SUCCESSFUL LUPIN HARVESTING IN WESTERN AUSTRALIA – A REVIEW

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ABSTRACT

Shedding of mature seed and poor plant flow into the harvester has added to the problems of harvesting lupins in Western Australia in the past. This paper outlines successful methods of harvesting lupins in Western Australia. Most losses have been found to be at the front of the harvester and the lowest losses from the harvester front are generally found using double density knife guards, extended knife to auger distance or draper fronts and air reels. Lupins should be harvested as soon as they are ripe. Delays can result in significant loss of yield due to lodging, pod shattering and pod drop. Harvesting should start as soon as the seed moisture content reaches 14%. Seed losses can be substantially reduced by harvesting when the relative humidity is high.

KEYWORDS

lupins, harvesting, losses, harvester modifications, seed moisture

INTRODUCTION

In the early 1980s when the lupin industry was developing in Western Australia 15% of yield was lost during harvest before the seed entered the harvester (Smart and Fosbery, 1983). Burch (1986) used high speed photography to find the major cause of the losses on open fronts was the action of the cutterbar causing plant vibration and deflection forward which resulted in whole pod loss. In dense crops this problem is compounded by poor removal of cut material from the front. A table auger is unable to handle well branched, bulky material. Burch found the spiral on closed front harvesters pushed the crop forwards into other plants resulting in high losses. He also found harvesting speed between 5 to 7 km/h reduced losses and that an 'air finger' front reduced losses from 27 to 9%. Losses were reduced from 100 to 60 kg/ha from an increase in air relative humidity from 40 to 80% respectively. Knife guard spacing tended to reduce losses when changing from the conventional 76 mm guards to 38 mm, double density, guards at ground speeds of 6 to 12 km/h. Jensen (1988) found Lupin Breakers® from Chamberlain John Deere reduced losses by 4% when averaged over a range of harvester speeds. He also found the distance from cutterbar knife to table auger was very important with losses reduced from 24% and 11% to 6% and 7% in 1.8 and 1.1 t/ha yielding crops respectively by increasing the knife to auger distance from 235 to 485 mm. Blanchard (1992) measured losses from 34 growers with a range of harvester front modifications. He found double density knife guards average loss was 141 kg/ha and adding an air reel reduced this to 84 kg/ha while extending the distance from the knife to auger by 450 mm reduced this further to 66 kg/ha. He also found the extra clearance of belt or draper fronts behind the knife reduced losses from 141 kg/ha with a conventional auger front in a 1 t/ha crop to 80 kg/ha with a draper front in a 1.6 t/ha crop. Riethmuller and Blanchard (1995) suggested that 880 ha would recoup the cost of front modifications, double density knife guards, extended knife and air reel in one season. Siemens (2006) work on chickpeas, that have a similar branched growth habit to lupins, found the lowest front losses (3%) were when using double density knife guards, an air reel and long finger guard extensions compared to a conventional batt reel, single density knife guards with no finger guard extensions (26%). Minimal research on finger guard extensions has been attempted in Western Australia and randomising the extensions was found to be most important due to higher losses near the centre belt on a belt front (Riethmuller, 2007).

Other factors that are important for quality seed include harvester drum speed and seed moisture. Blanchard (1990) found lupin seed germination rate had a strong negative correlation with increasing harvester drum peripheral speed ($r^2 = 0.96$) and decreasing seed moisture ($r^2 = 0.93$). It is recommended that drum speed should be decreased as the seed moisture decreases. A maximum peripheral speed of 12 m/s was suggested and seed moisture not lower than 12% for acceptable seed germination.

The aim of this paper is to outline the current best practice lupin harvesting equipment and modifications suited to Western Australian conditions.

REDUCING HARVESTING LOSSES

Making sure the knife is sharp, timed correctly so it stops under the knife guard at the end of its stroke and cuts closely to the ledger plate below the knife all help reduce losses. Damaged knife sections or too much

IN J.A. Palta and J.B. Berger (eds). 2008. 'Lupins for Health and Wealth' Proceedings of the 12th International Lupin Conference, 14-18 Sept. 2008, Fremantle, Western Australia. International Lupin Association, Canterbury, New Zealand. ISBN 0-86476-153-8.

clearance between the knife and ledger plate will cause poor cutting, which will increase front losses.

Matching ground speed to the capacity of the table auger and crop density rather than the capacity of the drum will help. If the ground speed is too slow, the plants will not have enough momentum to carry to the front. If ground speed is too fast the cut crop will not be cleared from behind the knife.

Keeping the table of conventional 'tin' fronts smooth aids the movement of material across the table. If the table is not smooth or rusty it can be polished with a sanding disc. At the end of the season the table should be sprayed with a protective coating.

TYPES OF HARVESTER FRONTS

There are generally two types of harvester fronts: conventional auger, or tin fronts, and the more recent draper or belt fronts.

CONVENTIONAL OR TIN FRONTS

The following modifications help reduce harvesting losses on conventional fronts:

- Replace original single density knife guards with double density (quad) knife guards (Fig. 1). This will limit the sideways throw of the plant during cutting. Growers have found using double density knife sections with double density knife guards can cause problems for the knife drive.
- Extend the table and knife forward by up to 300 mm to allow the crop to come under the auger, depending on the crop height (Fig. 2).

Fig. 1. Double density (quad) knife and single density single density knife sections.

- Use a large capacity auger that has one and a half pitches per rotation instead of the conventional one pitch per rotation. This will move cut material quickly.
- Raise the auger to give a larger gap between the table and the auger flighting. This works well for bulky material and will also improve feeding of cut material across the table and reduce losses.
- Replace standard batt reels (Fig. 3) or finger tine reels (Fig. 4) with air reels particularly for light crops. Air reels direct a blast of air blast into the front and are very good for moving shed seed onto the table. There are two types of air reels: Manifold and full width fan (Fig. 5).

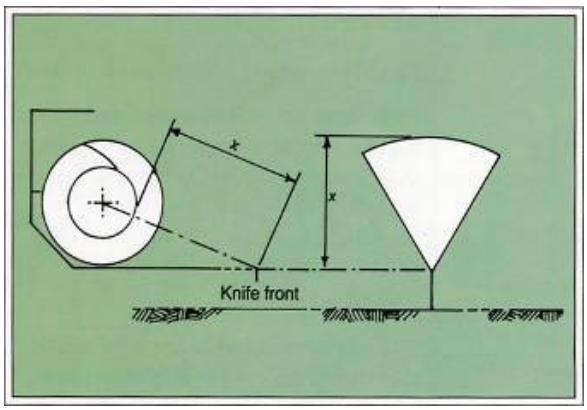

Fig. 2. Suggested knife position guards on the left on a conventional auger front. The uger barrel to the front of the knife is equal to the cut crop height 'x'.

Fig. 3. Batt reel on a draper type front.

Fig. 4. Finger tine reel on a draper front.

- Use Vibra-Mats® which are vinyl mats that oscillate with the knife. The mat helps clear cut material to stop it bunching at the knife. These are relatively inexpensive and can be an aid in light crops (Fig. 6). These mats also improve the evenness of feeding to the threshing and separating system, which reduces through-the-machine losses.

Fig. 5. Manifold air reel on a conventional auger front (left) and a full width fan (right).

- Fit Lupin Breakers® on the table auger (Fig. 7). This will help feed the cut material along the table.

DRAPER OR BELT FRONTS

The following modifications will help reduce harvesting losses on draper fronts:

- Fit double density knife guards and air reels.
- Move augers that are over the feeder house forward and fitting Lupin Breakers® to this small auger may feed in heavy crops (Fig. 7).

NOTE: Trade names are used for clarity and do not imply endorsement of those products over other products.

Fig. 6. Vibra-Mat® attached to the knife back.

HARVESTING LUPINS FOR SEED

Special care needs to be taken when harvesting seed for future crops. Harvest as soon as it is mature. Harvester drum or rotor speed must be set to a minimum and the concave opened fairly wide. This reduces damage to the seed embryo helping to maintain a high germination percentage. The seed embryo is very sensitive to impact if it becomes dry and brittle. Seed with no visible damage may have low germination percentage if it has suffered a high speed impact when its moisture content was low.

A general guide to reduce lupin seed damage is to have the peripheral speed of the harvester drum or rotor not greater than 12 metres per second. This compares with 20 to 30 metres per second for cereals. The drum rotation speed will be different for each drum diameter according to the following formula.

Drum rotation speed (rpm) = 60,000 x peripheral drum speed (m/s)

3.14 x drum or rotor diameter (mm)

Harvesters have a range of drum or rotor diameters so this will have to be checked in order to start at around the correct rotational speed (Table 1).

Fig. 7. Lupin Breakers® fitted to the centre auger on a draper front.

CONCLUSIONS

In Western Australia, harvesting should start as soon as the lupin seed moisture content reaches 14% and seed losses can be substantially reduced by harvesting when the relative humidity is high. Most losses have been found to be at the front of the harvester. Lowest harvester front losses are generally found using double density knife guards, extended knife to auger distance or draper fronts and air reels. Further research on losses of knife guard extension fingers is needed in Western Australia.

Table 1. Drum or rotor diameters and rotational speed for a selection of harvesters.

Make	Model	Drum or rotor diameter (mm)	Drum or rotor speed for 12 m/s peripheral speed (rpm)
Case IH	2388/AFX8010	762	300
Cat Lexion	480	600	380
Claas	116CS	450	510
Gleaner	R65/75	635	360
John Deere	9870 STS	750	305
Massey Ferguson	9790	700	325
New Holland	CR970	560	410

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