faba equina variety Nadwislanski were analysed for protein content. The mutants had been produced using chemical reagents at the Plant Breeding Institute, IHAR, Radzikow. The varieties Hangdown White and Hangdown Green were used as references.

Two methods were used to determine the protein content of the seeds. One of these described by Udy employs a dye binding reaction (DBC method) while the other involves the biuret reaction. Results of the analysis are given in the figure. Analysis of amino acid content of the seeds using a Beckmen 119 AA analyser showed that varieties which gave higher results using the DBC method (i.e. those on the upper left side of the graph) had a higher level of the basic amino acids lysine and/or arginine.



It is hoped in the future to include varieties from other regions and therefore samples of seeds (c. 20g) sent to the above address would be appreciated.

The amylose:starch ratio and protein and phosphorus contents of broadbean (Vicia faba) and their influence on cooking quality

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Studies have shown that the colloid chemical state of broadbean starch controls the overall cooking quality of the seeds (Fahmi et al, 1979) In particular it has been found the starch granules contain relatively low amounts of amylose resulting in a high swelling ability of the granules. Also the high molecular weight of the starch gives a high absorption ability. However, low amounts of protein bound to the starch, coupled with a high esterified phosphorus content, lead to the high swelling capacity of the starch granules and result in good cooking quality.

Table 1. Some chemical constituents and colloidal properties of starch in two broadbean varieties.

Constituent/ Property	Giza-1	Rebaya-40
Amylose (%)	20	22
Protein (%)	0.20	0.29
Phosphorus (%)	0.051	0.038
Granule Size (μm)	80	50
Transition Temperature (°C)	75	77
Viscosity at 95°C (B.U.)	400	290
Viscosity at 50°C (B.U.)	960	740

Table 1 shows that the Giza-1 variety, with low amylose, low protein and high phosphorus starch content, gave good colloidal properties of high viscosity and low transition temperature. Relatively poor properties were exhibited by Rebaya-40, which contained higher levels of amylose and proteins and a lower phosphorus content. This is in line with the work of Ahmed (1958) who found that the absence of phosphorus during the first six weeks after the end of germination had a marked influence on the subsequent production of fruit and seeds.

These results can also be considered in the light of work by Youssef (1978) who found that both viscosity at 95°C and transition temperature of broadbean starch were very significantly correlated with cooking quality (r = +0.72 and -0.91 respectively).

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Ph. D. Thesis, Fac. of Agri., Alexandria University.

Relationship between physical properties and cooking quality of faba beans (Vicia faba)

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Six samples representing two varieties (Giza 1 and Giza 2) of faba bean were collected from farms located in the Nile Delta and in Upper Egypt. In order to get a measure of the cooking quality the stewed beans (or medammis) were given to a taste-testing panel; penetrometer readings were also taken for the stewed beans. It was found that the two methods gave similar results in that they both showed that it was the location of cultivation rather than variety that affected the cooking quality.

Cooking quality was positively correlated with the following physical properties and characteristics of the raw seeds:

- lightness in the colour of the hull
- 100-seed weight
- specific gravity
- hydration coefficient

It was also found that the percentage of total solids in the stewing liquor increased with increased cooking quality, this varying between 13 to 15% in good quality beans to about 7% in low quality ones. When the amount of insoluble solids in the different liquors was investigated it was found that there was 5 to 7% insoluble solids in the good quality beans but only 0.5 to 1.6% in the low quality ones.

Details of the above work will be submitted for publication in the near future together with results on the relationship between cooking quality and chemical composition.

Hard seed problems with Vicia faba in the Sudan

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Hard seededness is a type of seed dormancy resulting from the presence of an impermeable seed coat. This character is commonly found in most species of the leguminosae and is attributed to both genetic and environmental factors. In the Sudan Vicia faba is grown primarily for human consumption, so the incidence of hard seed not only reduces the germination percentage but also adversely affects the cooking quality and therefore the market price of the product.

Recent work has been carried out to study the variation in hard seededness among different V. faba cultivars and selection lines. Studies have also been made on the effects of sowing date, harvesting date, water closure, storage period and seed size on hard seed percentage.

Hard seededness was found to range from 22.8% to 0.1% when 10 entries were analysed but there was no correlation found between hard seededness and grain yield. Three out of four lines tested showed a progressive reduction in the percentage of hard seed as the generations advanced, but there were again considerable differences between the lines at any one level.

Table 1. shows that for the variety 'Hudeiba 72' there was a progressive decline in percentage hard seed with successive harvest dates, a result similar to that obtained by El Bagoury and Niyazi (1973) working with Egyptian clover. Table 1. also shows that the hard seed percentage decreased dramatically with prolonged storage. Nakamura (1962) has suggested that fluctuations in air temperature and humidity increase the permeability of the seed coat, thereby reducing the hard seed percentage.

Table 1. Effects of Harvest Date and Storage on Hard Seed Percentage in Vicia faba

Plant Age at Harvesting (days)	Hard Seed Percentage		
	60 days	180 days	300 days after first sample
80	34.5	16.1	1.7
100	28.4	10.1	1.2
120	16.6	8.5	0.6
	$\pm$1.2	$\pm$0.6	$\pm$0.2

Table 2. Effect of Variety and Seed Size on Hard Seed Percentage.

Seed Size	Variety		
	BF2/2	H.72	Siliam
Small	9.18	8.05	6.67
Medium	8.10	6.88	6.58
Large	8.32	4.92	4.63

It was also evident that early water closure date and hence the enforced earlier maturity, increased the hard seed percentage. Table 2. shows that in two out of the three varieties tested the large seed category contained the highest percentage of hard seed.

These studies showed that there is considerable genetic variation between cultivars suggesting that it may be possible to obtain high yielding varieties with low hard seed percentage. The size of the problem can also be reduced by variations in cultural practices. However, more advanced research is needed in the area of seed physiology in order to reveal causes of the hard character.

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Institutions interested in *Vicia faba* Research

Names of individuals interested in *Vicia faba* are given in the next section. Please inform the Editors of FABIS of any corrections or additions that should be made to this list.

Country	Address Number	Institution
NEAR EAST AND AFRICA		
AFGHANISTAN	1	Agricultural Research Dept., Ministry of Agriculture, Kabul.
ALGERIA	1	I.D.G.C., BP 16, Al-Harrash, Algiers
	2	Station Experimentale, BP 59, Sidi Bel Abbess, Algiers
	3	Station Experimentale du Khroub, Constantine
BANGLADESH	1	Pulses and Oil Seed Division Bangladesh Agricultural Research Institute (BARI), Sher - E- Banglanagar, Dacca - 15.
CYPRUS	1	Agricultural Research Inst., Ministry of Agriculture and Natural Resources, Nicosia.
EGYPT	1	Agronomy Department, Faculty of Agriculture, Al-Shatteh, Alexandria University, Alexandria.
	2	Dept. of Agricultural Industries, College of Agriculture, Alexandria.
	3	Food Technology Dept., Al-Shatteh, Alexandria University, Alexandria.
	4	Agronomy Department, Aine Shams University, Nasr, Cairo.
	5	Bahteem Agricultural Research Station, Bahteem, Cairo.
	6	IDRC, 5 Latif Mansour, Heliopolis, Cairo.
	7	Agronomy Department, Faculty of Agriculture, Cairo University, Giza.
EGYPT (cont.)	8	Food Legume Section Field Crops Institute, Agricultural Research Center, Giza.
	9	Sakha Agricultural Research Station, Kafre El-Sheikh.
	10	Faculty of Agriculture, Mouchtahar, Kilobye.
ETHIOPIA	1	Agricultural Research Inst. P.O.Box 200, Addis Ababa.
	2	Agricultural Experimental Station, Addis Ababa University, P.O.Box 32, Debre Zeit.
INDIA	1	IARI Regional Station Kalyanpur Kanpur 208024
IRAN	1	College of Agriculture, University of Tehran, Karaj.
	2	Plant Genetic Resources Div. Seed and Plant Improvement Institute, Karaj.
	3	Dept. of Crop Science, College of Agriculture, University of Azarbadegan, Tabriz.
IRAQ	1	Abu-Ghraib Experimental St. Administration of Plant Protection, Baghdad.
	2	Directorate of General Fields Crops, Abu-Ghraib, Baghdad.
JORDAN	1	Dept. of Agricultural Research and Extension, Ministry of Agriculture, P.O.Box 2178, Amman.
	2	Faculty of Agriculture University of Jordan P.O.Box 13320 Amman.
	3	Agricultural Research Station, Karak.
	4	Agricultural Research Station, Shaubak.
LEBANON	1	Institut des Recherches Agronomiques, Tel Amara, Rayak.
LIBYA	1	Agricultural Research Centre P.O.Box 2480, Tripoli.

Country	Address Number	Institution
LIBYA (cont.)	2	FAO Project Agricultural Research Centre P.O.Box 358 Tripoli.
MAURITIUS	1	Agricultural Division, Ministry of Agriculture, Mauritius.
MOROCCO	1	Direction Recherche Agronomique (DRA), B.P. 415, Rabat.
	2	Institut Agronomique et Veterinaire National, Hassan II, B.P. 704, Rabat - Agdal.
	3	Societe de Gestion des Terres Agricoles, SOGETA, BP 731, Agdal, Rabat.
NEPAL	1	Parwanipur Agriculture Station, Birganj, Marayani Zone, Kathmandu.
PAKISTAN	1	Punjab Agricultural Research Institute, Faisalabad.
	2	University of Agriculture, Faisalabad.
	3	Agricultural Research Centre L-13, Almarkaz F-7/2, Islamabad.
SUDAN	1	Hudeiba Research Station, P.O.Box 31, Ed-Damer.
	2	Faculty of Agriculture, Shambat, Khartoum North.
	3	Food Research Center, Shambat, Khartoum North.
	4	Gezira Agricultural Research Station, P.O.Box 126, Wad Medani.
SYRIA	1	Farming Systems Program, ICARDA, P.O.Box 5466, Aleppo.
	2	Food Legume Improvement Program, ICARDA, P.O.Box 5466, Aleppo.
	3	Training & Communication Program, ICARDA, P.O.Box 5466, Aleppo.
	4	Agricultural Research Dept. Douma, Damascus.
SYRIA (cont.)	5	Esra' Agricultural Research Station, Cheaek Masken, Esra, Daraa.
	6	Agricultural Research Station, Deir-El-Zor.
	7	Agricultural Research Station, Ezraa.
	8	Agricultural Research Station, Abd Al Slam Al-Nbhani Str. Al-byad, Al-mahta, Hamma.
TUNISIA	1	Tunisian-Belgian Project, Fretissa Pilot and Demonstration Farm, B.P. 6, Mateur.
	2	Division Technique de l'Office des Cereales 30 Rue Alain Savary, Tunis.
	3	I.N.A.T., 43 Avenue Charles Nicolle, Tunis.
	4	Laboratoire de Phytopathologie, Institut National de Recherche Agronomique de Tunisie (INRAT), Avenue de l'Independance, Ariana, Tunis.
TURKEY	1	Agricultural Research Inst. P.K. 25, Adapazari.
	2	Bolge Zirai Arastirma Enstitusu, P.K. 226, Yenimahalle, Ankara.
	3	Dept. of Breeding Production Agriculture and Animal Husbandry, Ministry of Food Ankara.
	4	Plant Growth and Breeding Dept., Faculty of Agriculture Ankara University, Ankara.
	5	Regional Agricultural Res. Institute, P.K.39 Antakya.
	6	Agricultural Research Inst. P.K. 17, Eskisehir.
	7	Aegean Regional Agricultural Research Institute, P.K. 9, Menemen, Izmir.

FAR EAST

Country	Address Number	Institution
JAPAN	1	Tokachi Agricultural Experimental Station, Memuro, Kassi Gun, Hokkaido.

Country	Address Number	Institution
JAPAN (cont.)	2	Crop Science Laboratory, Faculty of Agriculture, Kagawa University, 2393 Ikenobe, Miki-tyo, Kagawa-Ken.
	3	Botanic Gardens, Koishikawa, Faculty of Science, University of Tokyo, Hakusan 3-7-1, Tokyo 112.
AUSTRALASIA		
AUSTRALIA	1	CSIRO Division of Plant Industry, P.O.Box 1600, Canberra City, ACT 2601.
	2	Plant Pathology Unit, c/o Plant Pathology Research Dept., Waite Agricultural Research Institute, Glen Osmond, S.A. 5064.
	3	Dr. Basil Baldwin Roseworthy Agricultural College, Roseworthy, S.A. 5371
AMERICAS		
ARGENTINA	1	Dept. de Botanica y Ecologia, Universidad de Ciencias Agrarias, Casilla de Correo 209, 3400 Corrientes.
BOLIVIA	1	Estacion Experimental de Pataca Maya, IBTA/MACA, P.O.Box 5783, La Paz.
BRAZIL	1	National Center for Research on Rice and Beans, BR-153, Km. 4 - Goiania/Anapolis, Caixa Postal 179, 74.000 - Goiania, Goias.
CANADA	1	Alberta Horticultural Research Center, Brooks, Alberta, TOJ OJO.
	2	King Grain Ltd., Chatham, Ont. N7M 5L6
	3	Crop Science Department, University of Guelph, Guelph, Ontario, N1G 2W1.
	4	Agriculture Canada, Research Station, Lethbridge, Alberta T1J 4B1.
	5	Agriculture Canada, Research Station, Morden, Manitoba, ROG 1JO
	6	Saskatchewan Pulse Crop Growers Assoc., Saskatchewan Dept. of Agric., Regina, Sask.
	7	Crop Development Center, University of Saskatchewan, Saskatoon, Sask. S7N OWO.
CANADA (cont.)	8	Department of Biology, University of Saskatchewan, Saskatoon, Sask. S7N OWO.
	9	Prairie Regional Laboratory, National Research Council, Saskatoon, Sask. S7N OW9.
	10	Dept. of Animal Science, University of Manitoba, Winnipeg, Manitoba R3T 2N2.
	11	Dept. of Plant Science, Faculty of Agriculture, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.
	12	Manitoba Agriculture Services Bldg., University of Manitoba, Winnipeg, Manitoba, R3T 2N2.
CHILE	1	Estacion Experimental, Quilamapu (INIA), Casilla 426, Chillan.
COSTA RICA	1	Centro Agronomica Tropical de Investigacion Y Ensenanza (CATIE), Turrialba.
GUATEMALA	1	Institute of Agricultural Science and Technology (ICTA), 5a Ave. 12-31, Zona 9, Edificio El-Cortez 2^{o}y 3^{o} Niveles, Guatemala.
	2	Institute of Nutrition for Central America and Panama (INCAP), Box 1188, Guatemala.
PERU	1	Direccion General de Investigacion Agraria (DGI), Ministerio de Alimentacion, Lima.
	2	Universidad Nacional Agraria La Motina, Apartado 456, Lima.
PUERTO RICO	1	Mayaguez Institute of Tropical Agriculture, P.O.Box 70, Mayaguez, Puerto Rico 00708.
U.S.A.	1	Current Serial Records, National Agricultural Library, TIS/SEA/USDA, Beltsville, Maryland 20705.
	2	Information Science/Genetic Resources Program, School of Business & Administration, 1229 University Avenue, University of Colorado, Boulder, Colorado 80309.
	3	Dept. of Biochemistry, University of Minnesota, St. Paul, Minnesota 55108.
EUROPE		
AUSTRIA	1	Bundesanstalt fur Pflanzenbau, 1020 Vienna.

Country	Address Number	Institution
AUSTRIA (cont.)	2	International Atomic Energy Agency (IAEA), P.O.Box 590, Vienna A-1011.
	3	Plant Breeding and Genetics Section, Joint FAO/IAEA Division, P.O.Box 590, A-1010 Vienna.
BELGIUM	1	Division of Market Organisation, Commission of European Communities, 200, Rue de la Loi, 1049 Brussels.
CZECHOSLOVAKIA	1	Institute of Experimental Botany, Czechoslovak Academy of Science, Flemngovo 2 Prague 6.
	2	Katedra Botaniky, Prirodovedecka Fakulta UK, Benatska 2, 12801, Prague 2.
	3	Botanical Institute, Czechoslovak Academy of Science, 25243 Pruhonice U Prahy.
DENMARK	1	Dept. of Crop Husbandary & Plant Breeding, Royal Veterinary & Agricultural University, Forsogsgarden Hojbackegard, Agrovej 10, D.K. 2630 Tastrup.
FINLAND	1	Plant Breeding Institute, SF-04300, Hyryla.
FRANCE	1	Etablissements Blondeau, B.P. No. 1, 59235 Bersee.
	2	Etablissements Clause, 91220 Bretigny sur Orge.
	3	Station d'Amelioration des Plantes, INRA BP 1540, 21034 Dijon-Cedex
	4	Station d'Amelioration des Plantes, INRA, 35650 Le Rheu.
	5	Grandes Minoteries a Feves de France, Rue Henri Bessemer, Z.I. Aix Les Milles, 13290 Les Milles.
	6	CRAM, Station d'Amelioration des Plantes, 34060 Montpellier-Cedex.
	7	Laboratoire d'Amelioration des Plantes, Faculte des Sciences, Batiment 360, 91405 Orsay.
FRANCE (cont.)	8	Grandes Minoteries de France, 44 Rue du Louvre, 75001 Paris.
GREECE	1	Agricultural Research Service, Ministry of Agriculture, 22 Menandrou Str., Athens (12).
	2	Benaki Phytopathological Institute, Odos Delta 3, Kiphissia, Athens,
	3	Ecole Superieure d'Agriculture, Votanicos, Athens.
	4	Forage Research Institute, Larisa.
HOLLAND	1	A.R. Zwaan and Zoom, Princes Mariannelaan 296, Postbox 992, 2270 AZ Voorburg.
	2	Center for Agrobiological Research, Wageningen, Postbus 14, Bornesteeg 65/67, Wageningen.
	3	Foundation for Agricultural Plant Breeding SVP, P.O.Box 117, Wageningen.
ITALY	1	Istituto de Miglioramento della Plante Agrarie, Via Amendola 165, 70126 Bari.
	2	Istituto di Agronomia Generale e Coltivazioni Erbacee, Via Valdsavoia 5, Catania.
	3	Istituto di Agronomia Generale e Coltivazioni Erbacee, Universita de Napoli, Portici-Napoli.
	4	Istituto di Agronomia, Universita de Padova, Via Gradenigo 6, 35100 Padova.
	5	Istituto di Agronomia Generale e Coltivazioni Erbacee, Universita degli Studi, Viale delle Scienze, 90126 Palermo.
	6	F.A.O., Via delle Terme di Caracalla, 00100 - Rome.
	7	Istituto di Agronomia Via Enrica de Nicola, Sassari-Sardegna.
POLAND	1	Dept. of Biochemistry & Physiology of Cultivated Plants, IUNG, 24-100 Pulawy.
PORTUGAL	1	Faculdade de Farmacia, Universidade de Lisboa, Av. das Forcas Armadas, Lisbon - 4.

Country	Address Number	Institution
PORTUGAL(cont.)	2	Gabinete de Botãnica, Escuela Suoerior de Agronomia Tapada de Ajuda, Lisbon - 3.
SPAIN	1	Departmento de Genetica, Escuela Technica Superior de Ingenieros Agronomos, Apartado 246, Cordoba.
	2	Instituto Nacional de Investigaciones Agrarias, Centro Regional de Andalucia (CRIDA 10), Apartado 240, Cordoba.
	3	Estacion Experimental del Zaidin, Granada.
	4	Instituto Nacional de Investigaciones Agrarias, Avda. Puerto de Hierro s/n, Madrid - 3.
	5	Instituto Nacional de Investigaciones Agrarias, CRIDA 06, Apartado 127, Alcala de Henares, 9 Madrid.
	6	Estacao Agronomica Nacional, Quinta de Marques, Oeiras.
	7	INIA, Apartado 13, San Jose de la Rinconada, Sevilla.
	8	Instituto Nacional de Investigaciones Agrarias, Centro Regional de Andalucia, San Jose de la Rinconada, Sevilla.
SWEDEN	1	Swedish Seed Association, Svalov.
SWITZERLAND	1	Station Federale de Recherches Agronomiques, Changins CH-1260, Nyon.
	2	Eidg. Forschungsanstalt fur Landw. Pflanzenbau, Postfach CH-8046, Zurich.
	3	Institut fur Pflanzenbau, Swiss Federal Institute of Technology ETH, CH-8092, Zurich.
U.K.	1	North of Scotland College of Agriculture, School of Agriculture, 581 King Street, Aberdeen.
	2	Rowett Research Institute, Greenburn Road, Bucksburn, Aberdeen.
U.K. (cont.)	3	Welsh Plant Breeding St., Plas Gogerddan, N. Aberystwyth, Dyfed, Wales
	4	Department of Botany, Wye College, Ashford, Kent, TN25 5AH.
	5	West of Scotland College of Agriculture, Cronin Building, Auchincruive, Ayr.
	6	Plant Protection Division, Imperial Chemical Industries (I.C.I.) Ltd., Jealott's Hill, Bracknell, Berkshire
	7	Long Ashton Research Station, Long Ashton, Bristol.
	7a	Dept. of Applied Biology, Pembroke Street, Cambridge CB2 3DX.
	8	National Institute of Agricultural Botany, Huntingdon Road, Cambridge.
	9	Plant Breeding Institute, Maris Lane, Trumpington, Cambridge CB2 2LQ.
	10	May and Baker Ltd., Dagenham, Essex RM10 7X10
	11	Hedderwickhill Farm, West Barns, Dunbar.
	12	A. Gibson & Sons (Animal Feeds), 22 Mains Road, Dundee.
	13	Dept. of Biological Sciences, University of Dundee, Dundee DDI 4HN.
	14	Scottish Horticultural Research Institute, Invergowrie, Dundee.
	15	Department of Botany, University of Durham Science Laboratories, South Road, Durham DHI 3LE.
	16	Beil Grange, East Linton, East Lothian.
	17	Dept. of Agriculture and Fisheries for Scotland, Chesser House, Gorgie Road, Edinburgh.
	18	East of Scotland College of Agriculture, The Edinburgh School of Agriculture, West Mains Road, Edinburgh.
	19	Hill Farming Research Organisation, 29 Lauder Road, Edinburgh.

Country	Address Number	Institution
U.K. (cont.)	20	Poultry Research Center, King's Building, West Mains Road, Edinburgh.
	21	Queen Margaret College, Clerwood Terrace, Edinburgh.
	22	Scottish Agricultural Industries Ltd., 25 Ravelston Terrace, Edinburgh.
	23	Scottish Agricultural Industries Ltd., 53 East High Street, Forfar.
	24	Henderson Brown Chemicals Ltd., Moat House, 14 Gala Park, Galashiels.
	25	Dept. of Food Science and Nutrition, Strathclyde University, 131 Albion Street, Glasgow.
	26	Rothamsted Experimental St., Harpenden, Herts.
	27	Soil Microbiology Dept., Rothamsted Experimental St., Harpenden, Herts AL5 2JQ.
	28	RHM Research Ltd., The Lord Rank Research Center Lincoln Road, High Wycombe, Bucks.
	29	Dept. of Plant Science, Agricultural Sciences Bldg., The University, Leeds LS2 9JT.
	30	Agricultural Research Council, 160 Great Portland Street, London.
	31	Dept. of Agriculture & Horticulture, School of Agriculture, Nottingham University, Sutton Bonington, Loughborough.
	32	Nickersons, 25 Westgate, North Berwick, East Lothian.
	33	John Innes Institute, Colney Lane, Norwich NR4 7UH.
	34	Newgrain Ltd., Moreton Mill, Moreton, Ongar, Essex.
	35	East of Scotland College of Agriculture, Development Unit, Bush House, Penicuik, Midlothian.
	36	East of Scotland College of Agriculture, Cleeve Gardens, Perth.
U.K. (cont.)	37	Agriculture & Horticulture Department, University of Reading, Earley Gate, Reading, Berks.
	38	Dept. of Agricultural Botany, The University, Reading RG6 2AS.
	39	Plant Environment Laboratory, University of Reading, Shinfield Grange, Cutbush Lane, Shinfield, Reading RG2 9AD, Berks.
	40	BOCM Silcock Ltd., Wright Street, Renfrew.
	41	Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AE.
	42	Scottish Plant Breeding St., Pentlandfield, Roslin, Midlothian.
	43	Nickerson Seed Co., Research Station, Rothwell, Lincs.
	44	Dept. of Biology, Building 44, The University, Southampton SO9 5NH.
	45	Department of Biology, Stirling University, Stirling, Scotland.
	46	Ministry of Agriculture Fisheries and Food, ADAS, Drayton Experimental Husbandary Farm, Alcester Road, Stratford-on-Avon, Warwicks.
	47	National Vegetable Research Station, Wellesbourne, Warwickshire.
WEST GERMANY	1	Akademic des Wissenschapten der DDR, Zentralinstitut fur Genetik und Kulturpflanzen forschung, Corrensstrasse, Gatersleben.
	2	Institut fur Pflanzenbau und Pflanzenzuchtung, Universitat Gottingen, Von Liebold Str. 8, 34 Gottingen.
	3	Botanisches Institut der Universitat, Duslernbrookerweg 17, 23 Kiel.
	4	University of Hoenheim, Stuttgart.
YUGOSLAVIA	1	Faculty of Agriculture, Akademska 2, 21.000 Novi Sad.
	2	Zmjoldelski Fakultet, Skopje.
	3	"Partenon" II/4, Smederavska-Palanka.

Individuals interested in *Vicia faba* Research

The Address Number refers to the Institution Address given in the previous section. Please inform the Editors of FABIS of any corrections or additions that should be made to this list.

Country Name	Address Number	Research Field
NEAR EAST AND AFRICA		
AFGHANISTAN		
Mr.Atequllah Aiar	1	Varietal testing.
Mr.Ghulam Haidar	1	
ALGERIA		
Mr.Said Bocherika	2	
Dr.L. Hachemi	1	
Dr.Walid Khayrallah	2	
BANGLADESH		
Mr.Ahmed Nasiruddin	1	
CAMEROUN		
Dr.E.Westphal	BP 138 Yaounde	
CYPRUS		
Mr.George Alexandru	1	Breeding
Dr.Andreas Hadjichristodoulou	1	Legume & Cereal agronomy.
EGYPT		
Dr.Ali Abdel Aziz	8	Breeding.
Dr.Mazhar Fawzi Abdalla	7	Breeding; pest resistance.
Dr.Anouar Abdel Bari	1	Grain legume breeding.
Mr.Ali Mohamed el Bayoumi	5	
Dr.Said Abbas Eid	8	Viriology
Dr.Aziz H.Fahmi	8	Cooking quality
Mr.Farag H.Farag	8	*Orobanche*
Mr.Helmi M.Farag	8	*Orobanche*
Mr.Mohamed Hassan	9	
Dr.Ali A. Ibrahim	8	*Orobanche*
Dr.Fawzi Kishk	6	
Dr.Fouad Khodr	1	
Dr.Moustafa Mursi	4	
Mr.Abdullah Nassib	8	Breeding
Dr.Hussein Rusdi	10	
Dr.A.M.El-Taby Shehata	2	Techn.& Nutrition
Dr.M.Sherbeeni	8	
Dr.Mohamed El Tabyi	3	
Dr.Mohamed Adel Tolba	8	Viriology
Dr.M.M.Youssef	2	
Dr. M.K.Zahran	8	Weed control
ETHIOPIA		
Mr.Geletu Bejiga	2	
Dr.Taye Bezuneh	2	
Mr.Asfawe Telaye	1	
INDIA		
Dr.Laxman Singh	1	
IRAN		
Dr.Farouk Khoyi	3	
Mr.Firouz Naderi	3	
Dr.P. Parveneh	2	
Dr.A. Sarafi	1	Plant breeding
Dr.Amir Shahi	1	Breeding
IRAQ		
Mr.Foleh Enad Foleh	2	
Dr.H.S. El Haidari	1	Pests & Diseases
Dr.G.M. Al Kawas	2	Soil moisture
Dr.Mohammed Mayouf	2	
JORDAN		
Dr.M.Duwayre	2	
Mr.Z.Ghosheh	1	
Mr.Nabil Kathkuda	1	
Dr.Jamil Quhaiwi	1	
Mr.Ma'an Shequera	2	
Mr.Rabdi Aid Sitain	3	
Mr.Salem Tahat	4	
LEBANON		
Mr.Mahmoud Mustafa	1	
Mr.Mohamed Shehad	1	
LIBYA		
Dr.P.Huxley	2	Project Manager
Mr.Ali Shredi	1	
MAURITIUS		
Dr.Boodoo	1	Crop production; agronomy.
MOROCCO		
Mr.Tabet Abdellatif	3	Seed production
Dr.P.A.Boorsma	1	Pests & disease control.
Mr.D.Dotchev	1	Sowing; *Orobanche*
Dr.L.Gallacher	2	
Mr.Mohamed Kamel	1	
Dr.Francois Papy	2	Tillage & Soil protection.
Dr.K.Schluter	1	Plant protection; entomology.
NEPAL		
Dr.R.P.Sah	1	
PAKISTAN		
Dr.M.Aslam	2	
Ch.Altaf Hussein	1	
Dr.M.Iqbal Khan	1	

Country	Name	Address Number	Research Field
SUDAN			
	Dr.H.S.Abusalih	4	Plant protection; viruses.
	Dr.Osman Ahmed Ali Ageeb	4	Agronomy
	Dr.Awad Yassin Ali	3	Nutrition
	Mr.Ibrahim A.Babiker	1	Soil chemistry
	Dr.Sami Osman Freigoun	1	Pathology
	Mr.Hussein El Hussein	1	
	Dr.Mustafa M.Hussein	1	Pathology-viruses
	Dr.Hassan Mohammed Ishag	4	Agronomy
	Dr.Ali E.Kambal	2	Breeding; powdery mildew.
	Dr.Abdallah M.O.Karoun	2	Agronomy
	Dr.Musa Mohammed Musa	4	Soil microbiology
	Dr.Abdel Mohsen Nadi	2	Physiology-water relations.
	Dr.A.R.Saeed	3	Propagation of species; canning.
	Dr.Farouk A. Salih	1	Plant breeding.
	Mr.Mohammed Gaafar El Sarrag	1	Agronomy
SYRIA			
	Mr.Ahmed Ali	5	
	Dr.Shawki Barghouti	3	Training & Communic.
	Mr.Fritz Basler	1	Weed control; *Orobanche*.
	Dr.David Gibbon	1	Farming systems.
	Dr.Salim Hanounik	2	Legume pathology
	Dr.Geoff Hawtin	2	Broadbean breeding
	Dr.Habib Ibrahim	2,3	Legume training; physiology
	Dr.Rafiqul Islam	2	Microbiology; *Rhizobia*.
	Mr.Khader Kerar	6	
	Dr.Mohammed Sadek El-Mott	4	Morphology; classification.
	Dr.David Nygaard	1	Economics
	Mr.Mamdour Omar	2	Breeding
	Mr.Mohamed Saleh	6	
	Dr.Mohan Saxena	2	Legume agronomy; physiology.
	Dr.Richard Stewart	3	Training & Communication.
	Mr.Bashir Al Waraa	4	Breeding: Agronomy.
	Mr.Nasratullah Wassimi	2	Agronomy; nutrition
	Mr.Farouk Yassin	8	Breeding; Agronomy.
TUNISIA			
	Mr.Bouzid Ahmed	2	
	Mr.Mohamad Bouslama	2	
	Dr.M. Djerbi	3	
	Mr.Mlaiki	4	
	Mr.Mohamad Mouaffak	2	
TURKEY			
	Mr.Atilla Altinay	3	Breeding
	Prof.Didar Eser	4	Breeding
	Mr.Muzaffer Isik	6	
	Mr.Yilmaz Sarifakioglu	2	
	Dr.Kasif Temiz	7	Pathology
	Prof.Tosun	4	Breeding
	Mr.Sahin Tufan	1	
FAR EAST			
JAPAN			
	Dr. Kiyoshi Kogure	2	Breeding; taxonomy; cropping systems.
	Dr. H. Ohashi	3	
	Dr. T. Sanbuichi	1	
AUSTRALASIA			
AUSTRALIA			
	Dr. Musharaf Ali	2	
	Dr. Basil Baldwin	3	
	Dr. L.T. Evans	1	
	Dr. A.H. Gibson	1	Broadbean nodulation.
	Dr. R. Knight	2	Agronomy
	Dr. L. Nitschke	2	Grain legume breeding.
AMERICAS			
ARGENTINA			
	Dr. A. Krapovickas	1	
BOLIVIA			
	Dr. W. Telleria Polo	1	Cropping systems; cultural practices
BRAZIL			
	Dr. Homer Aidar	1	
CANADA			
	Dr. Claude Bernier	11 or BP 2344, 1 Osiris Str, Cairo	Pathology.
	Dr. M.F. Betts	11	Weed research.
	Mr. John Buchan	6	Pulse grower.
	Dr. W. Bushuk	11	Chemistry.
	Prof. Ken W. Clark	11	Broadbean nodulation.
	Dr. B.M. Craig	9	
	Dr. John R. Dean	11	Forages.
	Dr. T.J. Devlin	10	Animal nutrition.
	Dr. L.E. Evans	11	Plant breeding.
	Dr. J.F. Furgal	11	Plant breeding.
	Mr. R. Gaudiel	1	
	Dr. D.J. Hume	3	
	Dr. J.R. Ingalls	10	Animal nutrition.
	Dr. P. Kharbanda	11	Pathology.
	Dr. R.R. Marquardt	10	Favism; growth inhibitors; tannins

Country	Name	Address Number	Research Field
CANADA (cont.)			
	Dr. R.A.A. Morrall	8	
	Dr. I.N. Morrison	11	Weed research.
	Mr. H. Mundell	4	
	Dr. G. Platford	12	Agricultural Services.
	Dr. G.G. Rowland	7	Breeding, genetics, germination.
	Mr. F. Scott-Pearse	2	
	Dr. M.D. Stauffer	5	
	Dr. E.H. Stobbe	11	Agronomy.
	Dr. S.C. Stothers	10	Swine nutrition.
	Dr. C.G. Youngs	9	
CHILE			
	Mr.Oscar C. Paredes	1	
COSTA RICA			
	Dr. Gustavo A.Enriquez	1	Plant breeding; Botrytis.
	Dr.Miguel Holle	1	Seed production; breeding.
GUATEMALA			
	Dr.R.Bressani	2	
	Dr.Donald Kass	1	Agronomy
	Dr.Silvio H.Orozco	1	Agronomy; breeding
MEXICO			
	Ing.Santiago Sanchez Preciado	A.P.56 Tepatitlan, Jalisco.	Grain legume breeding.
	Ing.Luis Osoria Rodriquez	A.P.10, Chapingo.	Broadbean breeding.
PERU			
	Dr.H.Moreno Jeri	1	Seed preparation and production.
	Ing.Felic Camarena Mayta	2	
	Dr.J.H.de la Cruz Rojas.	Jr.Lima 560, Cajamarca.	Germplasm
PUERTO RICO			
	Dr. G.F. Freytag	1	
URUGUAY			
	Dr. C.A. Labandera	Cornel Pereda 1525, Montevideo	
U.S.A.			
	Miss Boba	1	
	Prof. I.E. Liener	3	Toxic constituents of broadbeans.
	Dr. K. Rawal	2	
EUROPE			
AUSTRIA			
	Dr. R.D. Brock	2	
AUSTRIA (cont.)			
	Dr. A. Micke	3	Research funding; diseases; mutagenesis.
	Dr. K. Nagl	1	Breeding.
BELGIUM			
	Dr. N. Tanghe	1	
CZECHOSLOVAKIA			
	Dr. A. Chrtková	3	
	Dr. E. Klozova	1	
	Dr. A. Skalicka	2	
	Dr. Zdenka Slaviková	2	
DENMARK			
	Dr. M.H. Poulsen	1	Breeding; mutation; glucosides.
FINLAND			
	Dr.E.Kivi	1	
FRANCE			
	Dr. M. Berthelem	4	Field bean breeding.
	Mlle Bourgeois	4	Botrytis fabae.
	Dr. C. Clavier	6	Breeding.
	Dr. G. Duc	3	Field bean breeding.
	Mr. le Guen	4	Male sterility.
	Mr. Lallemant	5	
	Mr. Masson	2	Field broad-bean breeding.
	Mr. Valery-Masson	8	Breeding.
	Dr. J. Picard	3	Breeding.
	Mr. Thiellement	7	Breeding; male sterility.
	Mr. Verhaegen	1	
GREECE			
	Miss Joyce Clarke	1	
	Prof. Constantine Dalianis	3	
	Dr. Hebe Kouyeas	2	Rust diseases; mycology.
	Dr. P.E. Kyriakopoulou	2	Viruses
	Dr. G. Petropoulos	1	
	Dr. John Procopiou	1	Cooking quality; diseases.
	Dr. Evangelos L. Stylopoulos	4	Forage germplasm; diseases.
	Dr. Christos Yamvrias	2	Entomology.
HOLLAND			
	Dr. G. Dantuma	2	
	Mr. J.G. van Hal	1	Seed company; breeding.
	Ing. R.J. Heringa	3	Breeding for yield, protein, N fixation

Country	Address Number	Institution
ITALY		
Dr. H.A. Al-Jibouri	6	Project co-ordination.
Prof. Francesco Basso	3	
Prof. Salvatore Foti	2	Breeding; agronomy
Dr. Ciro de Pace	1	Breeding.
Prof. Luigi Postiglione	3	Agronomy; biochemistry.
Prof. Giuseppe di Prima	5	
Dr. Rosa Rao	3	Agronomy; amino acid content.
Prof. Rivoira	7	
Prof. Riccardo Sarno	5	Breeding; Orobanche
Prof.G.T. Scarascia Mugnozza	1	
Prof.Luigi Stringi	5	
Prof.Lucio Toniolo	4	Agronomy.
Dr.U.Ziliotto	4	Agronomy
POLAND		
Prof. E. Nowaki	1	Seed quality and composition.
Dr. H. Pskit	1	Seed quality and composition.
PORTUGAL		
Prof. Miguel Pereira Coutinho	2	
Prof. Jose Nascimento	1	
SPAIN		
Mr. Manuel Chamber	8	Rhizobium ecology.
Dr. J.I. Cubero	1	Legume breeding.
Dr. Antonio Martin	1	Gene localisation; hybridization.
Dr. Jose Luis Montoya	5	
Mrs. Maria-Teresa Moreno	2	Legume breeding.
Mr. Jose Olivares	3	Rhizobium.
Dr. R. Orive	7	Inoculant production.
Dr. Antonio Jose Da Silva Teixeira	6	
Mr. Francisco Temprano	7	Inoculant production.
Dr. Desiderio Vidal	4	Rhizobium.
SWEDEN		
Dr. J. Sjödin	1	
SWITZERLAND		
Dr. W. Gehriger	1	
Mr. W. Huber	2	
Prof. E.R. Keller	3	Breeding; growth regulators.
Dr. A. Soldati	3	
U.K.		
Dr. R. Bardner	26	
Mr. G.M. Barton	36	
Dr. J.E. Beringer	33	Rhizobium leguminosarum nodulation.
Dr. N.J. Berwin	33	
Mr. N. Birch	44	Amino acid distribution; aphid resistance.
Dr. F. Bisby	44	Aphid resistance.
Mr. G.R. Blakewell	32	
Dr. D.A. Bond	9	Breeding.
Prof. D. Boulter	15	physiology; protein content.
Dr. R.M. Brook	14	
Dr. G.D. Brown	28	
Dr. G. Chapman	4	Protein yield; growth habit and agronomic efficiency.
Dr. I.M. Chapman	42	
Mr. I.H. Clark	36	
Dr. K. Mary Clegg	25	
Dr. A.J. Cockbain	26	
Dr. G.R.A. Crofton	8	
Mr. R.N. Crossett	17	
Dr. R.R.D. Croy	15	Physiology; protein content.
Dr. J. Davidson	2	
Dr. J.M. Day	27	
Mr. A.G. Dewar	11	
Dr. D.A. Doling	28	
Dr. D.S.M. Drennan	38	Water stress; growth stages.
Dr. M. Dye	27	
Dr. D.G. Edwards	28	
Prof. J. Elston	29	Climatic effects; physiology and yield.
Dr. H. van Emden	37	
Dr.Alice Evans	7a	Physiology; protein content.
Dr. K.E. Fletcher	26	
Dr. V.R. Fowler	2	
Dr. P.J. Gates	15	Physiology; protein content.
Mr. A. Gibson	12	Animal feed.
Dr. P.A. Gill	14	
Dr. W.D. Gill	35	
Dr. D.W. Griffiths	3	Germplasm; nutrition; seed quality.
Dr. N. Haq	44	Genetics; breeding; hybridization.
Dr. R.C. Hardwick	47	
Mr. A.B. Harker	40	
Dr. N.T. Harris	15	Physiology; protein content.

Country	Name	Address Number	Research Field
U.K. (Cont.)			
	Dr. J.G. Harrison	14	**Botrytis fabae**.
	Mr. A. Haystead	19	
	Dr. P.D. Hebblethwaite	31	
	Dr. T.W. Hegarty	14	
	Mr. R.R. Henderson	24	
	Dr. D.G. Hill-Cottingham	7	
	Dr. J.C. Holmes	18	
	Mr. Johnson Holt	44	Aphid resistance
	Mr. A. Hood	23	
	Dr. D.S. Hooper	26	
	Miss Alison M. Innes	1	
	Mr. E. Jeffrey	16	
	Mr. T. Johnston	18	
	Dr. A.T. Jones	14	Viruses
	Dr. J. Karkalas	25	
	Dr. D.A. Lawes	3	Genetic variation; symbiotic efficiency
	Dr. H.M. Lawson	14	Herbicides
	Dr. C. Leaky	15 Cambridge Rd., Girton, Cambridge.	Breeding.
	Mr. D.I. Low	34	
	Dr. D.K.L. Mackerron	14	Canopy architecture
	Dr. J.W. Mansfield	45	
	Dr. J. McEwen	26	
	Mr. I. McMartin	1	
	Dr. J.M. McNab	20	
	Dr. E. Mellinger	2	
	Mr. L.P. Murray	22	
	Mr. L.R. Mytton	3	
	Mr. M.J. Nash	18	
	Mr. Newaz	3	
	Dr. J.M. Oliphant	46	
	Dr. M.S. Phillips	42	
	Dr. R.M. Polhill	41	
	Dr. J. Potts	5	
	Dr. A.J. Pritchard	30	
	Mr. J.B.A. Rodger	36	
	Dr. R.J. Roughley	27	
	Dr. A.D.F. Simpson	28	
	Dr. J. Smart	44	Interspecific relationships between V. faba and other Vicia species
	Dr. J.I. Sprent	13	
	Dr. Valerie Stanton	43	
	Dr. R. Summerfield	39	
	Dr. M.M. Taha	38	
	Mr. R.G. Tate	36	
	Mr. A.J. Taylor	36	
U.K. (cont.)			
	Dr. C.E. Taylor	14	Agronomy.
	Dr. H. Taylor	14	
	Dr. R. Thompson	14	Agronomy; flowering; assimilation.
	Dr. P.D. Waister	14	Seed quality.
	Dr. R.N.H. Whitehouse	42	
	Dr. A.A. Woodham	2	
	Mrs Margaret P. Woods	21	
	Dr. S.D. Wratten	44	Aphid resistance.
WEST GERMANY			
	Dr. I. Dorr	3	
	Mr. Martin Frauen	2	Field and broad bean breeding.
	Dr. P. Hanelt	1	Taxonomy; genetic resources.
	Prof. E. von Kittlitz	4	Breeding; pollination; plant models.
	Dr. Ch. Lehman	1	
YUGOSLAVIA			
	Prof. Katarina Bandzo	2	
	Prof. Milenko Lazic	1	
	Ing. Zivorad R. Nikosavic	3	

Vicia faba