

 MORE INFORMATION

DPIRD 'Lupins': <https://www.agric.wa.gov.au/lupins> and https://www.agric.wa.gov.au/lupins/lupin-essentials-%E2%80%93-growing-successful-lupin-crop?page=0%2C4#smartpaging_toc_p4_s2_h2

DPIRD 'Successful lupin harvesting in Western Australia – a Review': https://www.agric.wa.gov.au/lupins/lupin-essentials-%E2%80%93-growing-successful-lupin-crop?page=0%2C4#smartpaging_toc_p4_s2_h2

Harvest

10.1 Overview

Shedding (or pod drop) or shattering of mature grain, plant lodging and poor plant flow into machinery have been issues for lupin crop harvesting in Western Australia.

Experience in this State indicates that, to address these problems and lower the risks of yield losses and reduced grain quality, it is advisable to harvest lupin as soon as the crop is ripe.

The best harvesting window is typically within three weeks of crop maturity and as soon as grain moisture content reaches 14 percent. This is the maximum allowable moisture level to meet CBH Group receival standards.

Lupin grain losses can be significantly reduced by harvesting when humidity is high and temperatures are not too hot, especially in northern grainbelt regions.

In cooler southern environments, daytime temperatures are often not warm enough to cause major problems and it may be better to harvest the crop as quickly as possible, rather than swap between lupin and cereals.

Delaying lupin harvesting can lead to brittle grain that is susceptible to cracking and splitting – or incidence of staining, lodging, moulds or disease.

It is advised to take particular care when harvesting lupin grain to use as seed for the next year's crop. Grain harvested late for seed can be of poor quality, with a low percentage of normal seedling germination.

It is recommended to harvest as soon as the crop is mature, setting the harvester drum or rotor speed to a minimum and opening the concave relatively wide.

This tends to reduce damage to the seed embryo and facilitate a high germination percentage after sowing. The seed embryo is very sensitive to impact if it becomes dry and brittle.

Even seed with no visible damage may have a low germination percentage if it suffered a high impact at harvest or during handling post-harvest when its moisture content was low.

Harvest is an ideal time to employ weed seed capture and/or destruction to reduce weed burdens and help manage any herbicide resistance issues.

Tactics include creating and burning harvest windrows, towing chaff carts, using the Bale Direct system that captures chaff and straw material as it exits the harvester, funneling seeds into tramlines or adopting seed destruction technology.

Storing lupin grain for next year's crop also needs close attention, with harvested grain moisture levels of about 13 percent or less ideal for storage.

FEEDBACK

Using grain silo aeration systems to maintain the average storage temperature below 20°C until the next year's sowing is advised. This can minimise storage insect pest activity and maintain seed quality.

i MORE INFORMATION

GRDC's 'Grain legume handbook': <https://grdc.com.au/grainlegumehandbook>

New South Wales Department of Primary Industries 'Windrowing lupins': <http://www.dpi.nsw.gov.au/content/agriculture/broadacre/winter-crops/pulses/lupins/windrowing-lupins>

10.2 Harvest timing



Figure 1: *Lupin is best harvested as soon as the crop is ripe and within three weeks of maturity.*

(SOURCE: GRDC)

Risks of plant lodging, pod shattering, pod shedding (or pod drop), grain staining or disease can typically be minimised if lupin is harvested as soon as the crop is ripe and within three weeks of maturity.

Losses of 5-40 percent have been recorded in some WA lupin crops due to shattering of grain when harvest is delayed.¹

A moisture meter is useful to determine when the lupin crop is ready. Harvest is best started as soon as grain moisture content reaches 14 percent (maximum allowable moisture level for CBH Group receival standards).

In some seasons this will occur when plant stems are still pale green, although seeds may have turned yellow inside the seed coat.

In northern grainbelt areas, lupin grain losses can be substantially reduced by harvesting when humidity is high (at night or early morning if necessary) and temperatures are not too hot.

¹ Reithmuller (2008) Successful lupin harvesting in Western Australia – A review. Lupins. Org conference paper, <http://www.lupins.org/pdf/conference/2008/Agronomy%20and%20Production/Glen%20Reithmuller.pdf>

FEEDBACK

Lupin plants strip well during the night and early morning and, if possible, it is advisable not to harvest in the middle of the day.

In cooler southern environments, daytime temperatures are often not high enough to cause major problems for harvesting.

In these areas, it may be better to harvest the crop as quickly as possible rather than swap between lupin and cereals.

A tin front (also known as closed front) with an extended distance between the knife and auger is ideal for lupin harvesting and harvest is best carried out:

- » As soon as the crop is mature
- » In cooler, rather than hot conditions
- » With the harvester drum or rotor speed set to a minimum
- » With the concave opened relatively wide.

(SOURCE: DAFWA)

10.3 Minimising shattering and pod drop



Figure 2: Swathed and/or windrowed lupin can minimise issues with pod shattering and are typically mature in a similar time to a standing crop.

(SOURCE: GRDC)

Shattering or dropping of lupin pods on entry to the harvester can lead to significant grain losses in WA lupin crops as a result of:

- » Vibration due to cutter bar action
- » Plant on plant contact
- » Reel on crop impact
- » Poor removal of cut material by the auger.

FEEDBACK

Risks of shattering or pod drop resulting from splitting of mature pods can be reduced by harvesting in high humidity (at night or early morning if necessary) and when temperatures are not too hot. WA grower experience indicates temperatures below 28–30°C are ideal.

Crop-topping is a tool used by some WA growers to help minimise shattering/pod drop by advancing harvest timing and evening-up crop ripening.

This needs to be carried out at the correct crop maturity stage and is not recommended for crops where grain is being retained for planting seed (for more details see Chapter 9 'Desiccation').

Research in New South Wales has found swathing/windrowing lupin, when opportunities arise, can be useful to avoid pod shatter/drop.²

This has a positive spin-off in helping to reduce weed seed set in some years, but can lead to crop yield loss if lupin plant maturity is behind weed seed maturity.

Researchers advise swathing/windrowing when the top pods (those that are the last to mature) are past physiological maturity and in the dry-down phase.

At this stage, the lowest (most mature) pods on the primary or main spike will be close to ripe and have a moisture content of about 40 percent.

Average grain moisture for the whole plant will be about 65 percent and cotyledons will be turning from bright green to yellow (in narrow leafed lupin varieties).

Trials have found it is best not to windrow albus lupin varieties too early, as immature seeds can become shrivelled when dry.

Swathed/windrowed lupin typically mature in a similar timeframe to a standing crop and will be ready to harvest within about 10-30 days (depending on the environment).

But the risk of immature green seeds in the swath has meant most WA growers avoid swathing lupin crops.

Newer narrow leafed lupin varieties PBA Jurien[®], PBA Barlock[®] and PBA Gunyidi[®] have been bred for improved harvest shattering resistance (equal to Coromup[®] and Tanjil[®]).

10.4 Maintaining grain quality

Lupin grain quality can be optimised at harvest by matching timing to correct crop maturity and moisture levels.

Using appropriate machinery can also help to maintain quality by avoiding cracked grain and/or shattering (pod drop).

Grain staining, fungal and disease issues can be managed with correct disease control and fungicide use at the appropriate stage of crop development (see Chapter 8 Foliar diseases for more detail).

Seed coat and cotyledons can be discoloured by crop-topping or premature desiccation in parts of paddocks if ripening is uneven.

To maintain quality of lupin grain being stored for subsequent planting, it is advised to harvest at a seed moisture level of 14 percent or less.

Research has found it is best to store this grain at an average temperature of about 20°C or less. There can be significant loss of grain quality when storage temperatures rise above 30°C.

A wet harvest can lead to issues of staining and weather damage that reduce lupin grain quality for sale or subsequent planting.

MORE INFORMATION

GRDC Fact Sheet 'Retaining seed': https://grdc.com.au/uploads/documents/GRDC_FS_RetainingSeed2.pdf

² New South Wales Department of Primary Industries 'Windrowing lupins': <http://www.dpi.nsw.gov.au/content/agriculture/broadacre/winter-crops/pulses/lupins/windrowing-lupins>

FEEDBACK

Rain at harvest can also result in lupin seed that produces low seedling vigour at the next planting. It is advisable to harvest seed crops early and before any rain, if possible, to minimise the risk of seed quality issues.

Weather damaged seed grain is more susceptible to poor germination, low vigour and degradation during storage and handling.

Symptoms include loose and wrinkled seed coat, staining or fully germinated seed.

It can be worth testing any retained seed for germination, vigour and presence of any seed-borne disease.

It is recommended to avoid excessive handling of lupin grain, as it is easily damaged by machinery and augers during harvesting (shattering/pod drop), grading (cracking) and the next sowing.

 **MORE INFORMATION**

DAFWA 'Successful lupin harvesting in Western Australia – a review':
https://www.agric.wa.gov.au/lupins/lupin-essentials-%E2%80%93-growing-successful-lupin-crop?page=0%2C4#smartpaging_toc_p4_s2_h2

10.5 Machinery configuration

To minimise losses from pods shattering or dropping on entry to the harvester and to avoid damaging lupin grain, recommendations include:

- » Reducing the peripheral speed of the harvester drum or rotor to a maximum 12 metres per second (down from 20 to 30 m/s for cereal harvest)
- » Using double density knife guards
- » Extending knife to auger distance
- » Using draper fronts and air reels.³

Harvesters will have a range of drum or rotor diameters, each with different speeds.

Check the configuration so that the correct rotational speed can be used for lupin crops.

Other general rules-of-thumb for lupin harvester settings include incorporating:

- » Slow reel speeds
- » High spiral clearance
- » Thresher speeds of 400-600 rpm
- » Concave clearance of 10-30 mm
- » High fan speed
- » Top sieve of 32 mm
- » Bottom sieve of 16 mm.

(SOURCE: Pulse Australia)

Using closed (comb) fronts

Most losses from closed fronts are typically caused by the plant impacting with the spiral.

To avoid the risk of this occurring, it is advisable to ensure the height between the point of cut on the stem and the top of the crop is less than the distance between the knife and centre point of the spiral.

Consequently, it is recommended to use extended fronts – where the gap between the knife and the auger (spiral) is extended.

Losses may also be reduced by increasing the finger gap to 16 mm. Remove a finger as necessary.

When readjusting the front for wheat or barley crop harvesting, it is best to check the knife is timed so that it stops behind a finger.

³ Reithmuller (2008) Successful lupin harvesting in Western Australia – A review. Lupins. Org conference paper, <http://www.lupins.org/conference/2008/Agronomy%20and%20Production/Glen%20Reithmuller.pdf>

FEEDBACK

Using open fronts

Open fronts have typically replaced closed fronts in the WA grainbelt due to increased harvesting flexibility for a wide range of crops.

There are generally two types of header fronts used in WA: conventional auger/tin fronts; and the more recent draper/belt fronts.

Extended tin fronts are ideal for harvesting lupin crops, but these are often narrower than draper fronts (typically 9 m for tin front and 12 m or more for draper front) and often not as good as draper fronts for harvesting cereal crops.

Many WA lupin growers own a tin front specifically for harvesting lupin and switch to a draper front for other crops.

Draper fronts can cause high lupin grain losses, particularly when harvesting very short lupin crops.

To reduce lupin grain losses and optimise grain quality when using conventional auger or tin fronts, recommendations include:

- » Fit double density (quad) knife guards
- » Avoid a double density knife with double density knife guards
- » Use a finger or tyne reel
- » Extend the table and knife forward by up to 300 mm
- » Fit Lupin Breakers® on the table auger
- » Use a large capacity auger that has 1.5 pitches per rotation
- » Fit a reduced diameter auger barrel with larger flights than the conventional auger barrel
- » Raise the auger to give a bigger gap between the table and the auger flighting
- » Alter the retractable finger timing when fully retracted at the two o'clock position (viewed from driver's left-hand end)
- » Replace standard reels with air reels (on light crops), either manifold or full-width fan work well depending on power available
- » Use a Vibra-Mat® that oscillates with the knife.

(Source: DAFWA 'Producing Lupins' Bulletin)

When using draper or belt fronts, harvesting losses can be minimised by:

- » Fitting double density finger/knife guards and air reels
- » Raising the knife to be level with the belts to aid flow
- » Using a finger or tyne reel
- » Moving forward augers that are over the feeder house
- » Fitting Lupin Breakers® to this small auger.

Using swathing/windrowing

Lupin crops can be swathed and laid in a windrow when grain is close to physiological maturity.

At this point, the grain is fully formed and no longer increases in weight but is too moist to harvest with a conventional harvester.

The crop dries out in the windrow and is harvested between 10 and 30 days later.

Success of this strategy is highly dependent on swathing at the correct time, which is when the average moisture content of all seed on the lupin plant is about 65 percent.

This typically occurs at the start of leaf drop, when plant stems and leaves are light green to yellow and cotyledons of the seed are usually green (which may vary depending on where the seeds are held on the plant).

FEEDBACK

Swathing is generally not recommended if seed moisture content is less than 50 percent. This can reduce yields through pod drop during the swathing operation and as the plants dry in the windrow.

For swathing, the crop is best cut 10 to 20 cm above the ground.

A large width of crop compacted into a small, dense windrow reduces the loss of yield through pod drop.

Harvesting of windrows requires careful management, as most grain yield losses tend to occur during this operation.

It can be advisable if considering swathing lupin in WA to use a pick-up front for windrows to increase harvest speed and reduce grain losses.

There can be a risk of downgraded grain due to immature green seeds in the sample, which is likely to occur when swathing is carried out too early and before all lupin seeds are mature.

In WA, in some situations, swathing lupin crops can be beneficial. This includes when there is a need to harvest very short lupin crops.

Direct harvesting of short, low yielding lupin risks high grain losses due to shedding as the header front contacts the lupin crop.

Some growers using swathing in this situation will aim to concentrate two swaths into one swath to improve pick-up of the swaths.

But many WA growers avoid swathing lupin due to the high risk of immature green seeds being present and potential yield losses.

i MORE INFORMATION

WeedSmart '10-point plan': <http://www.weedsmart.org.au/10-point-plan/capture-weed-seeds-at-harvest/>

GRDC 'Integrated Weed Management Manual': <http://www.weedsmart.org.au/bulletin-board/integrated-weed-management-manual/>

GRDC Hot Topic 'Integrated weed management in WA': <https://grdc.com.au/Media-Centre/Hot-Topics/Integrated-Weed-Management-in-WA>

10.6 Harvest weed seed capture and control



Figure 3: Chaff carts are a practical and proven way to capture a high proportion of weed seeds at harvest.

(SOURCE: GRDC)

A major biological weakness of most WA cropping weeds is that most of their seed does not shatter before harvest, providing a good opportunity for removal.

FEEDBACK

Common harvest weed seed control (HWSC) tactics that can be used in WA lupin crops to lower the weed seed bank and help manage herbicide resistance issues include:

- » Collecting chaff in chaff carts
- » Using the Bale Direct system to collect straw and chaff as it exits the harvester
- » Depositing chaff on narrow windrows for burning or livestock grazing the next autumn
- » Using seed destruction technology to pulverise chaff fraction as it leaves the harvester
- » Diverting the chaff onto permanent tramlines (in controlled traffic farming systems) or into narrow rows.

The main benefits of HWSC systems are preventing inputs to the weed seedbank and removing seed from weeds that have survived earlier herbicide applications.

This reduces the selection pressure for herbicide resistance evolution.

Australian Herbicide Resistance Initiative (AHRI) research at 24 sites across southern Australia during the 2010 and 2011 harvests found windrow burning, chaff cart and seed destruction systems were equally effective at removing annual ryegrass (*Lolium rigidum*) seed from cropping paddocks.

Each of these HWSC methods led to an average 60 percent reduction in annual ryegrass germination the following year.

All HWSC systems are limited by how many weed seeds enter the front of the harvester.

The key to success is optimising the set-up and operation of the harvester.

In 2014 trials in south eastern Australia, five harvesters were used and settings were not changed from what growers were using across the remainder of the paddock.

Cab settings of the five harvesters used in the 2015 trials were adjusted to maximise the efficiency of an attached iHSD, although no physical changes were made to concaves or grates.

Adjusting these settings helped to ensure that grain and weed seeds were moved out of the concave and onto the sieves.

Key findings from these trials included:

- » An average 47 percent of annual ryegrass seed was lost in the straw fraction in 2014
- » The range of loss of this seed in straw fraction in 2014 was 28-70 percent
- » Only 3.4 percent of annual ryegrass seed on average was lost in the straw fraction in 2015
- » The range of loss of this seed in straw fraction in 2015 was 1-9 percent
- » Increasing harvester speed did not affect weed seed capture.

The research showed that by ensuring harvesters are not travelling too fast, growers can potentially prevent grain losses worth as much as \$20 per hectare (in wheat crops).

FEEDBACK

i MORE INFORMATION

GRDC ‘Grain legume handbook’
Chapter 9: <https://grdc.com.au/grainlegumehandbook>

Soil Quality.org.au ‘Fact sheets – Benefits of retaining stubble – WA’: <http://www.soilquality.org.au/factsheets/benefits-of-retaining-stubble>

10.7 Stubble management



Figure 4: *Stubble retention, such as pictured here sown with new lupin crop, maintains ground cover, reduces erosion risks and helps conserve valuable soil moisture and nutrients.*

(SOURCE: GRDC)

Historically in WA, the practice of removing crop stubbles by burning was widespread for ease of sowing the following year and to break cereal disease cycles.

In recent years, there has been a shift to alternative stubble management tactics, including mulching, slashing or leaving residue partially or wholly standing.

The primary agronomic purposes of stubble retention are to reduce runoff and soil loss from wind or water erosion, conserve soil moisture and nutrients for subsequent crops, protect young seedlings and lower the risks of rain splash of Brown leaf spot spores.

Retaining or partially retaining standing lupin stubble at a level of about two tonnes per hectare generally provides about 50 percent ground cover and research indicates this can significantly reduce soil losses compared to areas where stubbles have been burned.⁴

⁴ Soil Quality.org.au ‘Fact sheets – Benefits of retaining stubble – WA’: <http://www.soilquality.org.au/factsheets/benefits-of-retaining-stubble>



Stubble from lupin crops will also provide slow-release nitrogen (N) to the soil and has an added advantage of typically containing about 150-250 kilograms of grain per hectare after harvest.

This makes lupin stubbles an attractive grazing source for sheep and cattle during the summer months.

Levels of fallen grain in lupin crop residue can often provide enough feed for one to three months of sheep grazing, depending on: stocking rate; any development of lupinosis; risk of wind erosion; and rainfall.

Lupinosis is a disease that affects livestock that eat dead lupin stems colonised by the fungus *Diaporthe toxica* (formerly known as *Phomopsis leptostromiformis*).

The fungus produces toxins – called *phomopsins* – in warm moist conditions and when consumed by livestock these can damage the liver and can result in the animal becoming jaundiced.

10.8 Grain storage



Figure 5: Quality control is the key focus of on-farm storage for lupin grain to be used for seed the following year.

(SOURCE: GRDC)

Lupin grain with high germination and vigour test results can remain viable in storage for up to three years if seed moisture levels are maintained below 13 percent.

Storage life will depend on storage temperature and incidence of stored grain pests and diseases.

It is recommended to dry lupin seed that has been harvested at a moisture content above 15 percent before it is stored (especially in unaerated silos).

As a general rule, the moisture content of lupin grain to be stored and sown the next year should be 13 percent or less.

The optimal storage temperature for lupin grain is an average of 20°C and below 25°C.

It is advisable not to store lupin seed contaminated with green pods from wild radish weeds.

MORE INFORMATION

GRDC 'Stored Grain' information hub:
www.storedgrain.com.au

GRDC Back Pocket Guide 'Stored grain pests identification': <http://storedgrain.com.au/stored-grain-pests-identification-the-back-pocket-guide-2011/>

GRDC Hot Topic 'Using aeration cooling for stored grain in WA': <https://grdc.com.au/Media-Centre/Hot-Topics/Using-aeration-cooling-for-stored-grain-in-Western-Australia>

FEEDBACK

High temperatures can volatilise toxic compounds from the radish pod that can kill the lupin seed. This process can happen in a matter of days, so temporary storage can be damaging.

Other tips for optimal storage of lupin grain include:

- » Using white/light silos to reflect heat
- » Using silos with capacity greater than 75 t that remain cooler than smaller silos
- » Monitoring stored grain pest activity
- » Monitoring grain quality and temperature
- » Consider aeration cooling systems for stored grain insect and pest control and maintaining grain quality.

Loading and out-loading of lupin grain from storage should be done with care.

Silos are designed to withstand uniform downward and outward forces and, to keep these forces uniform, silos must only be loaded from the central top hatch.

Loading from the side top hatch will unbalance the lateral forces on opposite sides of the silo, which could distort the shell of the silo and place extreme pressure on the side holding the high side of the stack.

The same principles apply when out-loading and the silo should only be emptied from the bottom central opening.

It is best to not use the 'bagging-off' chute unless the silo is designed to withstand off-centre loads.

The physical characteristics of lupin grains means higher pressures are exerted on silo walls than with some other grains.

When transferred to the lower sections of the silo wall, these forces may cause crimping or pleating of the walls (seen in elevated and flat bottom silos). For this reason, it is advised not to store lupin grain in older type silos with thin walls.