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The development of an efficient lupin harvesting front

By Edward Blanchard, Agricultural Engineer, Dryland Research Institute, Merredin

Harvest losses represent a significant reduction in lupin production and farm productivity.

In the 1980s, the Department of Agriculture's Dryland Research Institute surveyed farmers' lupin harvesting operations. In one survey of 20 farmers in the Merredin area, harvest losses averaged 15 per cent and varied between 4 per cent and 37 per cent, with virtually all the loss during the cutting process at the front of the harvester.

Since 1984, the Department's Farm Machinery Research and Liaison Unit at the Dryland Research Institute has studied the lupin harvesting operation to improve its mechanical efficiency. An experimental and a prototype harvesting front were built and tested in the field. Guidelines for efficient lupin harvesting were produced, and commercial modifications developed.

Seed losses cost dollars

The Western Australian lupin industry has grown rapidly, from 57,000 ha sown in 1978 to 755,000 ha sown in 1989.

In 1987, the return to the Western Australian Grain Pool, less authority charges, was $97,644,000 from 618,000 tonnes. At this rate of return, a harvest loss of 15 per cent represents a financial loss of $14,646,000. Therefore in 1987, every percentage point the harvest losses could be reduced would have represented a saving of just under $1 million.

To overcome these problems many farmers attempted to modify their existing harvesters for lupins. However, they had no clearly defined causes of harvest losses and their evaluation of modifications usually lacked careful measurement.
The aim of the Department's project, funded by the Grain Research Committee of Western Australia and the Grain Legumes Research Council, was to define the main causes of loss and to evaluate modifications which could overcome those problems. Preliminary work in 1984 used high speed photography to define the main causes of losses on conventional harvester fronts in lupin crops.

Several modifications were evaluated during the three seasons of field trials since 1985. Testing of possible 'solutions' was restricted to those which addressed the problems defined by the earlier photographic work. The influence of groundspeed, cut height and time of day were examined to help define the best harvesting methods.

The main causes of high losses in harvesting lupins were:

- The action of the cutterbar on the plant stem which tended to shake the plant, making it shed pods.
- The poor removal of cut material from the knife.

**Experimental programme**

An experimental front was constructed in 1986 and tested during the 1986 and 1987 harvest seasons. It was used to test knife type, reel type and the benefit of using Lupin Breakers®, which bolt on to the flighting of the platform auger and improve crop flow.

**Cutterbar and knife configuration**

A major cause of lupin loss from open fronts was the cutterbar. Several cutterbar designs available commercially were claimed to improve harvesting efficiency, particularly in bean crops. A 'double sickle' design (Busatis®, fingerless cutterbar), and a 'double cut' design (Tiger Jaws® similar to the Kwik-Cut®) were tested in 1986 and 1987 and compared with the standard design.

The 'double sickle' design increased harvest losses significantly. Harvested yields were below those from the standard design by 70 kg/ha in 1986 and 36 kg/ha in 1987. There was no significant difference in harvested yield between the standard design and the 'double cut' design.

**Reel type**

The use of a bat reel, a finger reel or no reel were compared. There was no significant difference between them, but the finger reel gave slightly lower losses and seemed to be doing a better job than the bat reel or no reel.

**Breaking up the lupin stems**

Lupin Breakers® bolt on to the flighting of the platform auger and improve crop flow. Their use was tested over a range of groundspeeds. The average loss for the modified auger was 51 kg/ha, or 4 per cent of the yield, less than from the standard auger. Field observations supported the improved crop flow from the use of Lupin Breakers®.

**Increasing the knife-to-auger distance**

A prototype open front was constructed in 1987 and tested that harvest season. The main harvesting aid was an adjustable knife-to-auger distance, that is the distance between the tip of the platform auger flighting and the tip of the knife finger guard. Double density finger guards and double cut knife sections were fitted. Lupin Breakers® fitted to the platform auger improved crop flow.

The unit was tested in a light crop of 1,100 kg/ha near Merredin and a heavier crop of 1,800 kg/ha near Esperance. Increasing the knife-to-auger distance reduced harvest losses significantly in both crops. In the light crop, increasing the knife-to-auger distance from 320 mm (13 inches) to 440 mm (17.5 inches) reduced losses from 120 kg/ha, or 11 per cent of the yield, to 75 kg/ha, or 7 per cent of the yield. In the heavier crop increasing the knife-to-auger distance from 320 mm (13 inches) to 540 mm (21 inches) reduced losses from 438 kg/ha, or 24 per cent of the yield, to 103 kg/ha, or 6 per cent of the yield. This represented a saving of up to $60 per hectare with lupins at $200 per tonne.

**Lupin breakers and extension fingers**

Lupin Breakers® and Harvestaire® plastic extension fingers were tested. There was no significant difference in the light crop between the standard front and the front with lupin breakers and plastic extension fingers. The plastic extension fingers blocked up in the heavier crop.

**Field tests of commercial modifications**

**Cutterbar**

Fitting double spaced finger guards, giving a spacing of 38 mm (1.5 inches) instead of 76 mm (3 inches) reduced losses. Losses were reduced further by fitting double cut knife sections instead of single cut knife sections in a test conducted by Chamberlain John Deere.
Increasing the knife-to-auger distance

Two manufacturers are producing front extensions for the knife. Chamberlain John Deere’s (CJD) modification for their harvesters extends the knife forward 140 mm (5.5 inches). Harvester’s modification extends the knife 450 mm (18 inches) forward and fits most machines.

The CJD open front, as supplied, has a knife-to-auger distance of 360 mm (14.5 inches). The knife can be moved 100 mm (4 inches) in or out from this mid position. From this mid position the CJD extension increases the knife-to-auger distance to 480 mm (19 inches). The Harvester extension increases the knife to auger distance to 760 mm (30 inches).

Both extension pieces are made of stainless steel. They do not corrode and remain polished to allow the lupins to flow easily into the harvester.

Platform sweeps

With this relatively long extended front, the bulky crop had to be moved from the knife to the platform auger. Harvester makes Platform Sweeps which consist of two sections of long solid nylon fingers on a crank which forces the material back to the platform auger.

Platform sweeps can be used:
- on a conventional open front to reduce the problem of bunching of material in the centre or along the platform auger; and
- on a closed front to reduce the feeding problem when the front spiral is removed, turning the closed front into an open front.

Air assistance systems

To reduce losses from pods and loose grain falling in front of the knife, two Western Australian companies, Harvester and Aussie Air, have developed air assistance systems for an open front.

In the Harvester system an air reel which has air jet outlets aimed to blow material from the knife back into the front replaces the conventional reel. In a dense crop the reel can be lifted clear of the crop so as not to knock pods off. In a light crop the reel can be lowered to move the pods and loose grain in to the front.

In the Aussie Air system, hollow light crop fingers which have an air outlet in the top replace the conventional finger guards. The air, carrying the pods and loose grain, flows back into the front. Aussie Air say the ledge at the back of the light crop fingers traps some of the plant stems against the knife so the crop is not ‘bulldozed’ at higher ground speeds, and is cut cleaner, so reducing plant vibration and hence losses.
Changes to the platform auger

There are a number of ways of improving crop flow by modifications and adjustments to the platform auger.

- Fit a course pitch auger, with 1.5 times the normal pitch, to quickly move the cut material across the front. This is an option on John Deere harvesters.
- Fit a reduced diameter auger barrel with larger flights than the conventional auger barrel so there is more room for the bulky lupin crop. This modification is available from Aussie Air.

The next two ideas come from the “Reaper’s Digest” published by the Kondinin Group.

- Raise the auger, giving a bigger gap under it, for bulky material to flow through.
- Alter the retractable finger timing so the fingers are fully retracted at the ‘2 o’clock’ position, as viewed from the driver’s left hand side. The timing change reduces repeating of cut material over the auger and gives the fingers more reach over the platform to grip incoming material.

Belt-type open fronts

This open front uses belts instead of a platform auger to carry crop from the knife to the broad elevator. It shows promise as a versatile front able to harvest both wheat and lupins at reduced harvest loss levels. Aussie Air in Western Australia and MacDon in Canada have developed a belt-type open front.

Aussie Air’s front has a cutting width of 10 m (32 feet), and is fitted with their air assistance system.

A MacDon front was used in Western Australia last year. It has a cutting width of 11 m (36 feet). To minimize the effect of ground undulations, the front has two wheels, one wheel at each end, and is attached to the feeder housing with a suspension system that allows the front to ride over rocks and stumps. It shows promise as a versatile front able to harvest wheat and lupins at low loss levels. In low yielding crops this front can load the harvester to capacity. Its price may be similar to that of a conventional 9 m (30 foot) wide front.

Footnote

Trade names are used for clarity and do not imply endorsement of these products over other products that may perform equally as well.