Faba beans

This case study is the primary source of information on potential pollination services for the industry. It is based on data provided by industry, the ABS and other relevant sources. Therefore, information in this case study on potential hive requirements may differ to the tables in the Pollination Aware report (RIRDC Pub. No. 10/081) which are based on ABS (2008) *Agricultural Commodities Small Area Data, Australia 2005-06*.

Introduction

Faba bean (*Vicia faba*) is a winter-growing pulse, or food legume crop. It originated in the Middle East in the pre-historic period, and has extended its cultivation throughout Europe, North Africa, and Central Asia. The faba bean spread to China over 2,000 years ago via traders along the Silk Road, to South America in the Columbian period, and more recently to Canada and Australia (Stoddard 1991).

Faba beans have been used extensively in Australia for livestock nutrition but an emerging export market may in the future be more important (Somerville 2002). Faba beans have significant rotational benefits in predominantly cereal-based farming systems, and also in cotton rotations, by assisting in control of cereal diseases (especially root disease), nematodes, and weed control through use of a different spectrum of herbicides and through the fixation of nitrogen. They fix more than 80% of their own nitrogen needs under a wide range of conditions (Somerville 2002). In addition, faba beans are a relatively high-value product and are exported to major food markets in the Middle East with Australia being a major exporter.

Pollination has consistently been identified as a major limiting factor to higher, more reliable seed yields and improved seed quality in faba beans Numerous studies have shown the value of honey bees as pollinators of faba beans in Australia and overseas (Stoddard 1991; Somerville 2002).

Faba bean production in Australia

Faba beans were first grown commercially for grain in South Australia in the early 1980s and are now also cultivated in Victoria, New South Wales and Western Australia, and to a smaller extent in Tasmania and southern Queensland. Faba beans are a winter legume crop and are gaining increasing levels of interest from farmers as a rotation crop for cereals (Somerville 2002) due to their ability to control root rot and more suitable nature as an export commodity. Sowing usually takes place in May, although this can extend into June if conditions are favourable (Somerville 2002).

China is the world's largest faba bean producer, with Australia ranking about fourth. The total area of production across Australia has increased steadily since the start of the 1990s and is currently at 113,000 hectares (ABARE 2009). Yield and production of faba beans in Australia, like most other broadacre crops, are dependent on seasonal conditions, and thus vary significantly from year to year. An example of this can be seen from 2007/08 production figures where Australia averaged 1.04t/ha as compared to 2008/09 when it was estimated only 0.79t/ha were produced (see also Tables 1 and 2).

Prices of $200–$350 per tonne for food grade faba beans have been received in recent years. A significant proportion of Australia's faba bean crop is used for animal feed and demand from this quarter is likely to continue to grow (Somerville 2002).

Table 1	Production of faba beans by state (ABARE 2009)						
Faba beans (production kt)	**NSW**	**VIC**	**QLD**	**WA**	**SA**	**TAS**	**Total**
2009/10 latest ABARE forecast	53	30	2	5	98	0	**188**
Five-year average to 2007/08	45	46	0	6	107	0	**204**

Table 2	Area planted to faba beans nationally (ABARE 2009)						
Faba beans (area '000 ha)	**NSW**	**VIC**	**QLD**	**WA**	**SA**	**TAS**	**Total**
2009/10 latest ABARE forecast	45	22	2	4	57	0	**130**
Five-year average to 2007/08	27	48	0	5	84	0	**164**

Pollination in faba bean

There is a significant body of research to indicate that honey bees (*Apis mellifera* L.) play an important role in the pollination of faba beans. Honey bee activity has been recognised as contributing to pollination in faba bean crops in Australia (Somerville 1999), although the introduction of managed honey bees into a flowering crop of faba beans has usually been thought unnecessary in Australia due to sufficient feral honey bee activity (Somerville 1999; Stoddard 1991). Somerville (1999) found that honey bee pollination significantly improved the number of pods and yield of seeds of faba beans (Table 3).

Further research by Stoddard (1991) found that honey bees were an essential step in gaining optimal yields in faba bean crops in Australia. Stoddard (1991) suggested that growers in southern Australia have a unique situation in that the prevalence of feral bee populations means that growers should seldom have to consider importation of hives to supplement pollination by feral bees. This situation may be a luxury of the past, considering the prevalence of several pest and diseases likely to affect feral honey bee populations as well as managed honey bees into the future. The introduction of varroa poses considerable threat to the income of those farmers/horticulturalists relying on feral honey bee populations for pollination services.

Table 3	Yields of faba beans in various caged and open treatments (Somerville 1999)			
	Uncaged plots open to bees	**Plots caged with bees**	**Plots caged without bees**	**Plots shaded but open to bees**
Mean	1.86	1.51	1.22	1.73
± s.e.	± 0.064	± 0.064	±0.064	± 0.110

Pollination management for faba beans in Australia

There are a number of factors within the field which have a direct bearing on the pollination efficiency of honey bees:

Crop layout

- *Crop layout and blossom density*: Stoddard (1991) suggested that optimum sowing density, for an early planting which will flower in July, is about 20 per m^2 which will give about 60 stems per m^2. Thus about 80 flowers per m^2 open each day, and each flower remains viable for six days if not pollinated, resulting in up to 480 open flowers per $metre^2$. Maximum pollen collection occurs between 1300 and 1600 hours, so each flower has up to 18 hours during which it may be pollinated.
- *Access*: From a beekeeper's point of view, all-weather truck access is highly desirable. Limited access may lead to an increased workload for the beekeeper, uneven placement of hives and thus inefficient pollination.

Density of bees

A stocking rate of two hives/ha has been stated as adequate for pollinating faba beans (Somerville 2002). What is important is the number of honey bees and other insects actually working the flowers. The more pollen gatherers there are, the greater the chance of achieving maximum pollination.

On the other hand, only 40–50% of the flowers need to be pollinated to provide an excess of pods for the plant (Stoddard 1991). A preliminary estimate that may be verified by further experimentation is one colony (feral or hive) per 10 ha of beans (Stoddard 1991).

Arrangement of hives

Most seed is set within a 100m radius of a colony. Hives should be placed in minimum lots of 20 to 30. If the area is small, then one or two placements may be necessary. If bees have to fly further than 500m groups of hives should be split up and placed in appropriately spaced intervals.

Timing

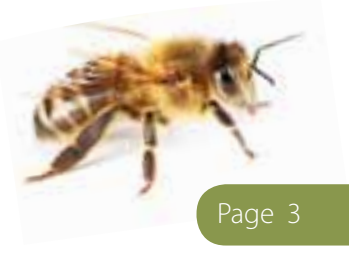
In general, hives should be introduced when approximately 5% of the crop has begun to blossom. This will encourage bees to commence working right away and once foraging begins, bees will show a marked fidelity to the chosen species and may stay on the blossom for a long time. Flowering extends for 5–6 weeks, depending on moisture and air temperature, occurring from late July to mid October. Depending on the time of sowing, moisture, climatic factors and geographic location an ideal pollination unit is approximately six frames of brood; however, with an expanding brood nest, the bees have greater need for pollen to feed their larvae. Therefore, they show far more enthusiasm in flying even during less than ideal conditions.

Bee husbandry in the paddock

Moving hives into a crop during the night is less stressful on the bees, because they are not flying and the representatives are generally cooler. Due to the shape of their flower, faba beans are a poor source of nectar for honey bees. The nectar is at the base of the flower and well beyond the reach of the honey bee (Stoddard 1991). Thus only some hives are suitable for pollinating faba beans, and they need to be managed by the provision of sugar syrup, so the bees collect pollen rather than seeking nectar (Stoddard 1991). Accordingly, it is necessary to have honey already stored in a hive before moving the bees into faba beans or else sugar syrup should be supplied as an artificial nectar source while the bees are on the crop (Somerville 2002; Stoddard 1991).

Attractiveness, nutritional value of pollen and nectar

Faba beans provide very little nectar, if any to honey bees (Somerville 2002). It is desirable, therefore to provide or ensure there is stored honey in the hive before the bees go onto the crop; or alternatively, provide the bees with sugar syrup.



Availability of honey bees for pollination

Other floral sources may be more desirable for beekeepers in that they provide superior sources of nectar and pollen for the production of honey (Somerville 2002).

Feral bees

Relying on feral populations of bees to do the pollination is a lottery, with success depending on crop size, population levels and the health of the feral colonies closest to those areas to be sown to faba beans (Somerville 2002).

Introduction of managed honey bee colonies is highly recommended where a faba bean crop is greater than 500m distant from stands of mature timber likely to harbour feral colonies, or where the crop is of a large enough size that the numbers of resident feral colonies would be inadequate to satisfactorily pollinate the crop. If the feral bee population is small or located some distance from the faba bean crop, then the amount of foraging will be reduced, particularly during cold or rainy weather. In addition, the general health and numbers of feral bee colonies can vary from one region to another and from one year to the next, generally depending on the floral resources available and the incidence of bee diseases.

Risks

Pesticides: Placing hives well back from the crop also may help the grower. If a crop needs spraying with pesticide, the location of the hives is crucial. The further the beehives are placed away from the crop the better. If spraying is necessary, then this should be conducted in late afternoon or evening when foraging bees have ceased their foraging activities. One of the biggest dangers of placing bees near any agricultural crop is the possibility of colonies or field bees being sprayed by pesticides.

It is strongly recommended that growers take the following steps to prevent or reduce bee losses:

- follow the warnings on pesticide container labels
- select the least harmful insecticide for bees and spray late in the afternoon or at night
- do not spray in conditions where spray might drift onto adjacent fields supporting foraging bees
- dispose of waste chemical or used containers correctly
- always warn nearby beekeepers of your intention to spray in time for steps to be taken to protect the bees; give at least two days' notice
- always advise nearby farmers.

Weather

Temperature and rainfall have a marked effect on honey bee activity. Bee activity is very limited below temperatures of 13°C with activity increasing up to around 19°C, above which activity tends to remain at a relatively high level. Decreases in both numbers of bees visiting blossoms and the distance from the hive at which bees forage occur with a decrease in temperature. Under rainy conditions bees fly between showers but only usually for very short distances. Wind, particularly strong wind, tends to reduce the ground speed of bees and hence reduces the number of flights per day.

Colony strength will also have a direct bearing on the temperature at which honey bees will leave the hive. Only strong colonies will fly at lower temperatures. Bees need to keep their brood nests within their hives at a constant temperature of 37°C. The cooler the external temperature, the more the bees are required within the hive to maintain that temperature. Hence if the colony is strong in numbers the surplus bees not required for maintaining hive temperature are available for foraging duties.

Environmental factors have a direct bearing on the amount of nectar secreted. It has also been found that nectar is the most concentrated in old flowers about to wither, but nectar concentration fluctuates widely in accordance with the relative humidity throughout the day. The number of honey bees that visit the blossom has been directly correlated with the amount and concentration of nectar produced.

Alternatives/opportunities for improvement

International research has included a range of bee species although honey bees are the only species that have been implicated in pollinating faba beans in Australia (Somerville 1999)

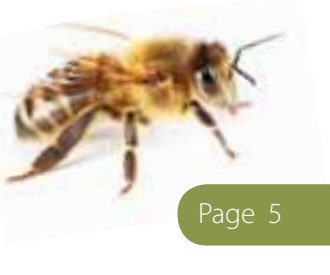
Potential pollination service requirement for faba beans in Australia

Optimal use of managed pollination services in all faba bean crops in Australia would require a service capacity as indicated in Table 4 below.

Table 4 Potential pollination service requirement for faba beans in Australia

State	Month (flowering)	Area (ha)*	Average hive density (h/ha)**	Estimated number of hives required
NSW	September	45,000	2	90,000
VIC	September	22,000	2	44,000
QLD	August	2,000	2	4,000
WA	September	4,000	2	8,000
SA	September	57,000	2	114,000
TAS	October	0	2	0
Total		**130,000**	-	**260,000**

Notes: *Area sourced from ABARE (2009), flowering times and average **hive density from Somerville. (2002).



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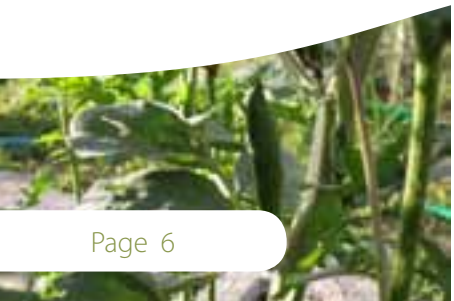
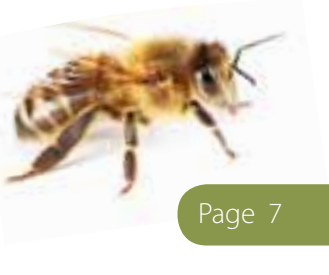
This case study was prepared as part of *Pollination Aware – The Real Value of Pollination in Australia*, by RC Keogh, APW Robinson and IJ Mullins, which consolidates the available information on pollination in Australia at a number of different levels: commodity/industry; regional/state; and national. Pollination Aware and the accompanying case studies provide a base for more detailed decision making on the management of pollination across a broad range of commodities.

The full report and 35 individual case studies are available at www.rirdc.gov.au.



Faba beans

Notes



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This project is part of the Pollination Program – a jointly funded partnership with the Rural Industries Research and Development Corporation (RIRDC), Horticulture Australia Limited (HAL) and the Australian Government Department of Agriculture, Fisheries and Forestry. The Pollination Program is managed by RIRDC and aims to secure the pollination of Australia's horticultural and agricultural crops into the future on a sustainable and profitable basis. Research and development in this program is conducted to raise awareness that will help protect pollination in Australia.

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