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LUPIN

SECTION 12

LUPIN AS A FEED SOURCE

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Lupin as a feed source

12.1 Overview

It is estimated about half of Western Australia's lupin grain production is retained on-farm for use as stock feed and planting seed.

Lupin growers also trade grain on the domestic and export markets to supply the stock feed manufacturing sector. The bulk of this is used for feed destined for ruminants (cows and sheep), followed by monogastrics (pigs and poultry).

There is growing interest in lupin grain for use by the WA dairy sector and a small, but increasing, use in aquaculture industries.

Lupin grain is a highly suitable feed for ruminants, as it is a relatively low-cost, high-protein and high-energy product with virtually no starch.

Composition of carbohydrates in lupin seed make it more suited to fermentative digestion in ruminants than to monogastric intestinal hydrolysis.

This means the energy value of lupin for ruminants is roughly equivalent to that of cereals, but for pigs, lupin grain is discounted by the proportion of energy recovered.

For poultry, the energy value of lupin is significantly compromised by the lack of any effective fermentative function within the avian stomach.

12.2 On-farm uses for lupin

12.2.1 Supplementary feeding

Lupin grain is a nutritional and economic source of on-farm supplementary livestock feed in WA's mixed farming systems.

It is high in crude protein (28–34 percent), digestible protein (13–15 percent) and metabolisable energy (ME), with low starch levels, and is a particularly safe feed option for ruminants.

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.

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 easy to broadcast into thick cereal stubbles.

The grain is an ideal option for finishing sheep for a particular market, such as live export or sale of prime lambs.

MORE INFORMATION

DPIRD 'Western Australian lupin industry': https://www.agric.wa.gov.au/grains-research-development/western-australian-lupin-industry

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

Lupins.org 'Resources – feed and food': http://www.lupins.org/feed/

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

MORE INFORMATION

DPIRD 'Supplementing feeding and feed budgeting of sheep': https://www.agric.wa.gov.au/autumn/supplementary-feeding-and-feed-budgeting-sheep?page=0%2C1#smartpaging_toc_p1_s2_h3

DPIRD 'Supplementary feeding calculator': https://www.agric.wa.gov.au/feeding-nutrition/supplementary-feeding-calculator-pregnant-and-lactating-ewes

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A high energy and medium protein ration, such as a lupin-cereal mix, is best when grain protein content is 12.5 percent or more for weaners/adults (weighing more than 20 kilograms) and 15 percent for weaners weighing less than 20 kg.[1]

The general rule-of-thumb for on-farm supplementary feed rations is three parts cereal to one part lupin grain.

Lupin can be included in drought rations of breeding sheep at levels of at least 10 percent of the ration (depending on the relative price of lupin and cereal grain).[2]

Lupin grain does not cause grain poisoning, which means it can also be conveniently used to condition stock to cereal-based rations by changing gradually from lupin to cereals.

12.2.2 Improving sheep reproduction

Research in WA has shown that feeding lupin grain as a paddock supplement to rams at a rate of 750 grams per head per day for eight weeks before joining can improve testicle size and condition and encourage maximum fertility.[3]

Feeding lupin grain to ewes as a paddock supplement at a rate of 400–500 g/head/day for one week before and after joining has been found in some trials to significantly increase lamb marking percentages (especially if ewes are less than condition score three).[4]

The nutrition of pregnant ewes influences lamb birth weight and survival and feeding levels should depend on: the condition of the ewes; stage of pregnancy; proportion of twins; and the amount and quality of dry paddock feed.

12.2.3 Sheep weaner performance

Feeding lupin grain to weaners can help maintain or increase weight without a significant setback following weaning.

Lupin and other grain supplements are used to achieve a target growth rate of about 50 g/head/day, and up to 150–250 g/head/day if destined for slaughter markets. Feed budgeting tools are available.

12.2.4 Milk and cattle production

Using lupin grain in feed rations has been shown to increase the milk production of beef and dairy cattle.

It can be more valuable to include in the diet than cereal grain because it tends to not lower the fat content of milk (as high levels of cereal grains may do).

As a result of improved nutrition (and increased milk production) from lupin grain supplementation, there can also be a marked boost in the growth of suckling calves.

Lupin grain is an efficient supplement for finishing cattle, which typically grow more quickly on these rations than those containing cereal grain concentrates. As with sheep, a good rule-of-thumb is to use a ration mix of three parts cereals to one part lupin.

Feeding lupin in a trough, or on the ground, at a rate of 3 kg/head/day will maintain cattle weight on dry summer pastures in WA.

1 DPIRD (2016) Supplementing feeding and feed budgeting of sheep, https://www.agric.wa.gov.au/autumn/supplementary-feeding-and-feed-budgeting-sheep?page=0%2C1#smartpaging_toc_p1_s2_h3

2 DPIRD (2016) Supplementing feeding and feed budgeting of sheep, https://www.agric.wa.gov.au/autumn/supplementary-feeding-and-feed-budgeting-sheep?page=0%2C1#smartpaging_toc_p1_s2_h3

3 DPIRD (2016), Feeding rates for rams pre-joining, https://www.agric.wa.gov.au/management-reproduction/joining-%E2%80%93-setting-potential-your-ewe-flock?page=0%2C1#smartpaging_toc_p1_s2_h3

4 DPIRD (2016), Flushing or feeding lupins prior to joining, https://www.agric.wa.gov.au/management-reproduction/joining-%E2%80%93-setting-potential-your-ewe-flock?page=0%2C2#smartpaging_toc_p2_s3_h3

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12.2.5 Pigs and poultry

Non-ruminant animals, such as pigs and poultry, lack the enzymes required to digest complex carbohydrates in the stomach and small intestine.

Unless there is fermentation in the lower tract (for example, in pigs), the digestibility of energy from lupin grain in these species is much lower than in ruminants.

Even where substantial fermentation in the lower tract does occur, the net energy yield from lupin is lower than for grains that are largely digested in the upper tract. There is evidence for pigs that this value may also be influenced by other components in the diet.

For pigs and poultry, it is advised that narrow leafed lupin grain is supplemented with free lysine and methionine – or combined with a protein source rich in these amino acids.

Commercial pig producers have successfully used up to 30 percent whole lupin grain in feed rations.

It is often not economical to de-hull lupin grain to enhance feeding value and this can lead to discounts of 1–1.5 MJ in formulations by stock feed manufacturers because so much of the carbohydrate is fermented in the hind gut and the energy is not fully available to animals.

Poultry rations typically contain less than 10 percent lupin grains and often this is in the form of kernels due to problems of sticky, or wet, droppings.

Albus lupin has a higher protein and crude fat content than narrow leafed lupin, with higher energy value and similar digestibility for this market.

12.3 Aquaculture uses

Demand for alternative protein sources to fishmeal in the aquaculture industry has stimulated interest in the potential of lupin grains in WA.

Major international feed companies are known to routinely use lupin kernel meal in aquaculture feed formulations.

Researchers have investigated the potential for lupin grain to be used as a plant-based feed source in aquaculture operations.

It found lupin was particularly useful for fish and fish diets because of the highly digestible level of protein, good levels of digestible energy and highly digestible phosphorus.[5]

Lupin grain also strengthened extruded pellets, leading to less dust and breakages.

The salmonid and prawn feed markets could potentially use value-added lupin products in this State.

Researchers have investigated the nutritional impact of removing the seed coat (de-hulling) of the lupin grain.

They used narrow leafed and albus varieties in whole-grain and kernel meal form to feed to silver perch (*Bidyanus didyanus*), an omnivorous species.

This research showed clear nutritional advantages from de-hulling lupin grains, irrespective of species used, in digestibility of dry matter, nitrogen (N) and energy.[6]

5 Brett D. Glencross, BSc(Hons) MSc PhD. DAFWA (2001), Feeding lupins to fish: A review of the nutritional and biological value of lupins in aquaculture feeds, http://www.fish.wa.gov.au/Documents/occasional_publications/fop031.pdf

6 Brett D. Glencross, BSc(Hons) MSc PhD. DAFWA (2001), Feeding lupins to fish: A review of the nutritional and biological value of lupins in aquaculture feeds, http://www.fish.wa.gov.au/Documents/occasional_publications/fop031.pdf

FEEDBACK

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 stubbles

Lupin grain losses during harvesting in WA often exceed 150 kg/ha, which increases the value of this crop stubble for grazing livestock.

The amount of grain on the ground will largely determine the paddock's stock carrying capacity because it has a high digestibility and a high proportion is used by the animal.

Sheep and beef cattle tend to do better on lupin stubbles than on cereal stubbles in WA because of the high energy value and protein content of the grain.

A low starch content also minimises the risk of digestive upsets (such as lactic acidosis), common when stock are introduced to cereal stubbles.

It is typically safe to graze lupin stubbles until there is about 50 kg/ha of grain on the ground, or the level of groundcover is 50 percent or less (whichever comes first).[7]

To measure the level of grain on the ground in lupin stubbles, recommendations are:

- Place a tenth of a square metre quadrat on the ground
- Count the number of grains inside
- Include grains in whole pods
- Sample at 30 random sites across the paddock
- Eight seeds per quadrat equates to about 100 kg/ha of grain in the paddock.

Grazing sheep will typically consume more than 250 g/head/day of lupin grain in stubble paddocks.[8]

For example, if there is 200 kg/ha of lupin grain remaining after harvest, sheep grazing at a rate of 10 dry sheep equivalent (DSE)/ha will eat down to 50 kg/ha within eight weeks (if grazing is uniform).

Research in WA has found lupin stubbles can maintain or increase the weight and condition of all classes of sheep and are a particularly good summer feed source for weaners.

Weaners and small cattle can gain up to 200 g/head/day when grazing lupin stubbles, but typical weight gains are about 100–150 g/head/day.

Lupin stubbles are also useful to use when joining sheep, as the good quality feed increases ovulation rates in ewes.

Typically, six weeks is the maximum length of sheep grazing of lupin stubbles in WA.

Development of lupinosis, caused by toxins produced by the fungus *Diaporthe toxica* (formerly known as *Phomopsis leptostromiformis*), is a risk.

This fungus mainly grows on the lupin plant stem and ingesting too much can cause damage to the animal's liver, leading to loss of appetite, poor production and, potentially, death.

It also results in significant animal production losses, without any other obvious symptoms.

Management is the key to preventing stock losses from lupinosis and close monitoring for early detection of affected animals in flocks or herds is important.

7 DPIRD (2016) Grazing stubbles and dry pastures, https://www.agric.wa.gov.au/autumn/grazing-stubbles-and-dry-pasture?page=0%2C2#smartpaging_toc_p2_s2_h2

8 DPIRD (2016) Grazing stubbles and dry pastures, https://www.agric.wa.gov.au/autumn/grazing-stubbles-and-dry-pasture?page=0%2C2#smartpaging_toc_p2_s2_h2

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Other tactics to reduce the risk of this condition in WA lupin stubble paddocks include:

- Grazing order – lupin stubbles before cereal stubbles
- Pre-feeding lupin grain before stubble grazing
- Ensuring water availability close to stubble
- Assessing paddocks for grain on ground and presence of fungus on plants
- Feed budgeting
- Husbandry procedures – don't introduce sheep with pink-eye
- Maintaining stocking rates at or below 15 DSE/ha
- Not using stubbles for pregnant ewes
- Removing stock from stubbles when rain is imminent.

(SOURCE: DAFWA)

Treating sheep affected by lupinosis:

- Immediately remove from lupin stubble
- Place 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
- Do not feed lupin or feed blocks
- Reduce all stress
- Restore appetite
- Avoid dehydration.

(SOURCE: DAFWA)

FEEDBACK

12.5 Lupin for stock feed manufacture

The bulk of WA lupin used by manufacturers for compound feed rations is destined for the ruminant (cows and sheep) market, followed by pigs and poultry.

There is also increasing demand for lupin grain from the domestic dairy sector and from a small aquaculture market.

The nutrient content of WA lupin grain, in protein, amino acid, energy and mineral levels, has been well established and is widely accepted by stock feed manufacturers.

Lupin grain stacks up well compared to alternative grain options for seed weight, seed protein, seed oil and alkaloids and has significant advantages in being able to be used as a whole grain in rations.

The thick seed coat (hull or testa) makes up about 30 percent of seed weight for yellow lupin, 25 percent for narrow leafed lupin and 15 per cent for albus lupin.

This is considerably higher than for most domesticated grain species and is mostly comprised of cellulose and hemicellulose. This means it is important to consider the composition and nutritional value of the cotyledons (kernel). There is virtually no starch in any grain produced from WA lupin species, which is in marked contrast to crops such as field pea and chickpea, which can have 50-70 percent of the cotyledon weight as starch.

Lupin is an economical source of protein and energy for livestock feed formulations, typically containing 28–42 percent crude protein (depending on variety).

The nutrient and energy value of major lupin species in outlined in Table 1.

Table 1: Nutrient and energy values of the three lupin species

Nutrient and energy values of the three lupin species (whole seed)			
	L. angustifolius	*L. albus*	*L. luteus*
Crude fibre (%)	15.4	10.6	16.3
ADF (%)	19.7	14.6	24.9
NDF (%)	23.5	17.6	34.3
Calcium (%)	0.2	0.2	0.2
Phosphorus (%)	0.3	0.36	0.43
Alkaloid (%)	0.02	0.02	0.04
DE Pigs (MJ/kg)	14.6	16.9	16.4
ME Cattle (MJ/kg)	12	11.9	n/a
ME Sheep (MJ/kg)	12.2	12.5	n/a
AME Poultry (MJ/kg)	10.4	13.2	11.4

(SOURCE: Petterson et al, (1997) The Chemical Composition and Nutritive Value of Australian Pulses. Grains Research and Development Corporation, Canberra Australia)

Other advantages of lupin grain compared to alternative feed grains include:

- High concentrated levels of both protein and energy
- Free from major anti-nutritional factors (such as trypsin inhibitors)
- No requirement for heat treatment
- Ease of handling and storage due to a robust seed coat
- Readily accepted by livestock.

(SOURCE: Lupins.org)

FEEDBACK

MORE INFORMATION

CSIRO 'A review of the nutritional value of lupins for dairy cows': http://www.publish.csiro.au/paper/AR06109.htm

12.6 Dairy – an emerging market for WA lupin grain

There is an emerging domestic market for lupin grain as a feed source from dairy producers in WA, mainly on the back of its cost effectiveness and high protein and energy value.

Other advantages include low acidosis risk (due to a lack of starch) and low levels of anti-nutritional factors, such as trypsin inhibitor, tannins, lignin and lectins.

Research in 2007 found the benefits of using lupin grain in dairy cow feed formulations included:

- Increased average milk production of 0.53 kg milk/kg dry matter of lupin (compared to straight pasture/cereal hay diets)
- No negative effects on milk yield, fat content or protein.[9]

But there was some reduction in milk protein concentration and variable effects on fat concentration.

This project found substitution of cereal grains with an equivalent weight of lupin grains in dairy concentrate rations typically resulted in increased milk yield, fat, and protein – and a higher fat concentration.

Researchers attributed the higher yield responses to the higher ME content of lupin, compared to cereal grains.

Although, contribution from a potentially lower incidence of rumen lactic acidosis could not be discounted.

The project found feeding albus lupin to dairy cows significantly shifted the fatty acid profile of milk towards Australia's national dietary guidelines for improved cardiovascular health in humans.[10]

9 C. L. White, V. E. Staines, M. H. Staines, (2007), A review of the nutritional value of lupins for dairy cows. CSIRO, http://www.publish.csiro.au/paper/AR06109.htm

10 C. L. White, V. E. Staines, M. H. Staines, (2007), A review of the nutritional value of lupins for dairy cows. CSIRO, http://www.publish.csiro.au/paper/AR06109.htm