



SOUTHERN

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GRAINS RESEARCH  
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CORPORATION

# LUPIN

## SECTION 12

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## LUPIN AS A FEED SOURCE

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OVERVIEW | GRAIN PROTEIN | FEED MIXES | GRAZING LUPIN CROP STUBBLES

## MORE INFORMATION

GRDC 'Grain Legume Handbook – Pulses as Stockfeed': <https://grdc.com.au/uploads/documents/10%20Pulses%20as%20Stockfeed.pdf>

DPIRD 'Lupinosis in Sheep': <https://www.agric.wa.gov.au/livestock-biosecurity/lupinosis-sheep>

# Lupin as a feed source

## 12.1 Overview

Lupin grain and stubbles can be valuable sources of livestock feed.

The lupin grain is high in crude protein (at 28-34 percent), digestible protein (at 13-15 percent) and metabolisable energy (ME), with low starch levels.

It is a particularly safe feed option for ruminants (cows and sheep), which makes it a desirable and cost-effective stock feed option compared to other pulses and cereals.

The bulk of narrow leafed lupin grain production in the southern region and in Western Australia is used by stockfeed manufacturers and on-farm for animal feed.

The biggest market is feed for ruminants, followed by the pig and poultry sectors.

There is a small, but increasing, use of lupin grain for feed in aquaculture industries and interest from the dairy sector (especially in WA).

There is also growing interest in the use of lupin grain for human consumption due to its potential nutritional and health benefits.

Lupin crop stubbles tend to retain high levels of fallen grain after harvest that can sustain livestock for several weeks or months, depending on location and season.

But a cautious approach to grazing lupin stubbles is advised due to the risk of lupinosis in livestock. This disease can damage an animal's liver, cause loss of appetite, poor production and, potentially, death.

FEEDBACK

## 12.2 Grain protein

Lupin is widely used as a source of protein and energy in livestock feeds. The grain and kernel composition changes between lupin types, as outlined in Table 1, and these qualities can assist growers when making feed decisions.<sup>1</sup>

**Table 1:** Whole versus dehulled attributes for the different lupin species.<sup>2</sup>

Chemical composition of whole lupin seed and kernels*								
Species	Narrow-leaved lupin		Albus lupin		Yellow lupin		Pearl lupin	
	% wholeseed	% kernel	% wholeseed	% kernel	% wholeseed	% kernel	% wholeseed	% kernel
Seed coat	24	0	18	0	27	0	16	0
Moisture	9	12	9	11	9	12	8	10
Protein	32	41	36	44	38	52	43	52
Fat	6	7	9	11	5	7	15	17
Ash	2	3	3	4	3	4	3	4
Lignin	1	1	1	1	1	1	1	1
Polysaccharides	22	29	17	21	8	11	9	10
Oligosaccharides	4	6	7	8	9	12	5	6
Minor components	0.5	1	0.6	1	0.9	1	1	1
Available energy contents# MJ/kg								
	MJ/kg	MJ/kg	MJ/kg	MJ/kg	MJ/kg	MJ/kg	MJ/kg	MJ/kg
ME cattle	12.0	15.0	11.9	14.0	-			
DE pigs	14.6	18.3	16.9	19.9	16.4			
AME poultry	10.7	13.4	13.2	15.5	11.4			
Protein and sulphur amino acids (g/kg)**								
Cysteine+Cystine	6.2	-	7.4	-	11.5	-	9.6	-
Methionine	2.0	-	2.4	-	2.7	-	2.8	-
Total S-aa's	8.4	-	9.8	-	14.2	-	12.4	-

#DE is digestible energy, ME is metabolisable energy.  
 \* Source: S. Sipsas, Department of Agriculture WA.  
 \*\* Source: S. Sipsas Perth GRDC Update paper Feb 2004 (by Barkolt and Jensen 1989 method).

1 Hawthorne, W (2006) Pulses nutritional value and their role in the feed industry, Pulse Australia, <http://www.feedgrainpartnership.com.au/items/927/Pulses%20Nutritional%20Value%20and%20Their%20Role%20in%20the%20Feed%20Industry.pdf>  
 2 Hawthorne, W (2006) Pulses nutritional value and their role in the feed industry, Pulse Australia, <http://www.feedgrainpartnership.com.au/items/927/Pulses%20Nutritional%20Value%20and%20Their%20Role%20in%20the%20Feed%20Industry.pdf>

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A high protein content makes lupin grain a valuable and economic feed for ruminant and monogastric (pigs and poultry) production systems.

The value of this protein is limited by relatively low levels of methionine and lysine in the grain, but this is not a major problem for cows and sheep that ferment it in the ruminant.

In pig and poultry diets, the shortfalls can be made-up from other proteins or synthetic amino acids.

Lupin grain feed supplements for livestock generally result in higher feed intake, liveweight gain and wool growth than comparable supplements using cereal grains.<sup>3</sup>

The demand for alternative protein resources to fishmeal in aquaculture diets has stimulated interest in the potential of lupins in this sector.

Some major international feed companies are now routinely using lupin kernel meal in aquaculture formulations.

Narrow leafed lupin is the most universally grown pulse in southern Australia and the most widely accepted as stock feed.

The price of these varieties typically also makes them the most economical of the stock feed options and ruminants do not need a period of introduction to the grain to avoid acidosis, due to the absence of starch.

Commercial pig producers have successfully used up to 30 percent whole narrow leafed lupin grain in diet formulations.

Poultry diets typically contain less than 10 percent lupin (commonly in kernel form) due to the problem of 'sticky' or 'wet' droppings.

Albus lupin has higher protein and crude fat content than narrow leafed lupin and is well suited to pig and poultry feed.

Digestability is similar, but more research is needed into depressed intake and reduced growth rates in pigs when lupin comprises more than 15 percent of the diet.

## 12.3 Feed mixes

Lupin has significant advantages in stock feed formulations compared to commonly-used soybean meal, including:

- » Concentrated source of both protein and energy
- » Lack of any major anti-nutritional factors (such as trypsin inhibitors)
- » No requirement for heat treatment
- » Ease of handling and storing due to a robust seed coat.

Lupin grain is readily accepted by most livestock and all types of lupin is mostly free of anti-nutritional factors, such as trypsin inhibitors, lectins and saponins.

In monogastric animals, the complex carbohydrate profile of the lupin grain is the main constraint to its use. This influences net energy yield and has been shown to affect the utilisation of other nutrients in the diet.

### 12.3.1 Ruminants (dairy, beef, sheep)

Ruminant animals can readily digest all components of narrow leafed lupin grain, as resident microbial populations provide the enzymes required to degrade the soluble and insoluble complex carbohydrates.

Content of lignin, the compound that can limit fibre digestion, is very low (at less than 1 percent) and the overall digestibility of lupin grain is about 90 percent.

<sup>3</sup> Hawthorne, W (2006) Pulses nutritional value and their role in the feed industry, Pulse Australia, <http://www.feedgrainpartnership.com.au/items/927/Pulses%20Nutritional%20Value%20and%20Their%20Role%20in%20the%20Feed%20Industry.pdf>

FEEDBACK

This high digestibility, combined with moderate oil content, results in an ME value of about 13 megajoules per kilogram, which is higher than in cereal grains.

A big advantage of lupin grain is that ruminants typically do not require an introduction period to avoid the potential problem of acidosis. This is due to its low starch level and relatively high digestible crude fibre content.

Lupin grains are also large, highly palatable and easily broadcast into thick cereal stubble.

In Australia, lupin grain and crop stubbles are mainly used for sheep grazing, effectively supplementing low roughage diets.

Sheep weight and growth responses vary, depending on the quality of the forage on offer.

The typical efficiency of utilisation of lupin grain in sheep feed in many parts of the southern region varies from a liveweight gain of 0.8 grams liveweight per gram of lupin dry matter for low quality roughages (where sheep are losing weight rapidly), to liveweight gains of 0.2-0.3 g liveweight/gram lupin dry matter where roughage quality is adequate to support maintenance or slow growth.

Lupin supplements typically result in higher feed intake, liveweight gain and wool growth in sheep than comparable supplements of cereals.

This is primarily due to the protein contribution of the grain to rumen microbial protein synthesis. Researchers indicate it could also be linked to rumen bypass protein effects, higher ME content and less disturbance to fibre digestion – which often accompanies the fermentation of cereal starch.<sup>4</sup>

Narrow leafed lupin is routinely used as a feed supplement for dairy production in Australia, Europe and Japan.

### 12.3.2 Monogastrics (pigs, poultry)

Variations in lupin grain protein content are an important consideration in feed formulations for monogastrics, as these animals can only tolerate and efficiently use a certain level in supplements.

Based on research and commercial experience, the maximum inclusion levels of narrow leafed lupin grain recommended for pig diets are:

- » Starter weaner (5-25 kilograms liveweight) 10-15 percent
- » Grower diet (25-60 kg liveweight) 20-25 percent
- » Finisher diet (60 kg to slaughter) 30-35 percent
- » Dry sow diet (gestation) 20 percent
- » Lactating sow diet 20 percent.

It is recommended the poultry feed formulation should not exceed more than 10 percent lupin grain.

This is because it can cause issues with wet or sticky droppings and there is no significant feed conversion above this level.

<sup>4</sup> GRDC (2008) Grain Legume Handbook – Pulses as Stockfeed, GRDC, <https://grdc.com.au/uploads/documents/10%20Pulses%20as%20Stockfeed.pdf>

## MORE INFORMATION

DPIRD 'Grazing Stubbles and Dry Pasture': <https://www.agric.wa.gov.au/autumn/grazing-stubbles-and-dry-pasture?page=0%2C2>

DPIRD 'Lupinosis in Sheep': <https://www.agric.wa.gov.au/livestock-biosecurity/lupinosis-sheep>

## 12.4 Grazing lupin crop stubbles

On average, between 50 and 400 kilograms of grain per hectare can remain on the ground after a lupin crop is harvested. Rates of 300-400 kg/ha are common in some areas.

This lupin grain in stubbles may be enough to sustain one to three months of livestock grazing unless lupinosis becomes an issue.

Typically in the southern region, weaner sheep show rapid weight gain and wool growth in the first few weeks after being introduced to grazing stubbles and then start to lose weight as the grain is used.

This grain intake and rapid growth generally occurs during early grazing, regardless of stocking rate.

However, heavy stocking rates tend to lead to grain being consumed and used faster, making the rapid livestock growth period shorter and leading to weaners potentially starting to lose weight.

Using lupin stubbles can help to achieve weight gains of up to 200 and 500 g/head in lambs and young cattle respectively.<sup>5</sup>

### 12.4.1 Lupinosis

Lupinosis is a liver disease of livestock, caused by animals eating lupin stalks affected by the fungus *Diaporthe toxica* (formerly known as *Phomopsis leptostromiformis*).

This fungus produces toxins, called phomopsins, in warm and moist conditions and the disease is common in summer and autumn – particularly after summer rains.

In relatively wet summers, the risk of lupinosis increases, as conditions favour fungal growth (even in resistant lupin varieties) that can often spread to seed and pods.

In these conditions, livestock are more likely to consume toxic fungus from lupin stems, pods or seed.

Symptoms of lupinosis in affected stock can appear as chronic liver dysfunction and can also predispose sheep to nutritional muscle disease (myopathy).

Early signs of lupinosis often develop as the fungus colonises the dead lupin stems.

It is advisable to monitor stubbles for amounts of grain remaining on the ground. If there is less than 50 and 100 kg of grain/ha for sheep and cattle respectively, the stock will tend to consume more potentially fungus-infected lupin stubble. Table 2 can be used to help calculate the level of grain in lupin stubbles to manage lupinosis risks.<sup>6</sup>

5 DPIRD (2016) Grazing stubbles and dry pasture, DAFWA, <https://www.agric.wa.gov.au/autumn/grazing-stubbles-and-dry-pasture?page=0%2C2>

6 Cowley, R, Casburn, G (2013) Reducing the Risk of Lupinosis and the Incidence of Phomopsis, NSW Department of Primary Industries, [http://www.dpi.nsw.gov.au/\\_data/assets/pdf\\_file/0010/478243/Reducing-the-risk-of-lupinosis-and-the-incidence-of-phomopsis.pdf](http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0010/478243/Reducing-the-risk-of-lupinosis-and-the-incidence-of-phomopsis.pdf)



**Table 2:** Method for calculating amount of grain remaining in a field following harvest.<sup>7</sup>

Steps	Process	Example
Step 1	<ul style="list-style-type: none"> <li>Measure width of header wind row in relation to width of header cut</li> <li>Calculate ratio of counts both within and outside the windrow</li> </ul>	<ul style="list-style-type: none"> <li>Cut is 10 m</li> <li>Windrow is 3 m</li> <li>Take one third of the counts within the windrow and two thirds outside the windrow</li> </ul>
Step 2	<ul style="list-style-type: none"> <li>Use 50 x 50 cm quadrant</li> <li>Collect all the grain Within the quadrant from random locations across paddock</li> <li>Ensure one third of samples are taken within the windrow and two thirds outside</li> <li>Weigh total grain collected</li> </ul>	<ul style="list-style-type: none"> <li>21 quadrant samples of grain were collected</li> <li>Total weight: 24 grams</li> </ul>
Step 3	<ul style="list-style-type: none"> <li>Calculate average weight of grain per quadrant</li> </ul>	<ul style="list-style-type: none"> <li>24 grams / 21 quadrants</li> <li>= 1.14 grams of grain per quadrant</li> </ul>
Step 4	<ul style="list-style-type: none"> <li>Calculate the amount of grain per hectare (A 50 x 50 cm quadrant = ¼ of a square meter)</li> </ul>	<ul style="list-style-type: none"> <li>1.14 grams X 4 = 4.56 grams per square meter</li> <li>There is 10,000 square meters in one hectare (ha)</li> <li>10,000 m x 4.56 grams= 45,600 grams per ha</li> <li>= 45.6 Kg of grain per ha</li> </ul>
Step 5	<ul style="list-style-type: none"> <li>Determine if grazing should cease</li> <li>Guideline: allow grazing if                             <ul style="list-style-type: none"> <li>– Sheep &gt;50 Kg grain / ha</li> <li>– Cattle &gt;100 Kg grain / ha</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>In this example there is insufficient grain: the benefit of grazing does not outweigh the risk of lupinosis or damage to ground cover</li> </ul>

<sup>7</sup> Cowley, R, Casburn, G (2013) Reducing the Risk of Lupinosis and the Incidence of Phomopsis, NSW Department of Primary Industries, [http://www.dpi.nsw.gov.au/\\_data/assets/pdf\\_file/0010/478243/Reducing-the-risk-of-lupinosis-and-the-incidence-of-phomopsis.pdf](http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0010/478243/Reducing-the-risk-of-lupinosis-and-the-incidence-of-phomopsis.pdf)

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All livestock, including sheep, cattle, goats, horses and pigs, are susceptible to lupinosis.

Sheep are most susceptible and weaners are most commonly affected because these animals tend to eat less lupin grain and more plant stem.

The liver damage that occurs from lupinosis increases the risks of pregnancy toxaemia in late pregnancy in ewes or cattle.

Stock affected by lupinosis may develop secondary photosensitisation.<sup>8</sup>

Grazing strategies to reduce risk of lupinosis in the southern region include:

- » Graze lupin stubbles soon after harvest (delays increase risk of fungus infection)
- » Graze sheep in mobs smaller than 600 head
- » Stock sheep at less than 10 animals/ha
- » Graze stubbles that do not have pycnidia (leopard spotting)
- » Graze paddocks sown with clean seed (with a minimum of a four-year gap between lupin crops)
- » Do not graze stubbles that contain discoloured seed.<sup>9,10</sup>

Acute signs of lupinosis in livestock include:

- » Marked appetite reduction
- » Jaundice (yellowing of the white of the eyes and other mucous membranes)
- » Lethargic animals – isolated animals in a paddock or tail of the mob
- » Dead and moribund animals
- » On post-mortem, jaundice is evident in the tissues and the liver is markedly swollen and yellow.<sup>11</sup>

Chronic signs of lupinosis in affected livestock include:

- » Loss of condition
- » Weak, lethargic animals
- » Animals that cannot keep up with the mob or are on their own
- » Sheep moving with a stiff-legged gait and hunched back
- » Sheep wandering in disorientated manner
- » Sheep caught in fences or pressing their head against objects.<sup>12</sup>

Signs that may be seen in both acute and chronic lupinosis in livestock include:

- » Abortions
- » Reduced lambing percentages
- » Lower wool production
- » Lower wool fibre diameter and low staple strength.<sup>13</sup>

Treatment options for lupinosis in livestock include:

- » Immediately removal of stock from affected lupin stubble
- » Place affected stock in a small paddock with shade and water
- » Provide a small amount of oats in the best-quality grassy paddock, or good-quality oaten hay
- » Avoid paddocks with green plants, as stock will be susceptible to photosensitisation

8 DPIRD (2016) Lupinosis in sheep, DAFWA, <https://www.agric.wa.gov.au/livestock-biosecurity/lupinosis-sheep>

9 Cowley, R, Casburn, G (2013) Reducing the Risk of Lupinosis and the Incidence of Phomopsis, NSW Department of Primary Industries, [http://www.dpi.nsw.gov.au/\\_data/assets/pdf\\_file/0010/478243/Reducing-the-risk-of-lupinosis-and-the-incidence-of-phomopsis.pdf](http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0010/478243/Reducing-the-risk-of-lupinosis-and-the-incidence-of-phomopsis.pdf)

10 DPIRD (2016) Lupinosis in sheep, DAFWA, <https://www.agric.wa.gov.au/livestock-biosecurity/lupinosis-sheep>

11 DPIRD (2016) Lupinosis in sheep, DAFWA, <https://www.agric.wa.gov.au/livestock-biosecurity/lupinosis-sheep>

12 DPIRD (2016) Lupinosis in sheep, DAFWA, <https://www.agric.wa.gov.au/livestock-biosecurity/lupinosis-sheep>

13 DPIRD (2016) Lupinosis in sheep, DAFWA, <https://www.agric.wa.gov.au/livestock-biosecurity/lupinosis-sheep>



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- » Do not feed lupin or feed blocks (the damaged liver is unable to effectively metabolise a high-protein diet)
- » Reduce all stress, restore appetite and avoid dehydration during the first couple of weeks of the convalescent period.<sup>14</sup>

If animals regain appetite this is a sign that they will typically fully recover within six months.

However, animals that are severely affected and do not start eating within a couple of days may be best treated with euthanasia.<sup>15</sup>

Newer narrow leafed lupin varieties have some resistance to the fungus causing lupinosis. Stubbles and grain from these varieties tend to develop low levels of toxicity.

Good paddock management can assist in ensuring stock are not grazing stems and are only seeking fallen grain.

Other tactics to prevent lupinosis occurring in livestock include:

- » Graze early
- » Provide water in varying locations to force stock to travel
- » Pre-feed stock seed to train foraging
- » Check stock conditions for signs of the condition
- » Remove stock once lupin seed count drops
- » Check lupin seed for fungus infection
- » If more than 10 percent of the lupin seed is discoloured (pale yellow to a darker purple brown) do not feed to stock.<sup>16</sup>

<sup>14</sup> DPIRD (2016) Lupinosis in sheep, DAFWA, <https://www.agric.wa.gov.au/livestock-biosecurity/lupinosis-sheep>

<sup>15</sup> DPIRD (2016) Lupinosis in sheep, DAFWA, <https://www.agric.wa.gov.au/livestock-biosecurity/lupinosis-sheep>

<sup>16</sup> DPIRD (2016) Lupinosis in sheep, DAFWA, <https://www.agric.wa.gov.au/livestock-biosecurity/lupinosis-sheep>