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Research and Development Prospects for Faba Bean

Report of a workshop held in Melbourne, Australia, 28–29 March 1994

Editors: Colin Piggin and Steven Lack

Canberra 1994

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Workshop Overview

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This workshop on faba bean (*Vicia faba*), funded by the Grains Research and Development Corporation (GRDC) and the Australian Centre for International Agricultural Research (ACIAR), was held in Melbourne on 28–29 March 1994. Twenty-six participants attended to assist in defining research and development priorities for faba beans at three levels—regional, national, and international (to develop Australia's links with international programs).

The following statements summarise the industry's 'profile' at the time of the workshop:

- Faba beans are one of the 11 grain legumes in the GRDC's portfolio, with predicted grower levies in 1994–95 of $160 000.
- The gross value product (GVP) of the Australian faba bean industry is approximately $21m. Australian production of this bean has increased from 70000 t in 1987 to around 120000 t currently. The industry now accounts for 6% of Australia's grain legume production, an increase from 3% in 1987.
- The main growing region used to be South Australia but the increasing incidence of disease in that State is influencing growers' planting decisions. Production has increased significantly in Victoria and southern NSW where the crop is relatively new and disease not established.

The Australian faba bean breeding program is based on the National Faba Bean Breeding Centre at the Waite Campus of the University of Adelaide. The prime objective of this program is to breed varieties resistant to disease and adapted to Australian conditions. The material under test includes over 1000 faba bean accessions held at the Australian Temperate Field Crops Collection at the Victorian Institute for Dryland Agriculture in Horsham, Victoria most of which originated from the International Center for Agricultural Research in the Dry Areas (ICARDA) in Syria.

Increasingly there is a need for faba bean varieties that suit growing conditions at specific localities within Australia and meet world market requirements for human consumption (particularly in the Middle East).

ICARDA has held the world mandate for faba bean development. The 10-year faba bean breeding program at this centre, where much of the world's faba bean germplasm is held, was terminated 2 years ago just as the advanced lines, which included many disease-resistant types, were to enter final testing. This late generation material is not available in Australia. ACIAR is examining the possibility of a project, in collaboration with ICARDA, involving germplasm exchange between China and Australia.

This workshop was held to review current faba bean R & D in Australia, to develop an integrated national program within Australia, and to ensure that this program is resourced and structured for access to, and development of, suitable genetic material from Australia and overseas. Figure 1 gives the structure of the current national faba bean improvement program. It is envisaged that material would undergo extensive hybridisation in a coordinated way, with hybrid populations available to regional programs for local selection.

Consideration of R & D Priorities

Workshop participants were canvassed for opinions on R&D priorities for an Australian faba bean development program. Results of the survey are presented in Table 1. Major areas identified for emphasis were marketing issues (market intelligence) and agronomic/management issues (disease control, genetic adaptation).

Working groups considered these priority issues further, and some objectives and outcomes of programs addressing these issues were developed and are presented in the following sections.

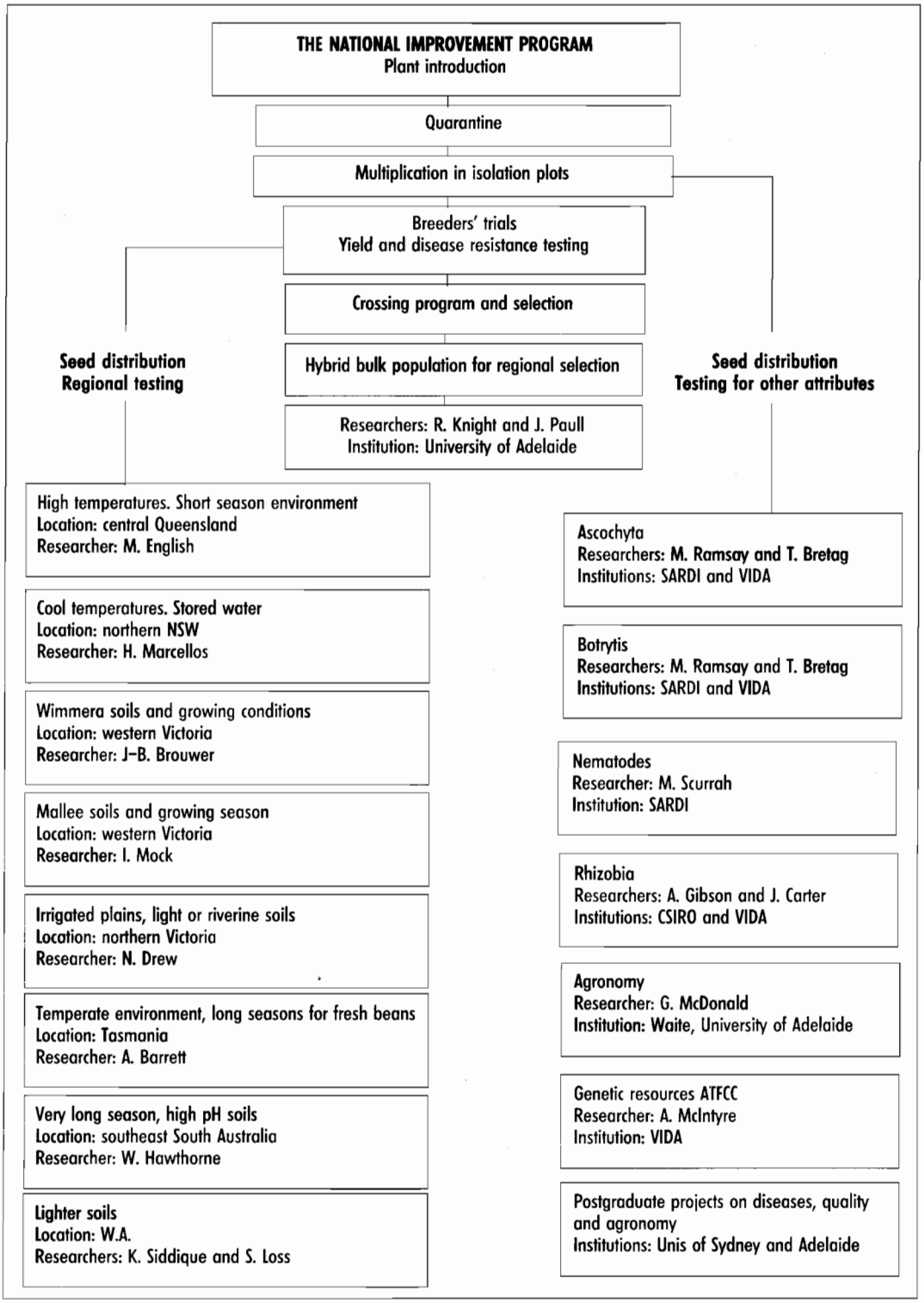

Fig. 1. Structure of current Australian faba bean improvement programs

Table 1. Rating of faba bean priorities at meeting (values in columns show priority ratings as percentages for each region)

Issues	Australian region			
	Northern (4.5)[a]	Southern (6.5)	Australian (10)	Overall avg (21)
Agronomic and management limitations	42	52	57	50
a) disease control	17	18	18	17
b) genetic adaptation	17	12	19	16
c) yield potential	2	7	11	7
d) rotations	2	3	3	3
e) pest control	2	3	1	2
f) rhizobia	1	4	2	2
g) other	1	5	3	3
Environmental limitations	10	9	4	8
a) high temperature stress	6	4	2	4
b) moisture stress	3	2	1	2
c) other	1	3	1	2
Sustainability (soil)	5	2	0	2
Adaptation limitations	4	5	6	5
Marketing limitations	24	26	25	25
a) market intelligence	4	10	10	8
b) uses–human	8	3	5	5
c) quality	4	8	3	5
d) other	8	5	7	7
Manufacturing limitations	16	6	8	10
a) processing–human	5	2	3	3
b) end-use–human	7	3	3	5
c) other	4	1	2	2
Total	100	100	100	100

[a] Number of respondents

Market opportunities

There are two main markets for faba bean: human consumption and stockfeed. Approximately 50% of the faba beans produced in Australia are used domestically in the pig and poultry industries, owing to their ease of milling and high protein (lysine) content. They compete with lupins, field peas, fishmeal, soybean meal and other protein alternatives. Faba beans can also be used as a replacement for lupins in feedlots and as supplementary feed in sheep enterprises. The demand for faba beans in stockfeed is a function of price, protein quantity, and absence of antinutritional factors. Grain size and appearance are of minor importance.

Stockfeed faba beans used locally are priced according to competing feed grains. Australian exports of faba bean for stockfeed are priced according to the world price for lupins, and are dependent upon future European Community (EC) policies on stockfeed imports.

Australian faba beans exports tend to be used as stockfeed in developed countries and for human food in developing countries. The EC is the dominant destination for stockfeed exports. The Gulf countries in the Middle East are the main markets for faba beans suitable for human consumption, and customers emphasise grain size, colour, appearance and cooking and canning qualities.

The Australian Wheat Board estimates that the Gulf markets would take 100 000 t of Australian faba beans for human consumption if this quantity of beans of consistent quality (size, colour, taste,

shelf life) were available. Australia's main competitor for Middle East trade is China, which holds a 70% share of the world's faba bean exports with its larger and flatter style of bean.

Workshop participants focused on the inadequate communication of end-product characteristics within the faba bean industry and the lack of understanding of quality factors for human consumption markets. The suggested approach was to set in place a long-term breeding strategy with improved links to information on trends in human consumption markets. This would seek:

- to improve market information channels through the establishment of a market intelligence system; and
- to establish a technical database which specifies the optimum or targets for quality or processing characteristics for each end-use product (e.g. colour, taste, cooking time, usage, texture) and provides market data which detail in both volume and dollar terms the current position of the Australian product, market growth rates and competitor market share.

Outcomes could include:

- breeders and marketers forming stronger links to assess and disseminate market information, and to develop together a market-focused strategy for production and breeding, enabling them to demonstrate late generation material to buyers before committing to variety release;
- projections of market potential, competition and constraints;
- an improved dissemination process including input into the existing GRAIL data base (chemical composition and nutritive value);
- an evaluation of value-adding opportunities in the Middle East and Asia;
- determination of premiums available for further segregation (uniform standards, tighter receival standards);
- processing technology and development strategies;
- improved pricing information (supply/demand trends); and
- greater understanding of demographic trends.

Participants requested that material from this workshop be made available to the Grain Legumes Strategic Planning Unit.

Potential funding bodies identified were: Austrade; GRDC; and industry.

Productivity constraints

The most highly ranked constraints to improved productivity in the faba bean industry were identified as disease management and adaptation to the environment.

Disease management

(a) Disease resistance

The dominant influence in faba bean production is disease susceptibility, with further expansion of the industry being constrained by the lack of disease-resistant varieties. As well as influencing productivity, fungal diseases also reduce grain quality.

Broad-based resistance to the fungal diseases, particularly chocolate spot, ascochyta blight and rust, was considered to be a long-term objective with high priority. Regional variations in these diseases are significant and should be reflected in the organisation of the research effort.

In northern NSW, rust is the most important disease, followed by chocolate spot.

In the southeastern region of Australia, ascochyta is a significant disease, followed by chocolate spot (faba bean resistance to fungal diseases improved marginally in southeastern Australia with the release of varieties Icarus and Ascot).

In the west, chocolate spot is the most significant issue, followed by ascochyta.

(b) Disease control

Until disease-resistant varieties are available, it was considered important to develop and promote technology for the effective management and control of these diseases. Priorities were identified as:

- development of integrated agronomic/fungicide control packages;
- provision of mechanisms for technology adoption;
- promotion of a low-cost national faba bean rust control program;
- development of seed production strategies for clean seed;
- investigation of disease epidemiology; and
- development of agronomic packages (sowing, weed control, fertiliser and pest-control technology) to minimise disease and maximum production.

It will be important in this research to consider fungicide application strategies, including predictive models for determining effect on grain quality

of fungicide application and the determination of maximum residue limits.

Faba bean is a specialist crop that is often difficult to grow. Cropchecks such as TOPCROP were seen to have potential benefit to the industry, with emphasis on support for establishing new participants. This could have a common approach, yet account for regional/local requirements.

Adaptation to the environment

Although much less important than disease management, it was considered that there are some environmental constraints to faba bean production. These include the need for shorter maturity times, tolerance to temperature and drought stresses, and good standability. In addition, tolerances to low pH and waterlogging are important, especially in the south and west of Australia. These adaptation features should be kept in mind in the breeding, selection and regional testing programs.

Possible organisation of the research

Overall, workshop participants supported a faba bean breeding program that was structured to enable ready access to suitable genetic material from overseas that could undergo extensive hybridisation in a national centre in Australia. This could be achieved through the existing core breeding for chocolate spot and ascochyta resistance at the University of Adelaide, with accessions and hybrid populations made available from this national centre to regional programs for local selection. While a core breeding program was seen as an efficient mechanism for servicing Australian regions with environments similar to those in the Mediterranean (southern and western areas of Australia), it was considered that additional resources were required in NSW to undertake appropriate screening for rust in the northern region.

Participants recognised that the northern region may need to diversify its range of crops and that the subtropical conditions of northern Australia may require completely different faba bean germplasm. If so, the benefits of investing today may not materialise for 10–15 years. There was some consensus that it would be valuable to evaluate existing germplasm before embarking on an ambitious and long-term breeding program in the north.

Available germplasm may be expanded greatly through acquisition of advanced ICARDA material in Morocco (with potential rust-resistant lines) without formal breeding and/or to gain access to varieties in China through an ACIAR initiative with ICARDA and the Zhejiang Academy of Agricultural Sciences (in both cases quarantine costs are likely to restrict bulk imports). These routes offer the chance of an immediate return to the industry in the north, while providing an opportunity to evaluate the potential benefits of a separate breeding program.

Participants considered that communication had been poor in some cases and that resources should be made available for researchers/breeders to visit national and regional evaluation sites regularly to exchange information. They advocated that any further GRDC-funded faba bean research be structured to persuade breeders and marketers to form stronger links for assessing and disseminating market information, and for jointly developing a market-focused strategy for production and breeding.

Ideally this would provide a capability to demonstrate late generation material to buyers before committing to variety release. It would also secure an improved flow of genetic material from overseas. Additionally the industry would benefit from better communication among faba bean researchers and also between researchers and marketers.

Possible Research and Development Program for Faba Bean in Australia

Consideration was given to appropriate components of an integrated faba bean R&D program for Australia. Components discussed included:

1. continued breeding and selection program centred at the University of Adelaide, Waite Campus, concentrating on yield potential and disease resistance;
2. continued germplasm introduction program, centred at the genetic resource centre at the Victorian Institute for Dryland Agriculture (VIDA) at Horsham, which should ensure ICARDA faba bean germplasm is conserved and accessible to Australia;
3. further collection of germplasm should be considered, in collaboration with ICARDA and the Cooperative Research Centre for Legumes in Mediterranean Agriculture (CLIMA) and supported by ACIAR and GRDC;
4. development of an adoption strategy, centred at VIDA, to promote the crop in southeastern Australia;
5. development of IPM strategies (including the use of fungicides) to control diseases, centred

at NSW Agriculture with collaboration from the South Australian Research and Development Institute (SARDI) and VIDA;

6. continued regional testing of breeding material and introductions to determine adaptation to local conditions;
7. improved communications and interaction between breeders and marketers to ensure that market requirements are considered in breeding and selection programs;
8. improved communication and interaction between national faba bean research and extension scientists through an annual faba bean meeting.

These components will be considered by GRDC and ACIAR in building an integrated national faba bean development program, with appropriate links to international research groups and other countries.

The Australian Industry

The Faba Bean Industry in Australia's Northern Temperate Region

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The northern grain region extends from about Dubbo in the south (32°S) to the central highlands of Queensland (22°S). Most of the winter cropping in NSW and southern Queensland occurs in areas limited by the 450 and 700 mm annual rainfall isohyets. Soils of the region are predominantly high in clay and range in pH from about 7 to 8.5. Because these soils have a high water-holding capacity, soil moisture stored during the fallow supplies between 30 and 50% of requirements for the winter crop.

Declining soil nitrogen due to cereal monoculture has become a major limitation to the economic sustainability of cereal growing in the region. The development of grain legumes and exploitation of their capacity to fix nitrogen have become part of the strategy to remedy the problem of fertility decline. Despite this, areas planted to winter grain legumes in northern NSW and Queensland are currently much lower those in southern areas. The ratio of area planted to wheat and barley to that of winter grain legumes in 1993 was 5:1 for Victoria, 10:1 for South Australia and 20:1 for NSW. The ratio in northern NSW is 36:1. Production of chickpea, lupin, field pea and faba bean in NSW in 1993–94 was estimated at 40000, 120000, 52000 and 38000 t, respectively, worth approximately $53 million on-farm. Additional benefits to cereal crops from grain legumes, in the form of higher yields due to nitrogen inputs and disease control, are worth $50–100/ha.

NSW Agriculture commenced research at Tamworth in the early 1980s to evaluate the potential of winter-grown grain legumes in northern NSW. It was concluded that chickpeas and faba beans were the most likely commercial prospects in the north, and that other species needed considerably more development or were unadapted to the soils and climates of the region.

The desirability of a northern improvement program for faba bean has been recognised since the mid-1980s, but the view within NSW Agriculture and GRDC until recently was that a 'national' program centred in Adelaide might adequately service the northern cropping region. It is proposed in this paper that a network of nationally coordinated research programs for faba bean be developed, including a northern improvement program, and that this network strengthen its links with the International Center for Agricultural Research in the Dry Areas (ICARDA). Planning for a cooperative faba bean project between China and NSW Agriculture is in progress, with support from ACIAR.

Industry Status and Potential in the Northern Region

NSW Agriculture recognises three broadly defined cropping systems in which faba beans may become an important component (Table 1).

Faba beans were initially promoted on the Liverpool Plains, where the cultivar Fiord seemed sufficiently well adapted except for its level of disease resistance. The maturity of Fiord is suitable, as is its yield potential. However, its yield has been highly variable due to disease, lodging, and sometimes poor seed set at high biomass levels. Seed size tends to be lower than that obtained in southern Australia.

Cotton growers began to experiment with Fiord as a rotation crop in 1990 and showed that the benefits to cotton were considerable. They are keen to increase their commitment to faba beans, and a company, Namoi Rural Traders, is assisting them in marketing. An increase in the use of faba bean in this system requires new cultivars which, compared with Fiord, mature 2–3 weeks earlier, resist rust and chocolate spot, produce less biomass when planted under irrigation in mid-April, resist lodging and produce seed suitable for human consumption.

In 1991, wheat growers in the north west plains planted Fiord in mid-April and achieved good

results. In this system faba bean is the earliest crop planted. It flowers in July and matures early enough to avoid rapidly rising stresses due to high temperature and water deficit often encountered in October. Harvest may commence in mid-October. Growers consider this system valuable in extending the range of options, but need varieties that have better disease resistance, stress tolerance and early maturity.

The history of industry growth in northern NSW is summarised in Table 2. Data for southern Queensland were not obtained in time for this paper, but areas planted on the eastern Darling Downs, and in the southwest under irrigation may amount to a few hundred hectares. The potential for faba beans in these areas is believed to be high, contingent on new cultivars and crop management research.

The Industry in NSW

NSW Agriculture estimated at the end of November 1993 that 38000 t of faba beans had been harvested in NSW from 16000 ha planted, to yield 2.4 t/ha. Production was approximately equal between southern and northern regions.

Table 1. Definition and size of northern NSW–southern Queensland cropping systems.

System	Potential area for cropping (ha)	System characteristics
Liverpool Plains Dryland	250000	Alkaline black earth, 600–700 mm rainfall, May planting, late October harvest, Fiord maturity satisfactory.
Namoi, Gwydir, McIntyre Irrigated cotton system	150000	Alkaline grey clays, 500–600 mm rainfall. Mid-April planting, early October harvest, 2 weeks earlier maturity than Fiord.
North West Plains (NSW) Darling Downs (Qld) Dryland	1 million	Alkaline grey clays, 500–600 mm rainfall. Mid-April planting, early October harvest, 2 weeks earlier maturity than Fiord.

Table 2. Summary of faba bean industry growth in northern NSW.

Year	Area sown (ha)	Comment
1984–85	287	Industry in juvenile phase. Evaluation of faba beans by NSW Agriculture, definition of agronomic requirements. Some promotion of the crop, and small areas trialled by growers.
1985–86	394	
1986–87	578	
1987–88	1793	Upsurge in interest on Liverpool Plains.
1989–89	2228	Very wet spring in 1988 caused severe chocolate spot.
1989–90	387	Collapse of confidence due to disease, dry autumn.
1990–91	742	Introduction of faba beans into cotton rotation, Narrabri
1991–92	1446	Increase in interest on NW Plains, Moree
1992–93[a]	6300	Growth in interest in cotton and NW Plains systems.
1993–94[a]	9700	Greater confidence in disease management due to recommendations from research by NSW Agriculture.

[a] Source: Australian Bureau of Statistics and NSW Agriculture estimates.

Industry Data for Faba Beans in Australia's Southern Region

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The States of Australia's southern region show some interesting trends in production and yield of faba beans (Table 1). In South Australia the faba bean industry developed earlier than in other states with the release of the variety Fiord in 1980. Crop area increased over several years but now appears to have reached a plateau above and below which there are large fluctuations. The fluctuations are related to the previous year's yields and the incidence of disease. Following 1991, which was a good year, there was an expansion in 1992. This turned out to be a disastrous year with widespread disease and low yields. This resulted in a smaller area being sown in 1993.

Victoria and southern NSW are still in the expansion phase and disease incidence has not yet strongly influenced the attitude of growers to faba beans.

Management of Risk (Diseases and Weeds)

With the continuing cost squeeze on all farmers there is an aversion to risk. With faba beans this was exacerbated by the 1992 season. Despite heavy investment in sprays, some growers were unable to control diseases, and financial losses were incurred. As a result some have adopted late sowing (June) to reduce the disease risk.

Table 2 compares costs, returns and implications of early and late sowing. Late sowing gives time for weed control with non-selective herbicides (e.g. glyphosate), thereby reducing the risk of herbicide-resistant weeds. The growers realise the potential yield is lowered by late sowing. It is necessary for plant breeders and agronomists to understand this alternative practice and develop suitable cultivars and technology, especially adapted to late sowing, early flowering and with insensitivity to high temperatures at flowering.

Late sowing may continue to be attractive for some growers because of the weed problem, even when disease-resistant cultivars are widely available. The risk of developing herbicide-resistant ryegrass and wild oats as a result of using selective herbicides is likely to affect attitudes to management of all crops.

Irrigated Faba Beans

Irrigation enables the grower to vary the growing season. Faba beans can be grown in summer, with irrigation, as well as in winter, as the flowers are unaffected by high temperatures. For the present, however, beans are likely to be grown in winter, with supplementary irrigation in the autumn to facilitate sowing and in the spring to increase yield. The control of weeds is simplified when irrigation is possible in autumn. Herbicide resistance in weeds should be less of a problem.

The areas in northern Victoria and southern New South Wales most likely to grow irrigated faba beans will never be large but with their high yields (many growers are achieving more than 4 t/ha) they can bring stability of production to the industry. An April sowing of beans will permit rapid germination, a lower seed rate and a long growing season, but such practice will depend on good disease control and/or disease-resistant cultivars.

Marginal and Short-season Areas

Attempts are being made to find varieties adapted to short-season areas. In general, faba beans are less adapted to such areas than some of the other grain legumes. The search is more likely to find a suitable large-seeded than a small-seeded variety. If this is so, and because of the large areas classified as marginal or short-season, this could influence the relative production of large- and small-seeded faba beans in Australia, with ramifications for our markets.

Table 1. Area sown, yields per hectare and overall production in Victoria and South Australia, 1989–93.

Statistic	Vic.	S.A.	Combined
Area (ha)			
1989	21 800	21 040	42 840
1990	35 140	19 930	55 070
1991	50 455	27 860	78 315
1992	61 180	35 070	96 250
1993		22 340	
Yield (t/ha)			
1989	1.56	1.63	1.59
1990	1.32	1.52	1.42
1991	1.23	1.81	1.52
1992	1.23	1.36	1.29
1993		1.42	
Production (t)			
1989	34 400	34 270	68 270
1990	26 562	30 230	56 792
1991	62 060	50 540	112 600
1992	75 160	47 710	122 870
1993		31 790	

Source: Australian Bureau of Statistics

Table 2. Comparisons ($A) of early and late sowings of faba beans.

	Early (i.e. May)	Late (i.e. June)	Requirements
Costs			
Seed	22	30	Higher rate
Fertiliser	33	17	Lower rate
Herbicides	39	42	More knock down
Fungicides	66	22	3 vs 1 application
Insecticides	15	15	
Machinery	40	40	
Other	80	80	
Total	295	246	
Returns	$		
1.0 t/ha	200		
1.5 t/ha	300		
2.0 t/ha	400		
Implications			
Yield potential	Higher	Lower	
Disease incidence	Higher	Lower	
Weed control herbicides	Selective	Non-selective	

A Faba Bean Perspective for Western Australia

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CRC for Legumes in Mediterranean Agriculture (CLIMA)

Faba beans have been grown in Western Australia (W.A.) over small areas (500–600 ha) in medium-high rainfall (450 mm) regions of Dongara, near Katanning and north of Esperance for the last 5–6 years. It was thought that faba beans were unsuitable for medium and low rainfall areas of WA because of their sensitivity to disease, high temperatures, moisture stress and poor growth on sandy soils. However, trial results in 1991 and 1992 illustrated that the variety Fiord escapes drought in our reliable Mediterranean-type environment by flowering and setting pods in August. It can produce yields of up to 4.0 t/ha even in 350 mm rainfall regions with very early sowing. The main factors contributing to the recent success of faba beans have been the development of a more effective strain of rhizobium and improved management practices through experience with field peas and lupins.

Consequently, the area planted to faba beans increased to about 7000 ha in 1993 which produced between 1.0–3.5 t/ha of grain yield. The grower interest in faba beans has increased dramatically over the last 2 years and sowings for 1994 should be 15000–20000 ha, given an early break to the season. Most growers are sowing 50–100 ha of faba beans as an initial trial and areas could expand rapidly in subsequent years. More than 4 million ha of neutral to alkaline fine textured or duplex soils are unsuitable for narrow leafed lupin production in W.A. and growers are demanding alternative grain legumes to include in their rotation for these soils. Most of these soils could produce reliable faba bean crops. At current yields and prices we expect that the area of faba bean production could increase to about 300000 ha over the next 10 years in this State.

No ascochyta blight has been detected in the northern wheatbelt region of W.A. Chocolate spot has been a problem there for several years, but in 1993 the infection occurred well into the podding stages and had little effect on yield. Most growers used one application of fungicide and although the quality of grain produced was fit for human consumption, most was sold for seed. The variety Icarus yielded significantly less than Fiord and appears to be late flowering for this environment.

In southern areas, both ascochyta and chocolate spot were present in 1993 and many crops needed two or three applications of fungicide. Most grain produced in this region was fit only for stockfeed because of seed infection and environmental discoloration. The variety Ascot showed clear resistance to ascochyta north of Esperance and it will reduce the need to use foliar fungicides and improve grain quality in the southern areas. Diseases were not a problem in the lower rainfall regions of the wheatbelt where disease pressure has not built up and the environment is much less conducive to diseases.

The W.A. Department of Agriculture has funding from GRDC for an agronomist/industry development officer and pathologist to concentrate on faba bean, although they will also be dealing with other grain legumes. The agronomist is collaborating with the national faba bean breeding program and hopes to test material from the program at three sites in 1994.

Future Research

Selection should be toward medium (Fiord) sized beans and within this we see disease resistance as a breeding priority—chocolate spot resistance, together with early maturity for the northern regions, and resistance to both chocolate spot and ascochyta diseases for southern areas. Better heat and moisture stress tolerance would improve faba bean's adaptation to the low rainfall parts of the wheatbelt. Increased tolerance to low pH and additional waterlogging tolerance would widen its adaptation in W.A. Studies on discoloration of the seed (environmental), management practices (time of seeding, harvesting time) and genetic resistance to overcome the discoloration problem also need to be investigated.

Data on the Australian and International Faba Bean Industries[1]

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Table 1. Faba bean production by Australian State

	NSW	Vic.	Qld	W.A.	S.A.	Tas	Total
Yield ('000 t)							
1988–89	4.4	19.5	0	0.5	38.8	0.06	63.3
1989–90	3.9	20	0	0	34.0	0	57.9
1990–91	6.2	20	0	0	26.9	0	53.1
1991–92	11	62	0.5	1.3	50.5	0.06	125
1992–93a	28	40	0	2	29	0	99
1993–94a	40	55	0	5	35	0	135
Area planted ('000 ha)							
1988–89	3.0	12.0	0	0.5	34.5	0.40	50.4
1989–90	2.4	20.0	0	0	21.8	0.36	44.6
1990–91	3.5	20.0	0	0	20.0	0.40	43.9
1991–92	5.5	50.4	0.5	0.5	27.9	0.03	89.8
1992–93[a]	16.0	37	0	2	27	0	82
1993–94[a]	16.0	45	0	4	22	0	87

Note: Totals may not add due to rounding.
[a] ABARE estimates, Australian Bureau of Statistics (ABS)

Table 2. Apparent consumption of faba beans in Australia

	1988–89	1989–90	1990–91	1991–92	1992–93
Production (t)	63 000	58 000	53 000	126 000	99 000
Seed use (t)	6 000	5 400	5 280	6 960	9 840
Exports (t)	25 578	25 054	29 424	68 631	51 805
Apparent consumption (t)	31 422	27 546	18 296	50 409	37 355

Note: Apparent consumption is obtained by subtracting seed tonnage and exports from production, since imports are negligible. For example, in 1992–93, imports were 2 t.
Source: ABARE, ABS

[1] These statistical tables are supplied as a synopsis of the Australian and international faba bean industries.

Table 3. Major export destinations for Australian dried, shelled broad beans and horse beans (includes faba beans)

Country	1988–89			1989–90			1990–91		
	Volume (t)	Value ($'000)	Value ($/t)	Volume (t)	Value ($'000)	Value ($/t)	Volume (t)	Value ($'000)	Value ($/t)
Egypt	0	0	0.00	0	0	0.00	4343	1403	323.10
Indonesia	42	10	231.49	0	0	0.00	43	15	355.07
Italy	728	198	272.33	7217	1670	231.34	1411	656	464.98
Jordan	215	62	289.66	645	280	433.67	409	165	403.18
Malaysia	2040	644	315.66	3297	1005	304.74	2837	904	318.69
Saudi Arabia	19115	5383	281.63	6618	2608	394.05	14651	4062	277.25
Spain	180	89	494.37	381	186	486.69	513	281	547.10
Taiwan	1361	624	458.35	1312	392	298.87	1116	584	523.71
United Arab Emirates	226	71	311.86	134	32	241.78	1388	451	324.98
United Kingdom	19	8	425.00	98	43	440.07	194	101	519.45
Total	23926	7089	3080.35	19702	6216	2831.21	26905	8622	4051.51

Country	1991–92			1992–93			1993–Dec 93		
	Volume (t)	Value ($'000)	Value ($/t)	Volume (t)	Value ($'000)	Value ($/t)	Volume (t)	Value ($'000)	Value ($/t)
Egypt	25713	8073	313.98	2860	992	346.91	0.00	0.00	0.00
Indonesia	489	208	424.85	1156	357	308.49	1186.00	477.00	402.19
Italy	688	418	607.66	2091	942	450.31	4756.50	1016.00	213.60
Jordan	5332	1961	367.83	1095	416	379.59	516.00	176.00	341.09
Malaysia	2603	912	350.35	1461	532	364.47	1290.00	480.50	372.48
Saudi Arabia	25483	7559	296.63	5379	1743	324.03	7436.40	1704.30	229.18
Spain	243	125	514.30	14921	4092	274.23	280.00	153.00	546.43
Taiwan	1453	743	511.36	866	449	518.45	983.50	505.20	513.68
United Arab Emirates	3172	1225	386.19	13219	3667	277.42	1145.00	408.50	356.77
United Kingdom	34	16	469.31	37	26	717.21	0.00	0.00	0.00
Total	65210	21240	4242.46	43085	13216	3961.11	17593	4921	2975.42

Table 4. World production of dry broad beans ('000 t)

Country	Average 1979–81	1985	Average 1990–92
Algeria	27	25	21
Australia	8	24	75
Austria	7	0	27
Brazil	41	45	25
PR China	2633	2300	2650
Czech Slovak Federal Republic	64	28	36
Dominican Republic	8	11	15
Egypt	219	302	436
Ethiopia	476	500	281
France	70	130	67
Germany	28	72	92
Italy	205	174	139
Mexico	62	40	23
Morocco	97	194	135
Netherlands	–	10	20
Peru	22	30	19
Spain	78	61	34
Sudan	37	45	43
Tunisia	47	43	36
Turkey	53	73	71
Other	112	112	67
Total	4294	4219	4312

Source: FAO Production Yearbook, 1992.

Table 5. Major exporters of dry broad beans (production in t)

Country	1989	1990	1991
Australia[a]	25054	29424	68631
Austria	68	26	31
PR China	139879	237077	300000
Egypt	2641	2408	2200
Ethiopia	3500	15000	4286
France	56370	27996	33864
Germany	1263	1999	n.a.
Italy	83	115	638
Mexico	258	305	305
Morocco	13360	4801	3689
Netherlands	11731	10190	5595
Saudi Arabia	42	46	n.a.
Spain	92	165	757
Tunisia	476	149	707
Turkey	38533	31474	24420
Total	293350	361175	445123

Source: FAO unpublished data

[a] ABARE estimate for the financial years 1989–90, 1990–91 and 1991–92.

n.a. information not available

Table 6. Major importers of dry broad beans (t)

Country	1989	1990	1991
Australia	24036	29355	29159
	(3)	(4)	(23)
Austria	156	291	52
P.R. China	n.a.	11	n.a.
Egypt	1	502	n.a.
France	5231	2812	2033
Germany	267825	129717	n.a.
Italy	269035	288351	321129
Mexico	347	646	646
Morocco	n.a.	18	9
Netherlands	61778	5365	3318
Saudi Arabia	13395	16478	15692
Spain	28352	120063	145848
Tunisia	3234	211	n.a.
Total	673390	593820	517886

Source: All figures are from FAO unpublished data, including Australia, where ABS figures are given in brackets. The enormous differences between the two Australian estimates highlight the problems with FAO data.

n.a.: information not available

Table 7. World consumption of dry broad beans (tonnes)

Country	1985	1988	1989	1990	Average of 1988–90
Algeria	25 422	13 275	21 880	6 980	14 045
Australia[a]	283	31 422	27 546	18 296	25 755
Austria	1 580	32 538	27 890	27 797	29 408
Brazil	45 896	26 691	24 244	25 265	25 400
PR China	2 174 833	1 950 015	1 912 621	2 251 933	2 038 189
Czech Slovak Federal Republic	76 381	19 698	24 975	29 413	24 695
Dominican Republic	6 337	14 065	14 065	14 550	14 226
Egypt	215 828	305 131	399 360	324 450	342 980
Ethiopia	282 766	214 357	228 500	226 440	223 099
France	63 311	89 011	66 027	60 742	71 926
Germany	48 219	343 054	433 934	247 402	341 463
Italy	197 433	322 300	363 100	373 000	352 800
Mexico	37 516	37 926	38 092	38 343	38 120
Morocco	123 812	159 440	152 530	154 054	155 341
Netherlands	8 364	67 316	83 047	13 175	54 512
Peru	18 293	21 416	18 397	18 795	19 536
Saudi Arabia	6 727	16 076	12 951	14 508	14 511
Spain	98 657	49 937	68 952	146 885	88 591
Sudan	28 546	42 560	39 900	24 320	35 593
Tunisia	28 491	20 243	27 501	22 821	23 521
Turkey	39 277	41 545	26 217	33 476	33 746
Other	113 664	140 431	157 544	157 151	251 050
Total	3 641 636	3 958 447	4 169 273	4 229 796	4 218 507

Source: FAO unpublished data.

[a] ABARE estimate for the financial years 1988–98, 1989–90 and 1990–91.

Note: The FAO consumption figures given here are likely to contain some inaccuracies and should therefore be used only to indicate general levels and trends.

Marketing Opportunities

Opportunities for Faba Bean Exports to the Middle East

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In *Saudi Arabia*, present consumption of faba beans is about 20000–22000 tonnes a year. Consumption is increasing at 5–10%/year.

Two modern canneries which will be operational in 1994 will increase the total demand by possibly 6000 t/year. The present demand is for whole and split beans in dry form. Saudi Arabia buys beans only for human consumption.

It is our expectation that, subject to quality, Australia will be able to supply a regular 15000–20000 t of the total demand, with China providing most of the balance. Our present varieties of faba beans—predominantly Fiord—suit the market in terms of size and taste characteristics (not resistance to disease). Australia lacks a larger sized bean (Chinese ganzu style) which the canneries will source elsewhere.

Egypt is a market for which accurate supply/demand figures are difficult to assess. It is estimated, however, that the country consumes approximately 1000 t/day, implying an annual production of about 350000 t/year. Consumption is estimated to be increasing by about 5%/year.

While Australia may continue to sell faba beans from time to time on an opportunistic basis, we do not see a bright future for Australian beans in Egypt until such time as:

- we produce what the market prefers, which is a Chinese-style bean of larger size and flatter shape than the Australian varieties; and
- we solve the problem of 'rough poppy' admixture with the Egyptian authorities. We need to either introduce a nil tolerance of rough poppy on receival of product from our growers or to convince the Egyptian authorities that our 'rough poppy' is harmless.

Yemen is a market that currently imports about 10000–12000 t of beans a year to service the needs of the military and of a canning factory. Unfortunately, the lack of foreign exchange has restricted the issuance of import licences and the fragile union between the north and south of the country is currently putting strain on economic recovery. We expect that this country, which is developing its oil industry at a rapid rate, will in time become an important market for Australian faba beans.

Having penetrated this market some 4 years ago, Australia failed to sell any quantities to Yemen in the past year because of the poor quality of our crop. The Yemenis bought English beans (which are not preferred) at higher prices than Australian beans.

General Observations

While there are many small markets in the Middle East which consume small tonnages of Australia faba beans, the markets in Saudi Arabia, Egypt and the Yemen are and will continue to be the most important for Australia as far as human-consumption markets are concerned.

We have one distinct advantage over European suppliers and that is that the Australian product is low in moisture. It can therefore be stored for long periods without the rapid deterioration that occurs with English, Polish and Hungarian beans.

The biggest drawback to achieving greater market penetration in the Middle East is that in recent years our quality has simply not been good enough. We must decide whether we are producing for the food market or the feed market!

European stockfeeders will continue to provide a safety net into which surplus Australian low-grade beans can be disposed, but this generally means low prices.

Faba Beans in the Beef Feedlot and Compound Feed Industries

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Over the last 15 years or so, grain legumes have risen from near obscurity to now constitute a significant component of pig, poultry and ruminant feeds right across Australia. The volume of stockfeed manufacture is estimated at 5.5 million t/year, with a potential grain legume content of the order of 1.0–1.5 million t.

To date, faba beans have tended to be one of the lesser legumes employed, with lupins and peas dominating. The reasons for this include the volume produced, differences in nutritive value relative to price, and human food/export opportunities for the beans.

However, when competitively priced, faba beans are used readily in the diets of pigs, poultry and ruminants. In least-cost formulation they tend to present a commodity value marginally below peas and lupins (depending on the formula being run), largely reflecting their lower energy value for monogastrics, their lower content of essential amino acids (particularly lysine) and lower overall protein content for ruminants (see Tables 1 and 2).

There has been some research and anecdotal evidence within the intensive livestock industry, that antinutritional factors limit the performance of animals where high levels of faba bean are included in the diet. But they are generally regarded as trouble free and yield their theoretical nutritional description when fed at practical levels (up to 20% of the diet).

Like many feedstuffs with higher values as human foods, the material available to the stockfeed industry may in fact have been downgraded or rejected due, for example, to discoloration, insect damage, excessive moisture, weed seed contamination, or chemical residues. As such, the subsequent performance recorded in livestock diets is not a true reflection of the inherent properties of this wholesome product.

Although there are some reports of faba beans having higher by-pass protein characteristics in ruminant diets, overall they do not have any unique nutritional advantages over peas and lupins. Consequently, their commercial competi-

Table 1. Proximate composition (% air-dry basis) and energy content (MJ/kg air-dry basis) of legume seeds or meal.

Component	Chick pea	Faba bean	Field pea	Lupin seed	Mung bean	Navy bean	Peanut meal	Pigeon pea	Soybean seed	Soybean meal
Crude protein	19.5	23.1	23.4	28.9	23.9	22.7	47.4	18.3	37.9	46.7
Dry matter	89.1	90.6	90.7	89.7	89.8	89.7	91.5	88.8	90.9	89.1
Crude fibre	7.0	6.9	6.1	13.0	3.9	4.2	13.1	10.5	5.3	5.2
Ether extract	3.9	1.2	1.2	5.4	1.3	1.5	1.2	3.3	17.4	1.2
Ash	2.9	3.2	3.0	2.8	3.7	4.1	4.5	4.5	4.9	5.9
Nitrogen-free extract	55.7	56.3	57.0	40.2	57.0	57.2	25.3	52.2	25.4	3.01
Energy										
DE – Pig	16.2	13.7	15.5	14.2	15.6	15.6	11.9	13.5	16.9	14.0
ME – Cattle	12.1	13.1	11.3	–	11.4	11.3	10.6	8.0	12.6	11.1
– Chick	12.2	–	9.2	8.9	10.5	9.7	9.2	–	13.9	9.3
– Pig	14.8	12.9	14.1	–	14.1	14.2	10.2	12.4	14.8	11.9
– Sheep	11.5	11.7	10.3	–	11.7	11.7	11.5	8.9	12.6	12.0

Source: Batterham and Egan (1987)

Table 2. Crude protein (%, air-dry basis) and amino acid composition (g/16 g N) of leguminous seeds or meals.

Constituent	Chick peas	Faba bean	Field pea	Lupin seed	Mung bean	Navy bean	Peanut meal	Pigeon pea	Soybean meal
Crude protein	23.0	23.2	21.2	28.9	25.1	24.7	50.7	20.4	45.8
Aspartic acid	10.1	10.6	10.8	9.3	10.8	–	9.9	8.7	10.4
Threonine	3.3	3.5	3.8	3.4	3.2	4.5	2.7	3.9	4.0
Serine	4.7	4.7	4.7	4.9	5.2	6.2	4.7	4.5	5.2
Glutamic acid	16.3	15.0	17.6	21.8	13.8	–	19.2	20.7	18.5
Proline	4.0	3.3	4.4	4.3	–	–	4.5	4.6	5.3
Glycine	3.6	4.7	4.3	3.9	3.2	3.9	5.1	3.8	4.2
Alanine	3.8	4.1	4.3	3.1	4.8	–	3.7	4.2	4.1
Valine	3.5	4.4	4.7	3.6	6.0	5.2	4.0	4.1	4.6
Cystine	0.9	1.4	1.2	2.2	0.4	0.8	1.3	1.7	1.3
Methionine	1.0	0.8	0.6	0.6	0.8	0.7	0.7	0.8	1.1
Isoleucine	4.2	3.8	4.3	3.9	4.8	4.6	3.4	3.8	4.5
Leucine	7.4	7.3	7.8	7.5	7.2	8.3	6.8	7.1	7.7
Tyrosine	2.6	3.5	3.6	3.7	2.4	3.5	3.9	2.7	3.6
Phenylalanine	5.2	4.1	4.6	3.7	4.8	5.8	4.9	8.4	4.8
Histidine	2.5	2.5	2.7	2.7	2.0	2.8	2.2	3.3	2.7
Lysine	5.8	6.2	7.3	4.7	6.8	6.9	3.3	5.8	6.0
Arginine	9.8	9.4	10.3	10.2	6.0	6.7	12.8	6.2	7.4
Tryptophan	0.64	0.7	0.83	0.60	1.8	1.7	0.83	0.74	1.03

Source: Batterham and Egan (1987)

tiveness tends to centre more on proximity to the end-user (freight) and market demand for alternative uses, e.g. human food exports.

Hence, the options to improve the competitive position of faba beans will involve developments in the following areas:

- Nutritional value (higher protein, more favourable amino acid balance, higher energy value in the form of increased levels of fat and digestible carbohydrate and reduced non-soluble protein and oligosaccharides, and elimination of any residual antinutritional factors)
- Market access—the development of cultivars suited to the agronomic conditions adjacent to major centres of potential use (stockfeed mills, pig and poultry productions, beef feedlots)
- Production efficiency (cost)—elevated yield, reduced susceptibility to weather, fungal and insect attack etc.

This raises the dilemma that what is perceived as an improvement for one species of animal or a particular end-use can be a net negative for others. For example, the tannin content is considered undesirable in pig and poultry feeds as it depresses intake and interferes with protein digestion/absorption, yet this is the very property which probably accounts for the higher by-pass protein value for cattle and is likely to be a critical aspect in insect/fungal resistance. Similarly, the non-soluble protein and oligosaccharide fractions, which lower the energy value for pigs and poultry and create flatulence problems, are of no concern to ruminants (in fact they represent a safer form of energy) and provide the dietary fibre value of beans to humans.

Thus, for faba beans to represent a larger component of the feeds used in intensive livestock production and beef feedlotting there needs to be demonstrable nutritional or economic advantage. No doubt those at this workshop will seek to identify what these may be and formulate a strategy for their development.

Reference

Batterham, E.S., and Egan, A.R. 1987. Utilisation of food legumes as feed. In: Wallis, E.S. and Byth, D.E., ed., Food legumes in Asian farming systems. ACIAR Proceedings, No. 18, 194.

Market Prospects for Faba Beans Grown in Northern New South Wales

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Faba beans in northern New South Wales have risen from obscurity in the early 1980s, with the first crops being grown in what was considered the most suitable area (the Liverpool Plains) in 1985–86. From a small beginning of 140 ha at that time the industry has risen to an area of 9640 ha in the 1993–94 season, with a production of 21 368 t (see Appendixes 1 and 2).

To date most of this crop has gone into stockfeed rations, with only small amounts finding their way into the export trade. Reasons for this have been poor quality and price disparity, with the stockfeed industry paying higher prices than the export market.

Since areas of faba bean planting are expected to increase rapidly, market potential has been addressed and is assessed as follows:

Domestic stockfeed – Within the last 2 years adequate volumes have been produced to attract permanent stockfeed users, putting some stability in the marketplace. The potential here will always be at the expense of the other competing ration supplements such as field peas and lupins.

Export stockfeed – This marketplace is available only to meet shortfalls in production in Europe and suffers the same fate as our own domestic stockfeed market, in that it has to be cost-effective against opposing grain supplements, e.g. Canadian peas.

Export for human consumption – The Middle East and Southeast Asia hold the best potential and are our biggest markets at the moment, with the Middle East the predominate market (approximately 50 000 t, with Asia being 5700 t). Quality issues need to be addressed to claim a larger portion of this market.

Niche markets – These need to be addressed but may come as a spin-off from catering for the larger areas of human consumption and stockfeed. There are possibilities for confectionery markets, e.g. snack food, and for special stockfeed preparations for horses.

New technology – Opportunities exist for novel uses of oils and other derivatives from plant materials. For instance in the United States a Chicago-based company has used rapeseed oil to develop a non-toxic, biodegradable release agent for laying concrete, to replace a petroleum-based agent in previous use. Other possible derivatives are basic starch preparations, gluten supplements and new vogue food preparations.

Taking the above marketing prospects into consideration, along with the following information of potential growth, the faba bean industry takes on some frightening proportions. Disposal and carry-over could be major problems within a very short time. So before this growth has any potential the market needs to be fully investigated to manage growth and ensure a degree of equity remains in the market for all parties concerned.

Growth Potential in the North

There are 275 000 ha of cotton grown in northern NSW and southern Queensland. Faba beans have the potential to complement cotton in many ways, so this large area under cotton is suited to rapid expansion for production of faba beans.

Advantages in planting faba beans after cotton

- Well suited to heavy soils
- Good tolerance to water logging
- No nitrogen fertiliser required
- Best option for low-N status soils—can leave 20–50 units/ha for cotton crop
- Easy to establish in cotton stubble
- Good weed competition
- Non-verticillium host
- Early harvest
- Suited to row spacing and permanent beds

Disadvantages

- Relatively high level of inputs required
- Foliar disease common

- Heavy use of water resource
- Must be planted early
- High seeding rate
- Possible heliothis (*Helicoverpa*) host
- No apparent orderly marketing options

The actual figures from a trial conducted by the district agronomist from Wee Waa on a property called 'Orien' are displayed in Table 1, showing the difference between a cotton/faba bean rotation and a traditional wheat/cotton rotation. These trial results illustrate why growers are using faba beans as a rotation with cotton; costs can be reduced and returns increased significantly by the use of faba beans rather than wheat in the rotation.

Table 1. Differences between faba bean/cotton and wheat/cotton rotations.

Cost/return ($A)	Faba bean/ cotton	Wheat/ cotton
Rotation crop growing costs/ha	90	52
Rotation crop gross return/ha	340	48
Cotton growing costs/ha	1280	1315
Cotton returns/ha	3375	3214
Rotation gross margin/ha	2345	1895

We consider that if there were no constraints on the disposal of faba beans then there would be potential for planting over 100000 ha, producing around 345 000 t. This is only the fallow portion of the total area of irrigated cotton production and any expansion in dryland faba bean production should be added to this and taken into consideration. Market and producer factors considered to be limitations to faba bean expansion are discussed below.

Market Limitations

Consumer countries

Information is available from various statistical reports produced by ABARE and the Australian Bureau of Statistics, but we need more detailed information on other competitors in the export market. We need to know whether they are supplying a better product into the same market, if their product comes into the market at the same time as ours, and how much potential growth any particular market can expect over the next 5 years.

Consumer requirements

Until such time as we know exactly what are our consumers' needs, and how these vary between countries, it would be inappropriate to breed varieties or market faba beans which could be unsuitable in terms of bean size, colour and delivery specifications.

Stockfeed requirements

Independent information is needed to assess faba beans versus other pulses in a ration for different requirements (pigs, poultry, cattle, etc.). At present we rely on stockfeed manufacturers to relate the differences to us.

Niche market requirements

Requirements for the canning, flour and confectionery industries all need to be known in order to understand the marketplace and to breed suitable varieties.

National standards for delivery

The present differences between States for delivery of the different grades of faba beans need to be standardised to allow for further multiple pick-ups in the export business.

National standards for specific markets

Segregation of beans should be addressed if premiums can be received by segregating for different markets.

Identification of new specialised markets

As mentioned earlier, opportunities exist for enterprising companies to develop new environmentally friendly products based on legumes or oilseeds.

Communication between States

To further the faba bean industry and allow it to develop to full potential, States must collaborate rather than compete.

Networking of producers/processors/exporters

Until a network is established, the faba bean industry will not develop to its full potential. There is already the problem of consumers working pro-

ducers, processors and exporters against each other to buy as cheaply as possible in the marketplace.

Industry standards

We should look to the example of the Mungbean Association, which has identified and implemented an industry standard attuned to market requirements.

Producer Limitations

A significant limitation is low net return on investments. This is attributable in part to high input costs—for example, the cost of controlling chocolate spot and rust in northwestern NSW for the 1993 season was on average $75.75/ha, which on a standard gross margin represents 23% of total variable costs.

Disease and weed seed carryover can occur because of poor selections of weedicides and fungicides. There are many escapes in both these areas which can prove costly for the grower to control in subsequent years.

Disposal of produce at harvest can cause problems if there is a rapid expansion of area grown to faba beans. If the problems of storage and disposal of the crop at harvest are not solved as the industry grows they could prove to be major stumbling blocks to expansion. Since growers at harvest time demand proper coordination it cannot be a stop/start affair, even though some traders would prefer to see it this way to manipulate the price. Also, lack of available processing facilities could limit the future of faba beans if production is increased, since there is considerable demand for faba beans in a dehulled and split form.

Variety selection is presently limited to one—Fiord. Some of the above problems could be rectified by the development of a suitable variety for northeastern Australian cropping areas.

Table 2. Increases in production of competitive grains

Grain	93–94	92–93	5 year avg
Lupins ('000 t)	1133	1145	870
Increase/decrease (%)		–1	23
Field peas ('000 t)	441	464	435
Increase/decrease (%)		–5	1.3
Faba beans ('000 t)	122	99	61
Increase (%)		18	50

Source: ABARE report, October 1993.

There is also competition from other grains for domestic stockfeed. Table 2 shows the expansion of competitive grains.

Increases in all areas of pulse production indicate that if faba beans are to expand in the domestic stockfeed market they need to be lower priced to take from lupins and field peas some of the 1000 kt compound feed market available in eastern Australia. The following is a price comparison paid for delivered end-user prices of three grains into different markets.

Pigfeed market	*Poultry feed market*
Lupins: $220	Field peas: $220
Faba beans: $215	Faba beans: $215
Field peas: $205	Lupins: $205

Price differences relate to desirable characteristics of the different grains.

Advantages of Increasing Area in NSW

Risk-spreading to meet market specification

If the Australian faba bean industry worked as a unit it would be possible to meet specific market requirements from different parts of the continent and also offer material on a continuity of supply basis. If certain areas were able to grow different varieties of faba bean, developed to suit different climate conditions and with specific markets in mind, the risk would be spread and the capacity for meeting market demand increased.

Strategy

To implement a market and research plan relevant to the market place, finance should be directed to research to determine marketing needs *before* breeding and agronomic problems are addressed. Any program introduced should be undertaken on a national basis, catering for environmental differences, and should include standards and specifications.

Appendix 1

Estimated state winter sowings of faba beans for NSW, as at October 1993

Northern Region			Southern Region		
District	Area (ha)	Yield (t)	District	Area (ha)	Yield (t)
Gunnedah	2000	5000	Cowra	50	150
Moree East	2000	5000	West Wyalong	500	750
Narrabri	4800	9600	Barham	500	1250
Scone	100	300	Coleambally	1800	5400
Tamworth	100	250	Dareton	700	2800
Coonabarabran	150	225	Deniliquin	250	500
Coonamble	180	288	Finley	50	125
Dubbo	40	80	Griffith	600	1920
Nyngan		1	Hay	500	1500
Walgett	170	374	Hilston	750	1650
Warren	100	250	Jerilderie	250	625
			Leeton	250	700
			Lockhart	300	540

Appendix 2

ABARE estimates of Australian faba bean production by State, January 1994

Period	New South Wales		Victoria		Western Australia		South Australia	
	Area ('000 ha)	Prod ('000 t)	Area ('000 ha)	Prod ('000 t)	Area ('000 ha)	Prod ('000 t)	Area ('000 ha)	Prod ('000 t)
1993–94	16	35	45	55	4	5	22	35
1992–93	16	28	37	40	2	2	27	29
5-year average to 1991–92	4	6	18	18	0	0	27	37

Constraints to Productivity

Research and Development Needs to Improve Faba Bean Productivity

C.S. Francis
Cooperative Research Centre for Legumes in Mediterranean Agriculture (CLIMA),
University of Western Australia

Faba beans seem set to undergo a renaissance in Australia. New varieties will shortly become available and an intense interest is developing in Western Australia and northern New South Wales. They have a very high yield potential relative to other commercial grain legumes and appear well adapted to alkaline soils.

Improved funding and moves to create a genuine national program were initiated by CIP committee in the last funding round and the input into the breeding program was doubled. The need for selection for shorter seasons was seen a priority. We are here to consider the implications of these moves so far and the willingness of GRDC to contribute further funding to faba bean development, particularly if adaptation can be extended to drier areas. GRDC has set aside funds to this end.

There are a number of possible research avenues which might extend and provide a better balance to the faba bean improvement program in Australia. Appendix 1 outlines the current program. In addition, some possible linkages with overseas programs could be developed—notably China and West Asia–North Africa (the ICARDA mandate region).

The large ICARDA program was ended 2 years ago after 10 years work, just when the advanced lines, which included many disease-resistant types, were to enter final testing. This late generation material is not in Australia.

We should consider the structure of the current National Breeding Program. Largely through lack of resources this has not been a truly national program. The current structure involves an emeritus breeder, Dr Ron Knight, a junior breeder to be appointed, two technicians, plus disease support from Mark Ramsey (a GRDC project). There is a mandate for an extended effort into the drier regions and it is likely that more technical and operational support may be needed.

Research Areas

Beside the core program, it may be argued there are fields of research involving integrated disease management, physiology, adaptation, seed quality and end use, as well as germplasm development which need to be considered as part of a coordinated program. We need to consider the adequacy of support for these projects.

Germplasm development

Breeding—This area has been under-resourced and as a consequence has lacked national focus. GRDC has more than doubled funding which should serve southern Australia. Whether subtropical conditions demand a completely different type of germplasm remains to be seen. There is a lot of material around the world to assess without formal breeding, but quarantine is a problem.

Formal links with other programs—The Australian Quarantine Inspection Service (AQIS) regulations make it is extremely expensive to import advanced germplasm from other programs into Australia. It may cost more than $300 a sample. To import the best material, some still segregating, from ICARDA (Morocco) and China is obviously prohibitive, and offshore screening is an option.

Should we contract to have material screened in a like environment and import only the best? We could develop a formal link with China, ICARDA or other centres with a substantial faba bean program. An outline of proposed linkages is given in Figure 1. ACIAR may consider funding projects in faba bean provided it has links to client countries and to a national effort in Australia.

Actual quarantine costs and germplasm acquisition are still major limitations even if offshore screening is carried out. Horsham would need some additional assistance specific to faba beans.

Wild germplasm, land races and plant collection—The roles of ICARDA, CLIMA and VIDA

in collection of land races for the program have been enhanced. This is one area which probably has adequate support following ACIAR funding for the western Mediterranean and possible support for the eastern Mediterranean region from GRDC.

Marketing and end use

Some data have been accumulated, e.g. the Rees report at this workshop. Do we know the realistic market potential? How would such a project be tackled? The information may be no different than that already available to the various sellers. Can we market a 500000 t crop? There needs to be at least a conceptual plan. There needs to be consideration of end-use projects, not necessarily specific to faba bean, like those which have been submitted to GRDC by Petterson et al. in WA and CSIRO North Ryde for the processing aspects.

Seed chemistry and quality

Rapid and accurate technology is available for measurement of toxins, vicine and convicine, and tannins. If considered important enough, it would not cost a great deal to set up an analytical laboratory located at the Chemistry Centre of W.A. There is evidence these compounds reduce performance in non-ruminant feeds. Value-adding to the product in terms of reduced vicine levels may give us a marketing advantage.

Analyses of amino acid and fibre profiles on the other hand could not be undertaken routinely and in the absence of a full project would need to be selective.

Faba beans need objective evaluation for alternative end-uses, particularly in animal and aquaculture industries.

Seed size and market price needs clarification, as large seed is a problem for farmers.

Legume microbiology

New *Rhizobium leguminosarum* strains for *Vicia faba* have opened up vast areas with the potential to grow faba beans in southern Australia, particularly W.A. which has a special problem with sandy infertile soils. Is the rhizobia support adequate? The narbon bean and faba program has relied so far on Alan Gibson in Canberra. Host strain compatibility appears no longer to be a problem. Persistence is also being tackled successfully in a separate GRDC project (DAW 241F; John Howieson).

Edaphic adaptation of faba bean and relatives

Legume selection for alkaline soils, especially in dry areas is a national priority. Definition of pH

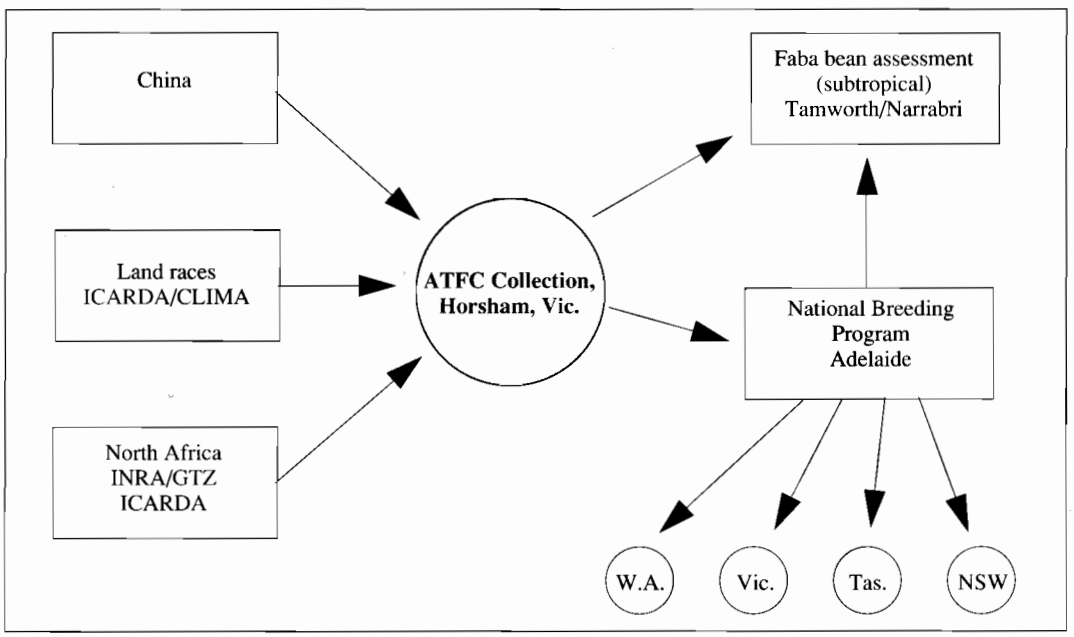

Fig. 1. Germplasm flow in the integrated national and international faba bean improvement programs.

and free calcium range would involve a small extension of a current GRDC project (C. Tang) focusing on lupin species.

Improved waterlogging tolerance may be useful for duplex soils.

Disease control

Although the screening for ascochtya and chocolate spot seems to be very successful, is adequate attention being given to fungicidal technology and integrated control measures? Because of the high yield potential, fungicides may be a viable short-term proposition. A project on this topic has been submitted to the GRDC western region committee.

Much more disease-resistant material is available from the ICARDA program but would need testing in Australia (perhaps with additional funding support).

Postgraduate projects

There are several postgraduate projects dealing with faba bean at the University of Sydney (Prof. Don Marshall) on genetics of *Ascochyta*, variations in chocolate spot, and hybrid breeding systems. At the University of Adelaide, postgraduate students are investigating relationships between water use, flowering date, seed size and yield; the effects of bean age on seed colour, hardseededness and cooking quality; and factors involved in splitting of faba beans. Some other good lines of research for postgraduate training would be:

- self compatibility analysis (the role of vectors, etc.)
- waterlogging tolerance
- stress, low soil moisture and temperature responses versus others e.g. *Vicia narbonensis, Lathyrus cicera*, etc.
- determinant types and pod retention
- ascochyta resistance

Others have, and will argue for, other priorities, e.g., virus resistance, insect resistances (*Helicoverpa*), genetic engineering and gene mapping. We could consider the relative importance of each, and any others, for possible funding and recommend accordingly.

Extension

Faba bean is a specialist and often difficult crop and may deserve specialist advisers and farmers.

Possible Program Funding

International (ACIAR)

- Establish a project with China to link directly with the Australian program. Off-shore testing may be carried out in China and in a mild climate site in Syria or Morocco (ca $660 000 over 4 years).
- Could support as an add on to the China project an ICARDA/CLIMA effort linked directly with the Australian national program. Adds an estimated $200 000 over 4 years to include travel for Ron Knight. (This might also be funded by GRDC and is included below.)
- ACIAR currently supports genetic resource development from the western Mediterranean. Faba bean from the eastern Mediterranean is very important. Add $10 000 per year for more focus on faba bean especially from Ethiopia the world's second largest producer and for land races of eastern Mediterranean faba bean.

GRDC new initiative funding—budget for discussion

Year 1

(a)	Support for DAN. Casual and operating Tamworth. Technical assistance to be supported by ACIAR project.	25 000
(b)	Strengthen casual and operating of core program because of the new material, distribution costs	20 000
(c)	Strengthen disease screening, casual plus operating	20 000
(d)	Genetic resources—plant quarantine, Horsham	15 000
(e)	Market analysis (one year only)	25 000
(f)	Soil adaptation, pH and free lime	10 000
(g)	Seed chemistry toxins/tannin	15 000
(h)	ICARDA north African project (alternative to ACIAR)	45 000
(i)	Postgraduate project (University of Sydney?)	27 000
Total		202 000

Year 2

As above with an additional PhD project to replace the marketing analysis.

Faba Bean in the Future

Constraints and requirements

- The potential market for faba bean. Can we sell a 500 000 t crop? We need to know this to justify large increases in expenditure.
- New germplasm acquisition if links are established with China, ICARDA, Ethiopia. Plant introduction via AQIS will remain a bottleneck even if there is some screening offshore. It would be a good investment to receive already improved material.
- Disease screening remains high priority. Additional material and a larger program will need extra support.
- With a high-yield crop, integrated control and use of fungicide systems are probably justified.
- Seed chemistry and quality have been totally neglected and may give a marketing edge. Linked to this is alternative end-use research.
- Agronomic packages and extension for the various regions. Faba bean has very high yield potential rarely realised. Better packages and their extension is a way for rapid increase in production and reliability.
- The crop lacks a basic and postgraduate support base.

Appendix 1

Current faba bean improvement support

GRDC	($A)
Direct support	
UA 22 Coordinated faba bean breeding program	202 000
DAS 37 Disease screening faba bean component	48 000+
Indirect support	
DAN 12 Grain legume development in northern NSW	78 000
DAV 242 Grain legumes for the Victorian wheat-belt	133 000
DAW 282 Grain legumes industry development	212 000
AMM 1 Assessment of grain legumes as an alternative in northern Tasmania	25 000
ACIAR	
CLIMA and ICARDA (ACIAR) Legume genetic resources from the western Mediterranean region.	200 000

The Faba Bean Program in Australia's Northern Growing Region

R.A. Spurway
NSW Agriculture, Orange

The predominant commercial cultivar grown in the northern region is Fiord. However, it is highly susceptible to rust and chocolate spot, has poor standability and yield at high biomass and is sensitive to high spring temperatures and water stress. It is most unlikely that the faba bean industry will grow while it remains based on a single variety with the attributes of Fiord. A range of cultivars which addresses the following constraints is required for an expanded and stable faba bean industry in the northern region:

- *Disease resistance*, particularly to rust and chocolate spot. Rust is a major disease problem in the north but is a minor problem in most years in southern Australia.
- *Adaptation* to short season, water and high temperature stress. In the north, faba beans are frequently affected by spring moisture stress and severe frosting.
- *Maturity* at least equal to Fiord for dryland production on the Liverpool Plains; 2-3 weeks earlier than Fiord under irrigation in the northwest of NSW and adapted to a mid-April sowing date for dryland production in the northwest of NSW and in southern Queensland.
- *High seed yield with high shoot biomass* to maximise grain yields and N input.
- *Good standing ability at high biomass* for ease of harvest, disease management and clean, unstained grain.
- *Grain which meets specifications for stockfeed* (tannin, % protein?) and *human consumption* (seed size, colour?).
- *Nitrogen fixation under high soil nitrate* to maximise the nitrogen contribution to the farming system.

Current Programs Addressing Constraints

NSW Agriculture is well placed to address the research, development and extension needs for faba beans in three areas:

- development of adapted varieties
- disease management
- extension.

NSW Agriculture objectives and strategies in each of these areas are as follows:

Faba bean improvement

Objective:

Select new cultivars of faba bean that are well adapted to the short season, high temperature environments in the north, resistant to the foliar diseases, rust and chocolate spot, have good standability and pod set at high biomass levels, with high N fixation capacity and quality characteristics to suit a range of market or product requirements.

Strategies:

- Evaluate advanced lines from the southern breeding program (R. Knight) and other sources as they become available (GRDC Project DAN 012).
- Request GRDC support for a northern faba bean improvement program coordinated from the Agricultural Research Centre, Tamworth and shared with the Agricultural Research and Advisory Station, Narrabri. It would be coordinated by Dr Harry Marcellos who would also be responsible for genetic resources, agronomy and field evaluation, and assisted by Ms Linda Heuke. Dr Ian Rose, currently breeding soybeans for eastern Australia will be the breeder,

progressively increasing his input annually to 45% in three years. Dr Kevin Moore has gained considerable experience with chocolate spot and rust through the project DAN 9C. Technology transfer would be the responsibility of the project TOPCROP. Research on grain milling quality and antinutritive factors would be done by Dr Harpal Saini.

- Seek University of Sydney participation in the program through postgraduate student projects on special topics, and also QDPI in regional testing and industry development. The latter would be greatly facilitated should the northern panel support the project proposed by Mr Bob Brinsmead and Ms Moira English.
- Develop a Phase II project with ACIAR on 'Improvement of faba beans in Australia and China through germplasm evaluation, exchange and utilisation'. Success with the ACIAR initiative would provide genetic resources and cooperation between the northern program, ICARDA, Australian Temperate Field Crops Collection, Horsham, the southern faba bean program and Chinese programs. The Chinese project is particularly relevant—90% of China's beans are largely landraces grown in a latitude range equivalent to that between Tamworth and Rockhampton, and climates from humid coastal to dry continental.

Disease management

Objective:

To increase the adoption and profitability of faba beans in eastern Australia by:

- Developing more reliable, statewide strategies for chemical control and management of foliar diseases of faba bean.
- Reducing fungicide use by increasing the efficiency of chemical control programs.

Strategies:

- Evaluate a range of fungicides and application strategies for control of ascochyta blight, chocolate spot and rust (GRDC Project DAN 9C).
- From field and glasshouse studies develop recommendations which answer the questions most asked by growers:
  - How long after application do fungicides protect the crop?
  - How long after disease is seen can fungicides be applied effectively?
  - How does the weather, especially rain periods, affect intervals between sprays?
  - Does increased disease (inoculum pressure) decrease effectiveness of fungicides?
  - Do crops differ in susceptibility as they age?
- Carry out on-farm demonstrations of the interactions between herbicides, fungicides and disease.
- Prepare a guide to disease identification for in-crop use by growers.

Extension

Objective:

To assist farmers growing grain legumes in northeastern Australia to effectively use decision support packages for crop productivity improvement (CROPCHECK) and crop selection (CROPCHOICE) to achieve maximum economic return and water use efficiency.

Strategies (GRDC Project DAN 173N):

- Integrated and focused use of NSW/Qld research results.
- Involvement of growers in local crop production groups, exchanging key crop, soil and environmental information.
- Finalising and having available for group members crop management systems for chickpeas, faba beans, mung beans and soybeans.
- Evaluating through grower groups decision-support frameworks dealing with crop choice systems for winter and summer crops.
- Support developing interest in both chickpeas and faba beans for use in intensive livestock rations.

The University of Sydney, with funding from GRDC, commenced a postgraduate project in 1994 which aims to develop F_1 hybrid breeding system for faba beans.

Current NSW Agriculture Resources

- Dr K. Moore (70%), ARC Tamworth. Disease management systems and systems for screening advanced lines. The faba bean pathology program is a statewide network coordinated by Dr Moore with support from Dr A. Nikandrow, ARVC Orange (20%) and Mr A. Watson, Agricultural Institute, Yanco (10%).

- Dr H. Marcellos (30%), Ms L. Heuke (10%), ARC Tamworth. Agronomy and adaptation in the northern region.
- Mr P. Hayman, ARC Tamworth and Mr G. McIntyre, QDPI coordinate the TOPCROP project in the northern region.

The Faba Bean Breeding Program in Australia's Southern Growing Region

R. Knight
Department of Plant Science, Waite Campus, University of Adelaide

GRDC-funded faba bean research projects in Australia's southern region during 1993–94 are listed in Table 1. As well, most government-funded organisations provide, from their own resources, a salary and infrastructure component additional to these research funds.

Table 1. GRDC funding for faba bean research in the southern region of Australia, 1993–94

Research program	Amount ($A)
Coordinated breeding	
South Australia, Waite Campus, Adelaide	140 000[a]
Victoria, dryland and irrigation research	60 000
Disease control	
South Australian Research and Development Institute	48 000
Hybrid beans	
Sydney University	11 000
Field testing	
Tasmania	26 000
Low rainfall areas	31 000
Total	316 000

[a] Includes $21 000 capital item

The aims of the breeding program are:

- to ensure high returns by keeping production costs down and yields high — increasingly there is a need for varieties adapted to local environments;
- to avoid yield losses from disease and quality losses from lesions on the grain; and
- to respond to any market information on the need for small, medium or large beans and for beans for niche markets.

The breeding and pathology programs in Victoria and South Australia (S.A.) are closely integrated. In terms of fungal diseases, in the South Australian component, this involves the pathologist Mark Ramsay in testing for ascochyta, chocolate spot and rust in the glasshouse. He also evaluates the accessions from the breeding program grown in many field trials, as does the pathologist Trevor Bretag in Victoria.

The material being tested includes all the genetic resources (over 1000 accessions) held in the collection, introductions made from ICARDA and segregating populations arising from crosses made to combine resistances.

The accessions being tested are grown in yield trials in various parts of South Australia and Victoria where it is known regular natural infections of disease will occur (ascochyta at Clare, S.A. and chocolate spot at Hamilton, Vic.).

Maria Scurrah (GRDC-funded) is evaluating resistance to stem nematodes in oats, peas, narbon beans and faba beans. The emphasis on each crop has varied over time. She has found ICARDA rankings of faba bean resistance do not agree with hers and has concluded different races of nematode are involved.

PhD students in S.A. are investigating the relationship between water use, flowering date, seed size and yield. Other research programs are concerned with seed colour, hardseededness and cooking quality and how each changes with ageing of beans. The programs are studying these effects in a range of genotypes. The research is funded largely by AIDAB postgraduate fellowships and the Universities Honours Program. Another PhD in engineering, funded privately by the Pea and Grain Exporters of S.A., is investigating the factors involved in splitting faba beans.

In the research on faba beans for low rainfalls areas, Glen McDonald is evaluating accessions from the genetic resources collection in those

environments. In particular, the effects on yield of seeding date, seed size, flowering date and disease are being assessed. The work is currently sited in S.A..

Research on faba beans under irrigation is being conducted near Kerang in Victoria by Nick Drew of the Department of Agriculture. Material introduced from countries in which irrigated faba beans are grown (Egypt, Sudan, Iraq and Iran) was multiplied in isolation plots last year for testing in trials this year. This material is adapted to high temperatures but its resistance to ascochyta may be questionable.

Collaboration with Other Regions

As we develop a picture of the factors that influence faba bean yields in different regions of Australia we will be able to focus more precisely on the material to be tested. It appears, for example, that the major diseases may occur in most areas but their relative significance is very different. The need and emphasis for disease resistance in varieties will be modified accordingly.

Adaptations to high temperature during flowering are also becoming evident from the regional collaboration.

International Perspective

The Australian Temperate Field Crops Collection

A. McIntyre
Australian Temperate Field Crops Collection, Horsham, Victoria

The Australian Temperate Field Crops Collection (ATFCC) is the national centre with a mandate to provide genetic resource services for temperate grain legumes and oilseeds. It is located in Horsham and is hosted by the Department of Agriculture at the Victorian Institute for Dryland Agriculture (VIDA).

The building was completed in 1988 using Commonwealth and Oilseed Research Council funds. The operations of the collection are jointly funded by the Department of Agriculture and the GRDC.

The ATFCC has accumulated 16 000 accessions, mostly from Australian plant breeders' collections. More recently large segments of overseas collections have been obtained.

Faba Bean Germplasm Collection

ATFCC holds 1229 faba bean accessions. The initial faba bean accessions came from the Victorian and South Australian projects, and in December 1993 a collection of 500 accessions was received from ICARDA, Syria. Some details of the collection are provided in Table 1.

The material from ICARDA was selected by Larry Robertson to give a representative sample of the diversity held by ICARDA. Efforts were made to avoid resupplying accessions which had previously been sent to Ron Knight.

ICARDA and Other International Links

In the early stages of establishing the collection, our links with overseas bodies have mainly been through our acquisition of germplasm. ATFCC has been coordinating the distribution of international nurseries from ICARDA and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) for several years. Recently ATFCC was able to provide ICARDA with kabuli chickpea germplasm, a pleasing reversal of our relationship.

In future the ATFCC will take on a greater role in characterisation and documentation of collections. These activities will enable us to expand our role, and will assist us to establish further links with other centres, and join in collaborative projects. The ATFCC may be an appropriate launching place for collaborative crop development projects in overseas countries by using our germplasm and information base.

There are several overseas genetic resource centres catalogued as holding faba beans. They include: the Netherlands (GCN), Spain (INIA), Italy (CNR), USA (Pullman) and Germany (ZIGÜK). The prospects for obtaining faba germplasm from these centres would be good. From past experience with China, it is difficult to obtain germplasm without an 'on-site' contact. Written requests to the China's National Genetic Resource Centre and university staff have been unsuccessful. Joint projects with Chinese institutions may be the only way to gain access to germplasm.

Quarantine

At ATFCC we are holding 518 accessions awaiting post-entry quarantine. Most of this material is from the ICARDA collection. The processing of new accessions through quarantine has improved with the availability of the new quarantine glasshouse provided by GRDC.

Australia's quarantine regulations impede the rapid introduction and evaluation of new faba bean germplasm. Since these regulations are essential, we must develop the technology to minimise their impact. Current requirements dictate that faba bean seed be grown to maturity in a quarantine glasshouse and that sap-transmission virus indexing be done using at least three indicator species.

Table 1. Origins of faba bean accessions held at the Australian Temperate Field Crops Collection.

Country	Number of accessions
Afghanistan	52
Algeria	20
Australia	8
Canada	9
China	8
Colombia	12
Cyprus	2
Czechoslovakia	30
Denmark	2
Ecuador	1
Egypt	58
Ethiopia	92
Finland	3
France	19
Germany	9
Greece	50
Hungary	19
India	15
Iran	15
Iraq	45
Italy	19
Japan	13
Jordan	18
Latvia	1
Lebanon	28
Morocco	28
Nepal	1
The Netherlands	15
Norway	2
Pakistan	10
Poland	4
Portugal	8
Romania	1
Spain	69
South Africa	2
Sri Lanka	4
Sudan	29
Sweden	3
Syria	65
Tunisia	31
Turkey	119
Ukrainian SSR	2
United Kingdom	71
Unknown	151
Uruguay	2
Israel/Palestine	7
USA	10
USSR	23
Yemen	7
Yemen, Democratic	2
Yugoslavia	15

A GRDC-funded project under the ATFCC umbrella intends to try new methods for screening viruses (e.g. PCR, ELISA) which may prove suitable for quarantine testing. These methods have the potential to speed the release of imported material, and will thus have lower resource overheads than present methods.

Regeneration

The present method for bulking up faba bean accessions is to grow seed in pots in either the glasshouse or shadehouse, and bag plants at flowering to prevent out-crossing. This process could be improved by the acquisition of screen mesh tents suitable for field use. Each method is very labour-intensive and thus restricts the number of accessions processed in a cycle.

Germplasm Donations

If you hold germplasm which has not already been accessed into a collection—please submit a sample. It is vital that we do not duplicate the effort of importing and quarantining material already in Australia.

Conservation of Faba Bean Germplasm at ICARDA[1]

J. Valkoun
International Center for Agricultural Research in the Dry Areas (ICARDA),
Aleppo, Syria

ICARDA maintains two germplasm collections of faba bean: (1) the ILB (International Legume Faba Bean) which is the original populations, usually heterogeneous and heterozygous, and (2) the BPL (Faba Bean Pure Line) collection which is derived by a process of cyclic single-plant progenies under mesh-covered screenhouses for five cycles of selection, which is expected to produce pure lines, homogeneous and near homozygous. An ILB accession is usually represented by 1–5 BPL derivatives. When the ICARDA breeding program was transferred to Morocco in August 1989, the development of BPL accessions was suspended. In line with the decision of the Technical Advisory Committee of the Consultative Group on International Agricultural Research (CGIAR), ICARDA has stopped all activities on faba bean germplasm enhancement. There are currently no activities devoted to faba bean improvement nor are any planned. An evaluation of the devolution of the faba bean development program to Morocco is approved in Appendix 1.

The current status of the faba bean germplasm collections is: (1) the ILB collection with 4419 accessions, including 2290 from West Asia and North Africa (WANA) and 159 from China; and (2) the BPL collection with 5238 accessions, including 2176 from WANA and 342 from China.

Current activities at ICARDA'S Genetic Resources Unit are concerned with rejuvenation of the entire ILB collection to produce the active, base and safety duplicate collections. Most ILB accessions have low seed supply and distribution is restricted. The BPL collection has been transferred to the medium-term cold store with a temperature of 5°C. The entire BPL collection has to be rejuvenated and multiplied. Distribution of BPL accessions is restricted to 10 seeds per accession. At the time of rejuvenation, the collection is further purified. If an accession is multiplied with fewer than five cycles of progenies, this is being multiplied from the last single plant taken. However, there are no resources available to continue the process of developing BPL accessions. At present, most BPL rejuvenation is of accessions requested by outside institutions.

Most resources devoted for faba bean germplasm activities, at present, are being used for multiplication of the disease and *Orobanche* resistance sources and the final products of the ICARDA breeding program before it was transferred to Morocco in 1992. These include determinates, IVS lines (reduced flower and pod drop), closed flower lines (self-pollinated), autofertile lines (without the requirement for insect pollinators for high seed set), as well as large- and small-seeded high-yielding lines. This allocation is justified, since more than 95% of the requests received for faba bean germplasm are for this type of material.

Future Faba Bean Research Activities at ICARDA

Germplasm rejuvenation and multiplication

ILB and BPL collections—Rejuvenation of the ILB and BPL collections with development of the active, base and safety duplications has to take the first priority in future research activities. The entire BPL collection is especially in need of rejuvenation, with care taken for maintaining purity. There is need for purification in both the ILB and BPL collections. Multiplication and rejuvenation of the faba bean collections are done in mesh-covered screenhouses to eliminate cross-pollination. Because of the low multiplication rate of faba bean, this will be a time-consuming process.

Genetic stocks—Multiplication of the ILB accessions with special characteristics (genetic stocks) including disease resistance, *Orobanche* resistance, closed flower, IVS, and determinate lines is of high priority. This type of material requires continued selection to maintain the

[1] This paper was not presented at the workshop, but was transmitted to the workshop organisers who included it for information.

desired traits. There is a particular need for keeping the purity of the disease resistance sources. Preferably, work could be done in conjunction with a plant pathologist to re-select the disease resistance sources for purity of disease resistance. Also, the final products of the ICARDA breeding program for determinate and large- and small-seeded lines need to be multiplied, along with selections that have advanced to cultivar release in national programs, to provide for requests for high-yielding, adapted germplasm.

Because of multiplication in screenhouses, the seed supply of BPL accessions is limited and additional multiplication of accessions with highly requested specific traits (high autofertility, high number of seeds per pod, large 100-seed weight, short stature, and high-yielding inbred lines) is needed.

Germplasm acquisition

Collection missions There is still scope for collection of landraces of faba bean. Recently, unique accessions of black-seeded faba bean were collected in Baluchistan, Pakistan. South American countries are not properly represented in germplasm collections of faba bean. Additionally, traditional landraces of faba bean from isolated counties of China from both autumn- and spring-sown areas should be collected. Multilateral missions would be most efficient in terms of insuring addition of this germplasm in internationally available collections.

Acquisition of improved germplasm ICARDA will add newly released varieties of faba bean from North Africa, Egypt, Sudan, Ethiopia and China to its germplasm collection. New sources of resistance to diseases, *Orobanche* and insect pests will also be added to the collection. ICARDA is in an ideal situation to ensure the widest possible distribution of improved germplasm.

Germplasm evaluation

The need for evaluation of the germplasm collection of faba bean remains. Most requests are for germplasm with a particular trait. This evaluation will be concentrated on the BPL collection using a minimal set of the IBPGR/ICARDA descriptor list. Germplasm catalogues will be produced, both in hard copy and disk form, to facilitate the use of this data by national programs.

Networking of germplasm enhancement

Through its regional project in the Nile Valley (Sudan, Egypt and Ethiopia) and in North Africa (Algeria, Morocco, Libya and Tunisia) ICARDA will continue providing technical back-stopping for faba bean germplasm enhancement work being conducted by the network scientists of these national programs. ICARDA's germplasm collection remains the major source of variability for these national programs for important biotic stress resistances and for material for improvement of the traditional faba bean plant type.

Activities for Support by GRDC

1. The pace of the rejuvenation of both the germplasm collections of faba bean could be increased. At present the resources available do not allow this to proceed at an acceptable rate. Work could be initiated to purify the sources of resistance to biotic stresses. Restrictions on distribution of germplasm are already in place because of lack of seed. Also, the speed of development of the base collection and safety duplication is unacceptably slow.
2. The germplasm screening for biotic and abiotic stress resistances/tolerances could be restarted. There are many new accessions in the collections that have not been screened for these stresses. There is a need to broaden the genetic base for most of the resistances to biotic stresses. There is scope for improving the autofertility of faba bean by screening the pure line collection. These are in-depth evaluations that cannot be supported by core funds.
3. If funds were available, further collections in both China and South America could yield very useful germplasm not available in present collections. These are areas which are the most removed from the areas where faba bean is thought to have originated (between Afghanistan and the eastern Mediterranean) and could provide useful variation from different natural selection pressures.
4. The program for development of the BPL (pure line) collection could be restarted. This collection has proven valuable in screening for many biotic stresses since selfing allows the expression of recessive alleles. The important trait of autofertility can only be evaluated with pure lines.
5. Chinese/Australian scientists could work at ICARDA in evaluation of Chinese lines, crossing them with promising sources and developing material ('pre-breeding') for evaluation in different locations in Australia and China.

Appendix 1

An assessment of the devolution of the faba bean research program from ICARDA to Morocco, undertaken by the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR)[2]

TAC decided in 1986 that ICARDA should discontinue working on faba bean. The recommendation was endorsed by the Second EPR, which stated '... the Panel urges ICARDA to identify another international organisation or donor agency which would be prepared to take over the program in its entirety and continue it from a country in the region' (p. 56). ICARDA pointed out that in the 1990–94 MTP that the option of finding such a centre was not realistic and requested help from TAC. With no guidance, ICARDA took the initiative to transfer its faba bean work to a national program. ICARDA decided not to transfer the work to the strong Faba Bean Program in Egypt, but rather to where faba bean was grown under rainfed conditions. However, in Morocco the Legume Program was weak. At the time ICARDA believed a number of donors were likely to support the project (1990–94 MTP, p. 129–30). ICARDA requested and was approved funding until mid-1991, giving it three years to transfer the Program and terminate its faba bean research.

The Panel believes the process of phasing-out faba bean research was not a case of successful devolution. It might have been if: (a) the concerned NARS was capable of managing and enhancing faba bean germplasm, and assuming regional responsibilities; (b) the site chosen had the infrastructure to enable safe management of germplasm, in a region known for its variable rainfall distribution; and (c) if regional collaboration was assured.

ICARDA's management expected to build up the weak legume team of the Institut National de la Recherche Agronomique (INRA) in Morocco in three years. In 1989 it transferred two faba bean scientists and equipment to Douyet station to initiate a breeding and pathology program and to train Moroccan scientists assigned to the commodity. There were no national scientists based at Douyet station. By 1990, a local masters-level breeder and agronomist arrived; an 'identified' pathologist never did. Over this period, the INRA scientists received intensive training from ICARDA staff. By the end of 1991, both ICARDA faba bean staff had left, but ICARDA retained a legume scientist at Douyet who was knowledgeable about the Program. By August 1992, after supporting the Faba Bean Program a year longer than planned, ICARDA terminated the funds for faba bean research. At this time external funding was promised, but not yet received. Meanwhile, few national funds were supporting the INRA faba bean research, and the national faba bean team was small and inexperienced. The Panel finds that INRA did not allocate enough resources to Douyet to facilitate a successful transfer of the Program from ICARDA.

Although Douyet station is well placed in the faba bean growing region, it is isolated from the main research stations in Morocco. For this reason, INRA found it difficult to attract staff. The station lacks infrastructure to adequately maintain a faba bean collection and segregating populations, and to manage materials in times of drought. There are no irrigation facilities. In the past year apparently 25–40% of segregating populations were lost. The collection and most germplasm were reinstated through intervention by the ICARDA team. This year there was another drought. In order to maintain germplasm for the region, irrigation back-up facilities should have been regarded as an essential criterion for site selection.

The GTZ regional coordinator arrived in Morocco in September 1992. Although it is still early, there are indications that the passing of regional coordination from ICARDA to GTZ will not progress easily. Communications on-station are poor. Little experience is available at the coordination level in regional networking, or in working with faba bean, which is a difficult crop. The reaffirmation, acquaintance and follow-up process with national programs has been slow, and regional collaboration uncertain. Tunisia so far has refused to sign an agreement because of budget disputes.

A successful devolution would have required a substantially longer ICARDA presence, which the Center did not feel it could provide (given the directives from TAC and the 1988 EPR) and a greater commitment of human and infrastructural resources by the Moroccan NARS.

[2] From: Report of the Third External Review of ICARDA, CGIAR Secretariat, World Bank, May 1993.

ACIAR Technical Reports

No. 1 ACIAR Grain Storage Research Program: research report 1983–84, 63p., 1985.

No. 2 Pastures in Vanuatu, D. Macfarlane and M. Shelton, 32p., 1986.

No. 3 ACIAR Grain Storage Research Program: research report 1984-85, 85p., 1986.

No. 4 Coconut germplasm in the South Pacific Islands, M.A. Foale, 23p., 1987.

No. 5 South Pacific agriculture: challenges and opportunities for ACIAR and its research partners, G.J. Persley and P. Ferrar, 87p., 1987.

No. 6 ACIAR Grain Storage Research Program: research report 1985-86, 96p., 1987.

No. 7 Building on success: agricultural research, technology, and policy for development: report of a symposium held at Canberra, 14 May 1987, J.G. Ryan, 39p., 1987.

No. 8 New technologies for rainfed rice-based farming systems in the Philippines and Sri Lanka: report of a workshop held at Iloilo, Philippines, 20–24 July 1987, 39P., 1988.

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