Strategy and understanding keys to snail management

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Minimising snail numbers requires a year-round strategy and a strong understanding of snail behaviour.

Soil type, proximity to previous snail incursions, climate, seasonal conditions, weeds and crop type all have a strong impact on snail populations, with numbers likely to be higher where there is more free lime in the soil, mild summer temperatures with overnight moisture and brassica weeds and crop times.

Monitoring snail behaviour is the starting point for effective snail management. Start by identifying the snail types on the property because different species can behave differently at different types of the year. Italian round snails, for example, are aggressive feeders on green vegetation and are less likely to take bait if there are growing crops and weeds available for them to feed on.

Identify differences in snail populations. Snail numbers are usually higher around sheep troughs and areas where sheep camp due to higher levels of nutrition and organic matter. A single size group of snails usually indicates they are moving in from nearby areas. A range of small to large snail sizes indicates snails are breeding in the area.

SNAILS CAN BE A MAJOR PROBLEM AT HARVEST TIME.

COMMON WHITE SNAIL

COMMON WHITE SNAILS HAVE A ROUND 'BELLY BUTTON' (UMBILICUS).

WHITE ITALIAN SNAIL

WHITE ITALIAN SNAILS HAVE A PARTIALLY CLOSED UMBILICUS.

CONICAL SNAIL

THE LENGTH TO WIDTH RATIO OF THE CONICAL SNAIL IS GREATER THAN TWO.

SMALL POINTED CONICAL SNAIL

THE LENGTH TO WIDTH RATIO OF THE SMALL POINTED CONICAL SNAIL IS LESS THAN TWO.

If resources are limited, concentrate on preventing further problems by baiting areas of incursion. Maximise baiting effectiveness by spraying out weeds and applying bait ahead of moisture events because moisture will soften baits and increase uptake of bait by snails. Snail populations can increase 400-fold in a season, so make every effort to reduce populations before mating and egg laying.

Metaldehyde bait is usually best applied at 5 kg/ha if there are less than 80 adult snails a square metre. Use 10 kg/ha or two applications of 5 kg/ha if there are more than 80 snails a square metre. Snail baiting needs to be completed two months before harvest to ensure bait does not contaminate grain.

Crops with open, low canopies, such as lentils, can help keep snail numbers low. Field peas and canola on the other hand encourage the build up of snail populations. There are several efficient methods available to clean snails from lentil grain and lentil stubble is short and sparse, providing an opportunity to achieve high snail mortality with summer stubble treatments. Using a Weed Wiper to control weeds in crop and desiccating lentils ahead of harvest increases snail mortality over summer.

Harvester modifications

Options to minimise snail contamination and downgrading of grain at harvest were evaluated as part of the GRDC Harvest Technology for Quality Grain project.

This research showed that strategies to reduce snail intake to the harvester are of benefit where snail contamination is heavy enough to create harvester gumming problems.

Techniques to minimise contamination were grouped into three categories:

- **Minimise snail intake into the harvester.** Tactics to achieve this include harvesting strategically in response to snail movement due to weather triggers, windrowing, mechanical dislodging of snails using add-on dislodger bars, or use of alternative front designs with the aim of harvesting as little straw as possible with the grain. A stripper front is the most effective machinery option to reduce snail contamination in medium to high-density crops.
- **Maximise opportunities for snail/grain separation within the harvester.** Options include using screens under augers, fixed aperture sieves, snail traps on the platform and thresher modifications.
- **Clean harvested grain before delivery.** Use of a grain snail roller to treat harvested grain is the most efficient and effective method to reduce snail contamination in all grain types except canola. Pay close attention to roller clearances to optimise snail reduction and maximise grain quality in non-cereal crops.

Harvest-time measures can be important, but it is best to aim for improved snail control throughout the year rather than to rely solely on harvester modifications to deliver quality grain.

Researchers found that some of the harvester modifications used to address snail problems may result in reduced harvester throughput or increased grain losses. The exception is use of a stripper front which can reduce snail contamination by 50% and increase harvest capacity by a similar amount with no more grain loss than from a standard open front used in good conditions. Stripper fronts are most effective in medium to heavy crops.

Setting the cutter bar higher to leave stubble longer will often minimise snail intake but can have negative repercussions on residue handling at sowing. Many farmers are now using a second pass of the harvester in hot weather in February to break stubbles down and reduce snail numbers.

Snails respond to weather triggers, with a fall of two to three millimetres of rain enough to trigger snail movement down the stalks. However, a fall of this magnitude often has little impact on grain moisture levels, and harvesting areas with high numbers of snails after a small shower of rain has enabled growers to harvest grain deliverable straight from the header.

The option of using dislodge bars to dislodge snails ahead of the harvester reel is an effective way of minimising snail intake.

More force is needed to dislodge snails later in the season. In 2000, the force needed to knock snails from stubble increased seven 10-fold in a five-week period preceding harvest of a faba bean crop. This means dislodging snails is easier at windrowing when the force needed is lower and the crop is tougher so there is less risk of grain loss due to crop damage.

Optimising dislodger-bar design and settings will minimise crop losses and maximise performance.

There is also a snail species effect. Results show dislodge bars are two to six times less effective in dislodging conical snails than in dislodging round snails. Best results are achieved when there are large round snails high in the canopy.

If the main source of snail contamination is conical snails low in the canopy, grain cleaning options will be a better option than using a dislodger bar.

The decision about whether or not to use a dislodger bar should be made on a paddock-by-paddock basis, based on the number and type of snail present in each paddock, taking account of snail levels within the harvested crop zone and averaging out paddock edges and weedy patches within crops. It also needs to take account of the silo readings and harvester clogging risks, which are as important as grain sample quality.

Faba beans

Particular dislodger bar designs are suited to specific crop situations. A range of design concepts from very gentle to very aggressive brushing systems was evaluated as part of the Harvest Technology for Quality Grain project.

In more fragile crops like faba beans, the use of dangling agricultural V-belts reduced snail numbers by up to 60%, with 4-5% more pod loss than crops harvested without a dislodger bar.

Cereals

In standing cereals, the better systems included rigid bars (Fig. 1) which dislodged up to 80% of round snails when set low enough into the crop (i.e. with the lower edge 50 mm above cutting height).

Measured head losses averaged two to 3%, increasing to five to 6% when operating against the direction of the barley hook.

Dislodger bars set low in the crop can break off many grain heads, particularly in mature barley. However, loose heads are not always lost, with a significant proportion of dislodged heads remaining in the harvested zone, especially in thick and tangled crops.

FIG. 1: RIGID DISLODGER BAR (TOP) FOR CEREALS AND WITH ADD-ON DANGLING BELTS (ABOVE) FOR FABA BEAN.

FIG. 2: DOUBLE DISLODGER BAR SET-UP.

FIG. 3: HYDRAULICALLY-DRIVEN ROTARY BRUSH PROTOTYPE.

Polypropylene brushes (Fig. 3) provided good snail removal (up to 70%) with crop losses of only 0.5 to 3%. Results were improved with a double row of brushes. There is also an interaction between crop density and bristle stiffness.

Fitting bars

Dislodger bars on harvesters should be fitted far enough ahead of the cutter bar to ensure few snails can be flicked onto the platform by the crop springing back. With a rigid dislodger bar, a distance of up to 2.2 m between the dislodger and the cutter bar is needed depending on the ground speed of the machine. Dangling devices do not generate much spring-back and can be set closer to the cutter bar, which reduces weight overhang.

It is ideal to be able to adjust the height of the dislodge bar independently of the reel or cutter bar height. The ability to adjust bar height on the go enables the operator to use a lower, more aggressive setting in areas with higher snail infestations (such as weedy patches and paddock edges) and increase the height in cleaner parts of the paddock to minimise crop losses.

Duragal hollow rail (120x48x2; 4.5 kg/m) was used as a horizontal dislodger bar in cereals and to suspend dangling belts in faba bean crops (Fig. 1).

The use of double dislodger bars (Fig. 2) can enhance the dislodging action but can also generate high crop losses in susceptible crops. The superior snail dislodging performance of double bars over single bar set-ups is a function of the positioning of the second bar, which needs to be set so it applies a second impact to crop springing back after being displaced by the first bar. In the trials the second bar was fitted 50 to 75 cm behind and 10 to 15 cm below the first bar.

Benefits

Dislodger bars can reduce snail intake by harvesters. However, the use of a dislodger bars on a harvester does not always result in significant improvement in grain quality. This is due in part to the fact that the bars preferentially dislodge bigger round snails, which if they entered the header may be crushed by the thresher or scalped out by the chaffer and/or cleaning sieve.

Trial results show that dislodger bars will reduce snail contaminants in harvested beans, barley and wheat but that in most cases the level of contamination is not low enough to receival standards.

The exception were crops harvested with a rotary stripper front.

Specific results were:

- 15-38% reduction (average 26%) in faba beans when using dangling V-belts (4 trials)
- 0-56% reduction (average 33%) in standing barley with a single dislodger bar (6 trials)
- 0-44% reduction (average 27%) in standing wheat with a single dislodger bar on an open front (6 trials)
- 4-38% further reduction (average 18%) in standing wheat with a double dislodger bar (3 trials)
- 48-51% reduction (average 50%) in standing wheat with a single dislodger bar on a rotary stripper front (2 trials)

Rotary brushes

Field experiments have highlighted the need for versatility in dealing with various crop types and conditions. The concept of a rotary brush was developed to enable operators to vary the aggression and direction of the brushing action depending on the crop's susceptibility to mechanical damage.

The rotary brush, estimated to cost $8,000, consists of five rows of 500 mm long polypropylene brushes on a 150 mm diameter tube. This 6 m wide unit is hydraulically driven by a small independent gear pump and tank unit with pressure relief valve, mechanically powered from the harvester front drive-shaft. It is fitted ahead of the normal finger reel (see Fig. 3) and can rotate forward or backward at speeds up to 160 rpm.

During testing last season the rotary brush showed a high potential for dislodging snails and the ability to be gentle enough for crops like peas and harsh enough in tougher crops like wheat. The level of aggression can be adjusted by changing the operating height and the speed and direction of rotation.

Set up

Make every effort to separate and remove snails that enter the harvester and reach the cleaning sieves intact.

Any crushed snails reaching the grain can later be removed by air separation after drying.

Many farmers opt for high threshing intensity with the aim of crushing a majority of snails. This approach is sometimes combined with cutting lower to take in more straw with the aim of having as much snail meat as possible attach to straw and be evacuated in the chaff stream in an attempt to minimise the amount of snail material recycling with the tailings. However, this approach has little or no effect on smaller snails such as the conical species and typically increases the risks of clogging grain transfer and sieving components.

Sieves can be used to separate snails from grain where there is sufficient difference between snail size and the size of the grain. When snails are significantly bigger than the grain (e.g. large snails in canola) it is possible to 'scalp' snails and remove them at the sieves. When the snails are

FIG. 4: (LEFT) REPLACEMENT SIEVE FRAME FOR FIXED APERTURE SCREENS.

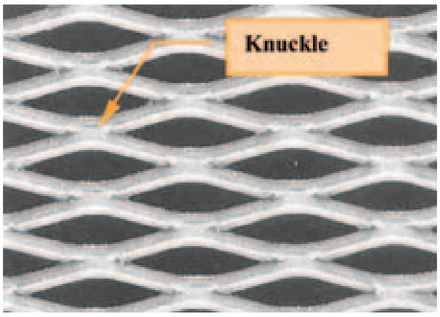

FIG. 5: (RIGHT) EXPANDED METAL MESH.

smaller than the grain (e.g. small snails in peas or beans) they can be sieved through the auger screens.

With intermediate-sized grains such as wheat and barley, the screening approach is less effective because many of the snails present are often similar in size to the grain.

Fixed aperture

The standard adjustable louvre sieves offer versatility in dealing with a range of crops but their ability to effectively remove snails from grain is limited. However, using a different type of screen in the chaffer (top sieve) or shoe (cleaning sieve) can improve snail removal. This requires replacing the louvre sieve with a purpose-designed frame (see Fig. 4) that allows sieves to be changed depending on grain and snail characteristics.

Because fixed-aperture screens typically have a lower open-area rating than louvre sieves they increase the proportion of material recycled through the threshing system, which reduces harvester efficiency. Reducing fan speed can minimise that effect, but the change to fixed aperture screens increases the reliance on physical screening and lowers the efficiency of air separation.

Light chains fixed to the top of sieve frames can reduce sieve clogging. Three chains 1.3 times longer than the sieve width will move back and forth with sieve movement, clearing sieve blockages.

Three main types of screens are available from a range of manufacturers, with off-the-shelf sizes varying with the manufacturer.

- Punched hole screens (PHS), with circular, oblong, square and hexagonal hole shapes are most common. Hole size and shape are chosen to suit crop type and seed size. Choose the highest available open area rating (proportion of screen area occupied by the holes) for maximum sieve capacity.

For screens with high open-area ratings, ensure the material is thick enough to provide adequate rigidity. Cost is related to the number of holes and the thickness of the sheet of material. A common sheet size is 2.4 m x 1.2 m. The smooth part of the screen should face upward when in place in the harvester.

Manufacturers include Richardson Pacific Ltd (ph 08 8352 3944), Masfield Manufacturing Pty Ltd (ph 03 5443 2687) and Metal Mesh Pty Ltd (ph 03 3588 1990).

- Expanded metal meshes (EMM) are manufactured by splitting and stretching solid metal sheets. This results in diamond-shaped openings that, in the standard form (raised profile), are set at an angle to the plane of the sheet. The openings have long and short-way pitch values; the ratio of which dictates the length of each the opening. These screens are typically installed so the short-way pitch is parallel to the direction of travel. Because the openings are angled there is also a preferred direction to expose the maximum open area of the screen. This is achieved when the knuckle joints (see Fig. 5) face forward within the harvester.

Placing the screen in the opposite position improves its ability to drive products across the sieve area but reduces the sieve capacity. This increases rear losses from the chaffer or the repeat ratio from the cleaning sieve, which can lead to cleaner samples.

Flattened profiles do not have this characteristic and are characterised by lower open-area ratings. Common sizes include 1.2 m x 2.4 m and 1.2 m square sheets.

Screens with flattened profiles may more easily trap residue and promote sieve clogging. Manufacturers include Expamet Pty Ltd (ph 08 8276 4745), BHP Lysaght products (ph 08 8447 9666) and Metal Mesh Pty Ltd (ph 03 3588 1990).

- Woven and welded wire meshes (WWM) are characterised by wire diameter and a square/rectangular aperture size. The screens are typically ordered to length from rolls with widths of 0.6 m to 1.8 m. Select the hole size to suit seed size and the minimum wire diameter needed to ensure the rigidity required to maximise screen capacity. These meshes need to be secured at the edges after cutting to size to ensure they do not fray. Welded mesh is less likely to trap residue and promote clogging.

Table 1: Example start-up sieve combinations for tested crops

CROP	CHAFFER SCREEN			CLEANING SCREEN (SHOE)		
	PHS	EMM	WWM	PHS	EMM	WWM
Canola	4.76 mm round 3.97 mm round	7 x 19 mm 6 x 16 mm 5.5 x 10 mm	3.25 mm	3.25 mm round 2.41 mm round*	3.5 x 6 mm	
Peas	11 mm round	--	10 mm	9.53 mm hex 9.53 mm round*	--	8 mm
Barley	9.5 mm hex	9 x 28 mm	8 mm	7.94 mm round	7 x 19 mm	6.3 mm

NB: SIZES ARE THE HOLE SIZE (PHS), NOMINAL MESH SIZE (EMM) AND APERTURE SIZE (WWM).

NOTE: SUITABILITY OF CHAFFER/SHOE SET-UP – E.G. SNAIL REMOVAL, CLOGGING ETC. - WILL VARY WITH EACH CROP SITUATION DEPENDING ON VARIETY, SEASON, WEEDS AND SNAIL NUMBERS. USE OF INTERMEDIATE SIZES CAN IMPROVE SNAIL REMOVAL BUT MAY SIGNIFICANTLY REDUCE HARVESTER EFFICIENCY.

* HIGHER RISK OF CLOGGING DEPENDING ON SEED SIZE.

Manufacturers include Melwire Hallweld Bennett Pty Ltd (ph 08 8347 0800) and Metal Mesh Pty Ltd (ph 03 3588 1990).

Options

Fixed-aperture screen sizes come in a variety of off-the-shelf sizes and example start-up combinations for a range of crops are given in Table 1. To optimise snail removal, these combinations will require fine tuning with intermediate screen sizes (higher cost), depending upon each crop situation and the acceptable level of compromise in harvester throughput. Self-cleaning modifications such as loose sweeping chains and double screen and rubber ball compartments can be added to minimise clogging.

Smaller apertures sizes on the chaffer will quickly increase rear losses, while reducing aperture size on the shoe will increase the amount of material recycling through the repeats.

Generally, farmers have used two separate concepts when adopting fixed aperture screens:

- a single sieve upgrade or chaffer-only set up combined with removing or fully opening the cleaning sieve.
- a dual sieve upgrade or chaffer/shoe set-up.

Experimental data shows that chaffer-only set-ups have limited capacity due to high potential rear losses but offer the practical benefits of not requiring removal of the shoe; a complicated process on some harvesters. Threshing also needs to be more thorough with a chaffer-only configuration because un-threshed heads or pods typically end up as rear losses.

Better results are achieved from a chaffer/shoe set-up, which provides a two-stage separation process. The operator can choose to optimise the performance of one or both sieves independently of one another. This configuration also provides the option, where the repeat stream is low in grain and high in snails, of wasting the repeats onto the ground to minimise the risk of clogging in the recycling systems.

Conclusions

Harvester modifications for handling snails will involve compromises around harvester efficiency and losses, separation/dislodging effectiveness and sample quality.

In most instances the priority should be reducing snail intake into the harvester by any means available, while aiming to keep crop loss due to snail reduction measures to a minimum.

The ability to change the degree of snail dislodging actions from gentle to aggressive across a range of crops is key to maximising the benefits of the mechanical dislodging approach.

Fixed-aperture sieves can provide effective solutions in many situations. For best results this approach requires an investment in a range of screen types and sizes, and regular re-assessment of the screens and harvester settings used for each crop situation.

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