Lupins

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

Lupins are members of the genus *Lupinus* in the legume family Fabaceae, comprising of up to 600 species, with major centers of diversity in South America, western North America, the Mediterranean and Africa. During the twentieth century they were domesticated for modern agriculture and have become an important protein source in many parts of the world. Some species have been bred to enhance their ornamental beauty, whilst others have been a traditional food in areas such as Mediterranean and the Andean highlands for thousands of years.

Many species of lupin were introduced into Australia in the mid-nineteenth century by the well-known botanists Ferdinand Von Mueller (in Victoria) and Richard Schomburgk (in South Australia). Lupins are legumes, meaning they are able to fix their own nitrogen. This trait, in addition to a deep taproot system, mean that lupins are very tolerant on many infertile Australian soils and are common in pastoral areas of Australia. They are mainly grown for stock feed for the cattle, pig, poultry and aquaculture industries; however, there are some lupins grown for human consumption but this is relatively small compared to livestock feeding (ABARE 2007). This case study will focus on *Lupinus angustifolius*, a species of Mediterranean origin that is becoming increasingly important in Australian agriculture for its use as a fodder and green manure crop.

Langridge and Goodman (1977) studied the pollination requirements of *L. angustifolius* and found significant benefits in terms of seed yields from the use of honey bees (*Apis mellifera*) as pollinators of the crop. Best-practise farming methods for lupins including managed honey bee pollination services may show significant potential, although only a minority of growers have fully identified this in Australia and are profiting as a result.

Lupin production in Australia

Australia is the dominant world producer of lupins, accounting for around 85% of world lupin production over the past ten years. Other producers include Belarus, Chile, the European Union and the Russian Federation, where production is relatively small compared with Australia's (ABARE 2007).

The European Union, Japan and the Republic of Korea are the major destinations for Australia's lupin exports, accounting for an average 90% of total exports (ABARE 2007). Lupin exports from Australia averaged 41% of annual production over the five years to 2005/06. Over this period, exports averaged around 430,000 tonnes, with a value of nearly $100 million a year (ABARE 2007).

Most production occurs in the winter/spring rain-fed parts of south-west Western Australia followed by South Australia, southern New South Wales and Victoria. Production in Western Australia and South Australia is dominated by *L. angustifolius*,



while in New South Wales and Victoria there is a significant proportion of *L. albus* (white lupin) produced.

Lupins are a critical component of a uniquely Western Australian farming system, the wheat/lupin rotation, which is barely 40 years old. Yet in this time, Western Australia has become the world's leading producer, currently responsible for about 80% of world production, and the only significant exporter of lupin grain. In 2005, the state produced 920,000 tonnes of lupins on 650,000 hectares.

In 2007, Australia produced over 1.2 million tonnes of lupins, from just over 800, 00 hectares (Table 1). Production is centered around the West Australian wheat belt region (83%) with South Australia (9%) and NSW (5%) making up the majority of remaining production (Figure 1).

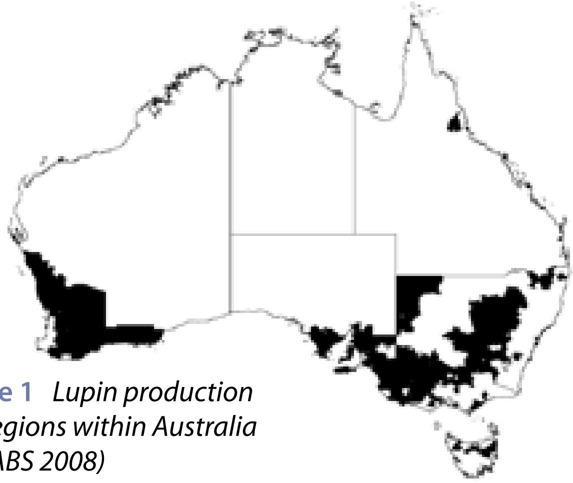


Figure 1 *Lupin production regions within Australia (ABS 2008)*

Table 1 Australian lupin production by state (ABS 2008)

	NSW	QLD	SA	TAS	VIC	WA	Total
Lupins for grain – area (ha)	36,613	99	72,376	356	27,088	672,342	**808,874**
Lupins for grain – production (t)	62,278	119	121,377	957	36,099	1,064,202	**1,285,032**

Pollination in lupins

Research suggests that honey bee pollination services have a significant role in the production of lupins in Australia (Langridge and Goodman 1985; Langridge and Goodman 1977).
Langridge and Goodman (1977), in a trial conducted in Victoria, concluded that mean yields of seed from *Lupinus angustifolius* were significantly greater from plots to which bees and larger insects had access, than from plots from which these insects were excluded, i.e. the number and weight of seed were increased as a result of honey bee pollination (Table 2). They found an 18.5% increase in yield by exposing flowers to foraging honey bees.
In the same trial they also found that lupin pollen was more attractive to bees than capeweed pollen.

Table 2 Study example (Langridge and Goodman 1985)

Attribute	Open	Enclosed	Significance
Plants per plot	159.2	161.1	No (P >0.05)
Mass of seed per plot (g)	675.7	513.7	Yes (P <0.01)
Mass of seed per plant (g)	4.2	3.2	Yes (P <0.01)
Germination (%)	95.2	92.9	No (P > 0.05)
Mass of 1,000 seeds (g)	30.2	28.0	Yes (P <0.01)

While lupins may be a significant seed crop and fodder for pastoralists, demand for hives may not exist as the economics for having bee hives in a crop simply don't add up. The broad-scale implementation of managed honey bee pollination services by lupin growers across Australia is lacking

for a number of reasons. The defining reason being that revenue gained from an increase in yield of 15–20% (seen in Langridge and Goodman 1977) using managed honey bee pollination services may not outweigh the cost associated with this service, thus the process is largely economically unviable. For example a production increase of 15% (approximately $36/ha increase in revenue) due to the introduction of hives into the crop would not justify the $225/ha cost of putting a hive into the crop ($50 a hive and 4.5hives/ha); the grower would be making a significant monetary loss.

Pollination management for lupins 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

- *Pasture layout and blossom density*: Lupins are a broadacre crop commonly planted in large open paddocks.
- *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

The stocking rate for honey production is approximately one hive per 4–12ha (Langridge and Goodman 1977). A stocking rate of 3–5 hives/ha is considered as adequate for lupin pollination, though the number of hives recommended for lupins has traditionally been 2–12 hives/ha (Langridge and Goodman 1977).

Arrangement of hives

Most seed is set within a 100m radius of a colony. Research has suggested colonies should be deposited in groups of 12-18 colonies per location with about 150m between locations (Somerville 2005).

Whatever the distribution pattern, hives should be placed in shady areas to avoid extreme temperatures. Honey bees collect significant amounts of water for use in the hive and as temperatures rise, the need for water increases, diverting many field bees into water gathering duties. Ensuring hives are located relatively close to water and in shady areas will significantly reduce stress levels of colonies, aiding in optimal pollination of the target crops (Somerville 2005).

Timing

Introducing honey bees into a lupin crop at or following 10–15% bloom will ensure fidelity to lupin flowers resulting in increased pollination efficiency (Somerville 2005). Lupins flower over a period of four to eight weeks in early spring.

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. Colonies used to pollinate lupins should be strong with a laying queen and eight or more frames covered with bees in a two-storey hive.

Attractiveness, nutritional value of pollen and nectar

Information of the value of lupins as a honey plant is limited. Landridge and Goodman (1977) claimed that lupins are good honey plants with 9–19kg of honey surpluses per colony on *L. angustafolius*. Somerville (2001) indicated no deficiencies whatsoever in the listed essential amino acids and the overall crude protein level is highly desirable being above 25%.

Langridge and Goodman (1985) suggested that honey bees collected appreciable quantities of pollen and nectar from the lupin flower, which enabled them to build up colony populations, store surplus honey and provide some surplus pollen to the beekeeper.

Feral bees

Orchardists relying on feral bees for part or all of their pollination services should be similarly aware first, that feral colonies are unlikely to be at full strength at the time that lupins flower and, second, that even if they were, foraging by these bees is unlikely to be sufficiently intense to achieve the level of pollination required for optimal production especially if there are alternative floral resources available to the bees in the same vicinity.

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.

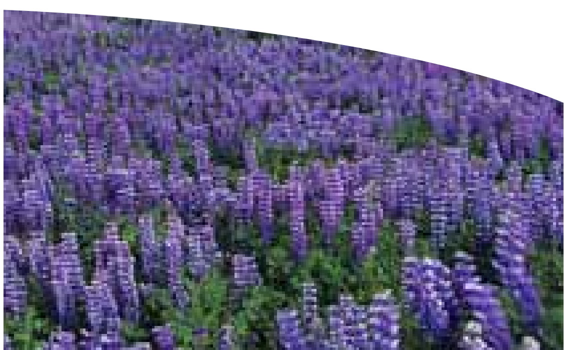
Weather

Temperature and rainfall have a marked effect on honey bee activity. Bee activity is very limited below temperatures of 13ºC, with activity increasing up to around 19ºC, 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 37ºC. 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.





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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.

Notes



Notes

Australian Government

Rural Industries Research and Development Corporation

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Know-how for Horticulture™

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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