

# Research Report

Kondinin Group



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## THE WAR AGAINST WEEDS

# HARVEST WEED SEED WARRIORS

**WEED**  
**smart**  
every weed every seed  
every farm every year





**Vertically challenged:** As one of the newer chaff mills on the market, the vertical HSD represents a radical departure in design from DeBruin's hydraulically-driven integrated Harrington Seed Destructor. While the mill units are common to both designs, the drive, layout and positioning of the mills is a clean-sheet design.

# The latest in harvest weed seed control methods

The inclusion of a harvest weed seed control option in the battle against weeds is well understood by growers. Leading weed research outcome communicators, Weedsmart, refers to harvest weed seed control as one of its "Big 6", comprising six core points to winning the battle against crop weeds. Kondinin Group researchers spoke to more than 20 farmers in compiling this report, which updates a similar report from February 2018 with a focus on the latest and most expensive harvest weed seed control technology; chaff mills.

**H**erbicides, crop competition, and natural seed decay usually provides around 98 per cent total control of annual ryegrass and usually holds the weed seed bank numbers level.

Assuming 98 per cent total control is achieved, the addition of a harvest weed seed control option can begin to erode the weed seed bank.

Between 50 and 90 per cent of target species such as annual ryegrass and wild radish in a paddock make their way through the harvester depending on the time of harvest and weed species.

Even if harvest weed seed control only achieves 50 per cent removal of any weed seeds standing in the paddock, (60 to 70 per cent is common), the total weed seed control level is increased from 98 to 99 per cent.

Ninety-nine per cent total control is sufficient to start reducing numbers in the weed seed bank.

Harvest weed seed control can be achieved by employing a number of

methods and each has an inherent labour, nutrition or time cost. But for whole-of-farm operations, for example, the inclusion of sheep in addition to the cropping operation can tilt some harvest weed seed control options in favour over others.

## WHAT ARE THE OPTIONS?

Of the growers utilising some form of harvest weed seed control, two in five are employing more than one option, this demonstrates different approaches can be more suited to weed density loading, overall enterprise production mix or crop type. Each option has benefits and disadvantages and comes at a range of costs.

Dr Michael Walsh conducted over two

dozen trials looking at the comparative efficacy of the Harrington Seed Destructor (HSD), chaff cart, and a windrow burn. All performed equally and resulted in a 60 per cent reduction in overall ryegrass germination the following year.

## TIMING IS IMPORTANT

Getting in early is also important, as weed seeds will continue to shed after the crop ripens and is ready for harvest.

For example, research has demonstrated that at just two weeks past crop maturity, around 11 per cent of annual ryegrass seeds and 21 per cent of wild oat seeds will have already shed and therefore harvest weed seed control is reduced.

The Kondinin Group research team would like to thank: Peter Newman and the Australian Herbicide Resistance Initiative team, Dr Michael Walsh University of Sydney and research partners, Nick Berry and the Seed Terminator team, Devon Gilmour and Duncan Murdoch and the McIntosh Distribution team, Marney Strachan, Trevor Thiessen and Dean Mayerle - Redekop, Tom Lewis and the TecFarm team, Siegert family, Haywood family, Lawson Grains, Andrew Todd, Aaron Beugge, Graham Dickson, Candeloro family, Roger and Alex Newman, Chris Schell, Brendan Williams, David Treweek, Brodie Cunningham, Rod and Courtney Shaddick, Sam Trengove and others involved in assisting with information to compile this report.



Narrow windrows offer an alternative to a full paddock burn. But narrow windrow burning still removes up to 50 per cent more residue than chaff-only methods, so nutrient removal can be expensive.



## NARROW WINDROW BURNING

Confining the chaff and straw into a narrow windrow for burning is an alternative to chaff carts but where chaff carts remove between 10 and 30 per cent of the crop residue, narrow windrows remove 50 per cent, as the harvested straw is added to the windrow to aid burning.

This means that while the weed-seed kill outcome is superior to a full paddock burn thanks to a concentration of fuel and a resulting hotter burn, the cost is higher because more nutrients are removed. In a controlled traffic or permanent harvest run-line scenario, this is exacerbated because post-burn residual potassium becomes concentrated along a single path and is lost.

Concerns regarding nutrient removal in a windrow burn are less for lower rainfall environments with soils containing high levels of potassium.

## CHAFFLINING

A chaff lining chute offers a low-cost approach to aggregating chaff in a narrow row. While some issues exist with harbouring or feeding pests with the chaff residue, and plant establishment in the chaff-line is not optimal, the system is simple to implement.

Essentially, the chute captures everything coming off the sieves and drops it in a narrow band behind the harvester. The chaff, including the weed seeds can then rot in the narrow row.

Preliminary research conducted by George Lehman (USyd honours student) determined that ungrazed chafflining is highly effective, reducing viable weed seeds captured in the chaff stream. With over 2200 ryegrass weed seeds measured per lineal metre of chaffline immediately after harvesting a low yielding wheat crop (0.61t/ha), just seven ryegrass plants emerged in a one metre square encompassing that chaffline.

Grazing, while providing a ration for sheep over summer, (approximately 2 DSE consumed about 38 per cent of the chaff biomass over a four month period), saw emerging ryegrass increase significantly to 84 plants germinating in a one metre square area encompassing the chaffline.

The Australian Herbicide Resistance Initiative (AHRI) recommends maintaining year-on-year consistent chaff-line placement to concentrate weed seeds. It also allows the option of dropping a canola windrow on the chaff-line and burning it as part of the rotation. If farming under a controlled traffic farming (CTF) system, a chaff-deck may be an alternative.

The only drawback with chafflining is that nutrients are concentrated in a very narrow band and may lead to uneven crop development and ripening.

Numerous chute designs have been fashioned using an array of materials,

including cutup intermediate bulk containers (IBCs) and scrap sheetmetal.

While many of these chutes have been home-made with varying levels of success, they can also be purchased as a professionally fabricated bolt-on product.

Western Australian based, WestOz boilermakers has developed a range of bolt-on kits to fit most harvester brands.

Kits are available for John Deere S600 and S700 series for \$5150 excluding GST. John Deere 50, 60 and 70 series STS with or without MAV cost \$3920. CaseIH 7010, 7120, 8010, 8120, 9120, 7230, 8230, 9230, 7240, 8240 and the 9240 as well as the new 250 series sell for \$4760. New Holland kits are available from the CR960 onwards up to the 10.90 narrow and wide body models kits cost \$5370 and \$5455 respectively. Claas wide body kits are available for \$3860.

Contact WestOz on 0428 540 323. ▶





## BALING

Hay crops that remove all plant material will also take weed seed in the process. Some growers will bale high weed pressure areas around crops prior to harvest to assist in keeping weed number in check.

Baling when harvesting with the Glenvar Bale Direct system gathers all chaff and straw from the back of the harvester and bales it, thereby removing all weed seeds at the same time. With it goes any nutrient value the crop residue may contain, but the straw bales made with the Bale Direct system can be utilised as stock feed, bedding, strawboard or the cellulose component in fuel.

Adapting the Bale Direct system to a harvester requires some minor modifications to both the harvester and baler.

The Bale Direct method uses around 70kW of power from the harvester engine, but this is offset by around a 30kW power saving from not spreading residue.

The pick-up on the baler is removed and replaced with a belt-conveyor to carry chaff and straw into the baling chamber.



The harvester-integrated kit is typically fitted by a dealer. Removing the bale-direct system is less involved; unhitching, and re-fitting straw spreaders to take the harvester back to a regular configuration. Where a viable market for the straw exists, the bale direct system could work for growers and generate additional

income, but if not, the cost of removed nutrient may exceed the financial benefit gained. Bale Direct has a higher weed-seed capture potential over conventional residue windrowing and secondary baling.

A mechanical drive option will soon be available, with a John Deere kit the first of these to be produced.

## CHAFF CARTS

Chaff carts rely on weed seeds being collected through the harvester before being transported off the back of the sieves via a hydraulically-driven conveyor belt in the cart.

Chaff dumping is usually timed so that dumps are placed in a straight line to make fire breaks simpler when the dumps are burnt.

Alternatively, with around nine per cent of the chaff collected containing weed seeds along with portions of broken grain kernels, dumps can be effectively grazed.

With lambs, sheep and wool stacking up well financially, the nutritional value of the chaff dump can provide a significant ration.

According to AHRI, less than three per cent of annual ryegrass seeds will survive digestion through a sheep.

Chaff carts are built in sizes between 30 cubic metres and 50 cubic metres and cost between \$65,000 to \$80,000 excluding GST to purchase new. Depending on the make, they can be purchased at around 50 per cent of new prices second-hand with some growers moving to alternative weed seed control methods including chaff mills.

Because they need to be hydraulically connected and set-up to capture the chaff, dropping the chaff-cart off is simple if going to, for example, chaff-lining. But to go back to standard specification may be more complex depending on the make of harvester.

Getting the mix of straw and chaff right for an efficient, hot and rapid burn of chaff dumps can also require some refinement. Options include in-cart cameras, automated dumping at pre-set programmed locations and configuration to adhere to 3m or 4m wheel centres to match CTF operations.

Cost of operation in addition to nutrient removal depends on yield, but as an example, a figure of \$14/ha including nutrient removal was quoted by WeedSmart in 2000ha of wheat averaging 2t/ha.

Of this \$14/ha, \$8/ha is the cost of using the chaff cart. If grazing the chaff dumps and not burning them as per the WeedSmart example, the feed value could reduce this to \$8/ha.

With significant feed shortages nationwide at the end of the 2019 harvest, several growers have baled chaff dumps with varying degrees of success. The process generally relies on jury-rigging arrangements to spread out the dump, which can then be raked and baled. But this also runs the risk of spreading captured weed seeds, and can be problematic and dusty to bale.







# Free online courses from WeedSmart to help growers & agronomists win the battle against herbicide resistant weeds.

**We recognise that the herbicide-only era is over.** Diversity Era acknowledges that the solution to herbicide resistance is not the next herbicide & in order to act, we need to be educated. To sustain herbicides into the future, we aim to incorporate DIVERSITY in tools & tactics in our farming systems to combat weeds and drive productivity.



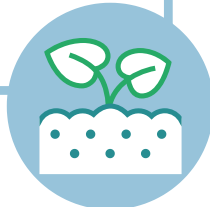
## HERBICIDE RESISTANCE 101

This course covers the different types of target & non-target site resistance in simple terms.

Plus there are practical tips to help you tackle these resistance mechanisms in the field.

## PRE-EMERGENT HERBICIDES 101

This course covers why pre-emergent herbicides are an important tool in Australian cropping systems & how they can help to manage herbicide resistance in crop weeds in both winter and summer cropping systems.



## HARVEST WEED SEED CONTROL 101



This course covers the science of harvest weed control, the nutrient implications, & the costs of all the different tools.

We'll run through all of the six different HWSC tools, talking about the pros & cons and about where they fit in the farming system!

## CROP COMPETITION 101

This course delivers research & practical information on crop competition tools in winter and cropping systems, including understanding row spacing, seeding rate, crop vigour & crop orientation.



Check out the Diversity Era free online courses



Diversity Era is a WeedSmart initiative

**WEED smart**  
every weed every seed  
every farm every year



### CHAFF DECKS

A similar approach to chaff-lining, chaff decks drop the chaff portion of residue in the permanent wheel tracks of a CTF system.

Consolidated in the wheel tracks, the seeds can rot as they do in chaff-lining, but if any survive, they have to penetrate the highly trafficked soil and then are likely to be driven over again.

If substantial emergence occurs, the weeds can be sprayed out with a targeted application.

Kondinin Group engineers have seen a number of home-made units, but Primary Sales are the agents for the commercially-built Emar chaff-decks.

Primary Sales have worked hard to improve fitting instructions over the last two years and owners recently purchasing the Emar chaff deck report installation takes less than a day.

As a side-benefit, some owners have reported significantly reduced dust levels when conducting postharvest summer sprays.



### CHAFF MILLS

The concept of mills for weed seeds on harvesters has been around for over a decade now. But only in the last five years have they been available as integrated units.

Chaff mills work by shearing, crushing, grinding and impacting weed seeds contained in the chaff fraction of harvest residue.

The Harvestaire Rotomill kicked it all off in around 2000 with *Farming Ahead* reporting “100 per cent weed seed kill measured by Dr Michael Walsh and this was achieved at 4000rpm”.

Credit for the concept must go to Ray Harrington for persisting with the idea, and Grains Research and Development Corporation for funding the research and

path to commercialisation. Dr Walsh is still heavily involved in testing various methods of weed seed kill methods today.

Initial commercial HSD units were tow-behind and hydraulically driven using a separate engine, and were soon followed by more hydraulic drive installations, this time integrated into the harvester and driven by its engine.

Since our report in 2018, mill technology has improved significantly and reliability has followed suit.

Mills are now almost exclusively mechanically driven with very few hydraulic HSD units now being sold.

The mechanical drive is delivering the efficiency benefits that could be expected over a hydraulic drive which robbed power

and generated excessive levels of heat. Double or triple-rib belts are used to drive the mills from an engine jackshaft pulley.

It would be fair to say that the departure from hydraulically driven mills has seen the development of more efficient and reliable systems available today.

The most recent manufacturers on the scene, Redekop and TecFarm, have also opted for mechanical drive mills.

Both manufacturers of chaff mills featured in our 2018 report have implemented significant changes to their designs.

HSD manufacturer DeBruin Engineering and supporting dealer McIntosh Distribution have focussed heavily on their new design with vertically orientated mills and a central auger on the same shaft feeding these mills with chaff material as it comes off the sieves.

Seed Terminator has also undertaken design changes to their mill with more abrasive-resistant steel selected for mill fabrication to improve longevity. Tweaks to the stator design have improved aerodynamics and material flow, reducing power requirements.

Kondinin Group engineers agree that while the advice in 2018 was to wait until mill designs had matured, we are pleased to report that this has now largely been achieved. Provided weed kill efficacy is substantiated, the mechanical drive mills are operating reliably and effectively provided an allowance for the power to drive the mill has been considered.







## SURVEY DATA

In Kondinin Group research from the April 2019 National Agricultural Survey, Growers were asked to indicate harvest weed seed control measures used or planned for implementation over the next year as at April 2019. See Figure 1.

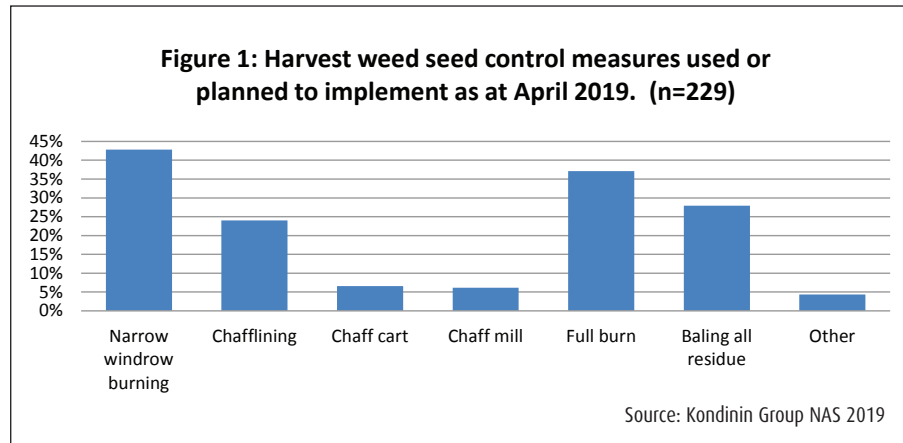
Collated data indicates that narrow windrow burning is the most practiced method of harvest weed seed control methods but 42 per cent of survey respondents indicated they had implemented two or more of the options for managing weed seeds at harvest.

A full burn was regularly performed by 33 per cent of growers while a surprising 28 per cent of growers indicated they baled all crop residue.

While still a relatively recent method of harvest weed seed control, almost a quarter of growers had implemented or were looking to implement chaff lining.

Baling residue could include both Baledirect or baling straw. The former is likely to gather significantly more weed seeds than a cut, rake and bale or baling windrowed straw where a lot of weed seeds are likely to be lost in the process.

Geographically, Western Australian



growers were more likely to have plans to, or have already implemented a harvest weed seed control strategy according to the survey.

More than two-thirds of Western Australian growers indicated the adoption of one or more harvest weed seed control options.

### RISE OF THE CHAFF MILL

Anecdotal evidence would suggest that since the survey was completed nine months ago, the six per cent adoption or planned

adoption of chaff mills may underestimate the current level of interest.

Kondinin Group researchers have been asked with increasing frequency by members for opinions and data pertaining to chaff mill performance.

Until now, these are difficult questions to answer because of frequent changes in design in established chaff mills, the iHSD and Seed Terminator, or arrivals to the market including the Redekop SCU and TecFarm Weedhog. ▶

## WEED smart

Harvest Weed Seed Control is one of the WeedSmart Big 6 & allows growers to capture weed seed survivors at harvest using chaff lining, chaff tramlining, chaff carts, narrow windrow burning or weed seed impact mills.

WeedSmart has a bunch of practical & informative resources on how to use each of the harvest weed seed control tools, including case studies of growers using different tools, set-up videos, cost estimate tools, an online course & so much more!

Check out the  
WeedSmart HWSC  
resources



“Harvest weed seed control has been a really important tool for the past 6 years, it is almost **the only thing** we can do at the end of the season.

You sit down and do the numbers on what the management implications would be for ongoing generations of ryegrass and it's a **no-brainer**.

– Ben Ball, Wagin, WA



@WeedSmartAU



**Table 1.** Chaff mill annual ryegrass (*Lolium rigidum*) confirmed and claimed kill rates

Mill	Manufacturer	Kill rate	Source	Notes
Hydraulic iHSD	DeBruin	95%/98%	Walsh <i>et al</i>	In-field testing
HSD Vertical high speed/high kill	DeBruin	98%	Walsh <i>et al</i>	In-field testing
HSD Vertical mid speed/high kill	DeBruin	95%	Walsh <i>et al</i>	In-field testing
Seed Terminator MY17	Seed Terminator	98%	Walsh <i>et al</i>	In-field testing
Seed Terminator Standard	Seed Terminator	98%	University of Adelaide	Laboratory bench testing
Seed Terminator HiFlo	Seed Terminator	85-90%	University of Adelaide	Laboratory bench testing
SCU	Redekop	approx 95%	Manufacturer	Claimed initial result with ryegrass. Figure to be confirmed.
WeedHog	TecFarm	80%	Manufacturer	In-field testing

## STANDARD KILL TEST REQUIRED

With an increasing number of growers wanting to make an informed chaff mill purchasing decision, comparative and current kill rate specifications are difficult to find.

In individual consultation with manufacturers and researchers, each has conveyed a willingness to actively participate in the development of a defined and agreed standard test protocol.

All parties agree that an established protocol will assist benchmarking kill levels and aid future development.

Agreement from manufacturers and researchers on managing variables and test methods would need to be established in the process of developing a formal test protocol.

In much the same way as the Australian Fertiliser Services Association (AFSA) worked to develop an industry recognised, repeatable standard for testing fertiliser spreader performance, a comparable test protocol for harvest weed seed kill could also be settled.

The protocol should also ensure a regular review timeline to be updated as chaff mill technology evolves into the future.

The establishment of this standard would allow growers to directly compare mill performance and be confident that the cost of running a chaff mill was delivering the results expected.

The Kondinin Group research team is working to facilitate the development of this agreed protocol in collaboration with industry, manufacturers and researchers.

## KILL RATE INFLUENCE

Chaff mill kill rates are influenced by a wide range of factors including mill design, mill speed, chaff throughput rates, weed seed species and seed weight and moisture content. In all cases, annual ryegrass is used as the benchmark test weed seed as it is typically the most difficult to kill.

## MILL TESTING IN THE LAB

Laboratory-based testing of chaff mills for weed kill involves a mill set up to run on a test-bench with a counted number, (typically 5000), dyed ryegrass seeds of a known germination mixed with a fixed volume of wheat chaff.

The seed and chaff material is fed through the mills at a specified rate from a conveyor belt and all material passed through the mills is then collected in a large sock, much like a yard leaf vacuum mulcher bag.

This milled material is then handled one of two ways. The more labour intensive method is to manually scour through the milled material searching for the dyed weed seeds and propagating these in agar, a sterile medium used to germinate plants in a laboratory environment. The fraction of surviving seeds is established by counting the number of germinated ryegrass seeds.

Alternatively, a sub-sample of all the collected milled chaff and weed seed material is spread out onto soil trays and regularly watered up, taking a count of germinating weed seeds in the trays to establish the surviving fraction of weed seeds.

## MILL TESTING IN THE FIELD

As an alternative to the laboratory-based bench test, recent testing by the University of Sydney has incorporated in-field test methods.

The field testing of chaff mills uses a tube extending from the engine deck at the rear of the harvester down into the left-hand chaff mill.

The tube is used to manually dose the chaff mill with dyed weed seeds while the harvester is in operation in a paddock under operating conditions. Typically the test occurs over a 10m run with chaff fed through the harvester as it would in operation.

Material exiting the mills is again collected in large sacks and as with the laboratory-based testing, one of two methods is used to evaluate weed seed survival numbers.

This method is arguably open to more uncontrolled variables, not the least being harvester setup, but is a more rapid and less onerous approach to evaluating mill performance. The paddock has to be free of any ryegrass which may influence the results. To reduce errors and improve data quality, the process is replicated ten times.

## CURRENT KNOWLEDGE AND TESTING

Dr Michael Walsh, the Director of Weed Research at the University of Sydney has

undertaken numerous tests of chaff mills both laboratory-based and in-field.

Most recently, in-field testing using the weed seed dosing tube has been the most prevalent method of weed seed kill testing employed by Dr Walsh and his collaborative research team.

Testing by Dr Walsh *et al* has included iHSD, vertical HSD and the 2017 build Seed Terminator mills.

Manufacturers have also been actively testing variations on mill performance.

Seed Terminator refers to both internal and third-party testing undertaken via a South Australian Grain Industry Trust (SAGIT) project by the University of Adelaide weeds research group.

DeBruin (licensees for the iHSD/vertical HSD) refers to research work by Dr Walsh and his team to validate its advertised kill rates.

TecFarm has carried out in-house testing utilising a consulting agricultural scientist, Agtech Innovations, employing a similar technique to Dr Walsh and his team.

Redekop initially utilised canola to conduct baseline testing to correlate weed seed kill rates but has recently commissioned a third party to test its mills with ryegrass seeds.

## KILLING BY THE NUMBERS

On a research level, Dr Walsh and his collaborative research partners have found results that should give growers confidence in the technology.

In a research paper due to be released at the GRDC updates from Walsh and his research partners, kill rates for vertical mills matched that of the original horizontally orientated mills at 95 per cent while figures for the MY17 mill design from Seed Terminator were measured at 99 per cent. At the time of press, Redekop was working on finalising ryegrass seed kill testing results.

Kill rates quoted may have also been measured by manufacturers adopting similar protocol to Dr Walsh. These should be viewed in the context that kill rates can be influenced by a range of variables, highlighting the need for independent testing and an agreed and standardised protocol that will account for all of these variables. See Table 1.

## JUST HOW MUCH KILL IS REQUIRED?

There seems to be a lot of fuss around kill rates and rightfully so. The expense of adding and running a mill needs to be justified with good results. But at what cost?

If we are accounting for 98 per cent control of weed seeds with herbicides, crop competition and natural seed decay, what fraction of the weed seeds collected at harvest need to be killed when using a chaff mill to reduce the weed seed bank?

It is possible to capture between 50 per cent and 90 per cent of weed seeds with the harvester. So assuming a typical portion, say two-thirds of annual ryegrass weed seeds are captured, does it really matter if we are killing 80 per cent, 95 per cent or 98 per cent of these?

There is a variety of opinions on the answer to this question.

AHRI western extension agronomist, Peter Newman, says growers need a choice to be able to balance the requirement for harvester capacity and weed seed kill. In many cases, things like standing crop risk could be the more pressing matter.

Dr Walsh says that if a grain grower is going to the trouble of targeting weed seeds during harvest, then the aim should be to kill as many as possible.

He adds that mills also need to be able to kill more weed seeds than other options, like chaffining to justify their expense and complexity.

As with anything in farming, we suggest there are compromises to make. Maintaining harvest capacity is important for most growers. But delays in harvest due to capacity decreases could see significant weed seed shedding, defeating the purpose of having the mill and adding significantly to the cost of harvest. The bottom line is that kill levels should be as high as possible without this capacity compromise in all crop conditions, including green GM canola.

## MUSCLE-UP TO MAINTAIN CAPACITY

If you are planning on installing a mill, expect to either lose some harvest capacity as chaff mills rob the harvester of engine power.



A fully loaded mill can consume as much as 72kW according to manufacturer-provided data when harvesting at 60t/h in wheat.

Options to maintain capacity include purchasing a larger capacity harvester at the time of ordering the chaff mill knowing that the mills will be consuming power.

Some growers fitting mills to existing harvesters have opted to remap or chip engines to extract additional horsepower to run the chaff mill without impacting machine capacity. Chips or remaps cost around \$4000 and can vary in performance.

One grower operating a New Holland 8.90 had a 37kW (50hp) engine remap installed and found no significant improvement in capacity or engine performance. After uninstalling the remap, he subsequently fitted a Steinbauer chip promising a 20 per cent engine power increase and gained a 15 per cent improvement in capacity and improved fuel efficiency. Kondinin Group engineers are keen to investigate engine remapping and chipping options in the future.

Warranty implications for a new machine should also be considered by growers if contemplating the installation of a chip or engine remap.

## CROP IMPACTS

Crop types can impact on mill capacity. Green (particularly GM) canola is especially difficult to handle and provides mill owners with the majority of blockage problems.

Of the cereals, wheat has the highest volume of chaff per tonne of harvested grain so is the most difficult crop for chaff mills to handle.

Barley has a slightly higher harvest index (ratio of grain to residue) than wheat, but barley also has a higher ratio of straw to chaff. This means the capacity impact through the use of chaff mills in barley is usually less pronounced than in wheat. ▶

## WEEDSMART WEEK

WEEDSMART WEEK IS WEEDSMART'S ANNUAL FLAGSHIP EVENT TO ENGAGE GROWERS & AGRONOMISTS ON THE WEEDSMART BIG 6 MESSAGES.

A day of presentations, followed by two days of farm visits, you will hear first-hand from growers & agronomists about innovative weed management practices to minimise the impact of herbicide resistance.

In 2020 we will be hosting WeedSmart Week in **Clare, SA** and in **2021, Esperance WA**.

More information on past & upcoming events can be found here



**WEED smart**  
every weed every seed  
every farm every year

The industry voice that delivers science-backed weed control solutions



@WeedSmartAU





### MILL WEAR RATES

Kondinin Group has encouraged growers and manufacturers to move away from expressing mill wear in hours.

More important than the number of rotor hours is the crop type, yield, area, and condition as well as soil type and crop cut height as these all impact on mill life.

Sand and soil wears mills out significantly quicker than chaff, grain and seeds. As a result, pulse crops are particularly harsh on mills as growers usually have the harvester front very low, increasing sand and soil intake and causing high rates of wear as it exits through the mills.

Mills stators or screens will typically wear more on the outer ring than the inner, so the ability to replace individual stator rings could ensure maximum life is extracted from the whole of the mill.



### FOREIGN OBJECTS

Kondinin Group engineers have experienced first-hand what can happen when foreign objects pass through mills when a fire started in stubble after piece of sieve went through a mill after inspection.

Manufacturers are starting to address this issue. For example, Seed Terminator has developed a high strength magnetic strip mounted behind the sieves, designed to catch metal objects before they enter the mill.

The DeBruin vertical HSD has, by the nature of its design, an integrated rock trap below the lateral chaff auger to capture rocks and heavy objects and prevent them from entering the mill.

Capturing stones, forgotten tools, wire and even harvester parts before they enter the mill is important because they can cause extensive damage to the mills or harvester and in some cases, could start a fire.



### HARVESTER SETUP AND MAINTENANCE ESSENTIAL

One of the most important learnings from conversations with chaff mill operators and manufacturers over the 2019 harvest was the importance of machine setup.

Good straw and chaff separation is essential. It prevents the mills from unnecessarily processing straw and overworking. It also assists in preventing mill bridging, where mills can be temporarily bridged by straw and then overloaded as a large dose of chaff breaks through and floods the mills.

In many cases a relatively low cost baffle plate above the chaff mills can assist in maintaining residue separation. In New Holland harvesters, the optional Positive Straw Discharge (PSD) straw conveyor may be considered as an upgrade alternative.

Concave settings also need to be optimised as over-threshing in the concaves can increase the volume of small sections of straw that go into the chaff stream and ultimately into the mill.

Uniformity of sieve loading ensures mills are fed evenly, equally sharing the load and wearing at a uniform rate.

Increased dust levels caused by the processing of the chaff may also see air filters block sooner than they normally would and can increase the risk of fires. Growers with chaff mills fitted are advised to maintain vigilance and blow down more regularly if needed.

### GET IN EARLY

This year will undoubtedly be a big one for chaff mill installations and manufacturers are preparing themselves for the onslaught.

All manufacturers are encouraging growers to place early orders to ensure there is ample time to supply and install prior to harvest.

As an incentive to support early ordering, both Seed Terminator and McIntosh have early order programs that offer up-front discounts or allow growers to buy and have mills fitted now, with a pay later (July 30) scheme respectively.

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### WIDER TURNS AND WHEEL TRACK WOES

One of the issues with fitting mechanical-drive mills and the associated drive-belts is that the pivot of the rear steering wheels can require limiting to prevent damage.

Depending on tyre selection, one option is to adjust rim fitment or modify the steering axle to widen the rear wheel track. Rear axles can also be repositioned, effectively raising the back of the harvester to create more clearance.

More typically, collars on the steering rams are used to limit steering angles and prevent the rear steering wheels from contacting the mill or drive. In most cases, only one side is prone to contact so only one steering ram may need to be limited.

Harvesters running on 3m centres are particularly prone and steering angle may be significantly more restricted depending on the harvester model.

# Running costs for chaff mills

Mills can cost up to \$120,000 excluding GST (fitted). They also see fuel consumption increase and maintenance costs go up as mills wear out and have to be replaced. Considering these costs should be part of the equation when calculating the running cost of a chaff mill as a harvest weed seed control method.

**K**ondinin Group research from the 2017 harvest determined that as an example, a net cost of around \$12/ha on a typical broadacre Western Australian farm. Research under the South Australian Grains Industry Trust (SAGIT) suggests this could be double that figure with smaller scale farms and higher yielding crops with more legumes in the rotation.

Costs to be considered include fuel, maintenance, capacity and opportunity cost along with the benefit of retained nutrient. Other factors that will influence the cost of running a chaff mill include wear rates in specific crops and conditions.

Due to the extent of frosted crop and relatively poor yields, data gathered for the 2019 harvest was not sufficiently conclusive to separate the relative performance metrics for the mills from DeBruin, Seed Terminator and Redekop.

But for the purposes of budgeting, an example for a Western Australian farm of typical scale harvesting 2000ha of wheat averaging 2.5t/ha follows:

**Fuel use:** Typical fuel use in a modern harvester without a mill is around 2.3l/t of wheat harvested. Using this as a baseline and excluding data outliers and noted frosted crop areas, fuel use ranged similarly for all three makes, but averaged around 3.3l/t of harvested wheat crop meaning fuel use increased by around 1.0l/t of harvested crop over the 2.3l/t baseline. Using a nominal on-farm fuel price of \$1.35/litre equates to an additional fuel cost of around \$1.35/t or in a 2.5t/ha crop, \$3.38/ha.

**Mill maintenance:** As discussed previously, mill wear is highly variable depending on crop type, yield and cut height with lower-cut crops or other instances where high volumes of sand and soil may wear mills out sooner. Depending on the design, stators typically wear on the outer screens first. Some stators can be flipped to wear on both sides but cost significantly more to buy in the first instance negating the value of this feature. The cost of mills has increased marginally since 2018, but so too has the mill longevity it would seem. Estimates from growers suggest that our previously assumed \$1.75/tonne of harvested wheat is still close to the money.



**Capacity cost:** Previous Kondinin Group research indicated capacity cost as the most significant of all of the costs of running a chaff mill, putting it at around \$2.46/t of grain harvested. Improvements in design have seen a marginal decrease in the chaff mill impact on harvester capacity. But in almost all cases, harvesters had been remapped or chipped to accommodate the additional power requirement, thereby returning the harvester to a comparable capacity without a chaff mill. To purchase a remap or chip costs around \$4000 and while this could have some longer term implications for engine life, upgrading to the next harvester class has been put at around \$44,000. Either way, this cost should be added to the opportunity cost consideration.

**Opportunity cost:** Opportunity cost has decreased over the past two years thanks to lower entry price points for mill options. There is now a significant range from \$50-120,000, which at five per cent overdraft rates presents an annual opportunity cost of \$2500-\$6000 over 2000ha at 2.5t/ha equates to between \$0.50/t and \$1.20/t of wheat or on an area basis, \$1.25/ha and \$3/ha for this example. As noted above, additional opportunity costs should be added to

maintain capacity using software, a chip or a machine upgrade.

**Summary:** The cost of running a chaff mill has reduced in part because mill entry prices have reduced. Mills have become marginally more efficient and the significant capacity cost issue can be overcome with a couple of power upgrade options via engine management upgrades or harvester class upgrades. The bottom line is that if considering a chaff mill in a 2000ha scenario averaging 2.5t/ha of wheat, the cost is likely to be between \$4.35/t of crop produced and \$6.10/t (or \$10.88/ha and \$15.25/ha)

**Nutrient benefits:** Chaff mill costs can be partly offset if soils have low potassium levels. In this case a benefit of retaining the chaff of around \$5.63/ha applies for a 2.5t/ha crop.

**Depreciation:** Depreciation depends largely on the value of a used chaff mill. Given they can be removed and transferred to a new harvester and all wearing parts replaced with new, it is expected that chaff mills should hold their value unless the technology improves significantly. **FA**

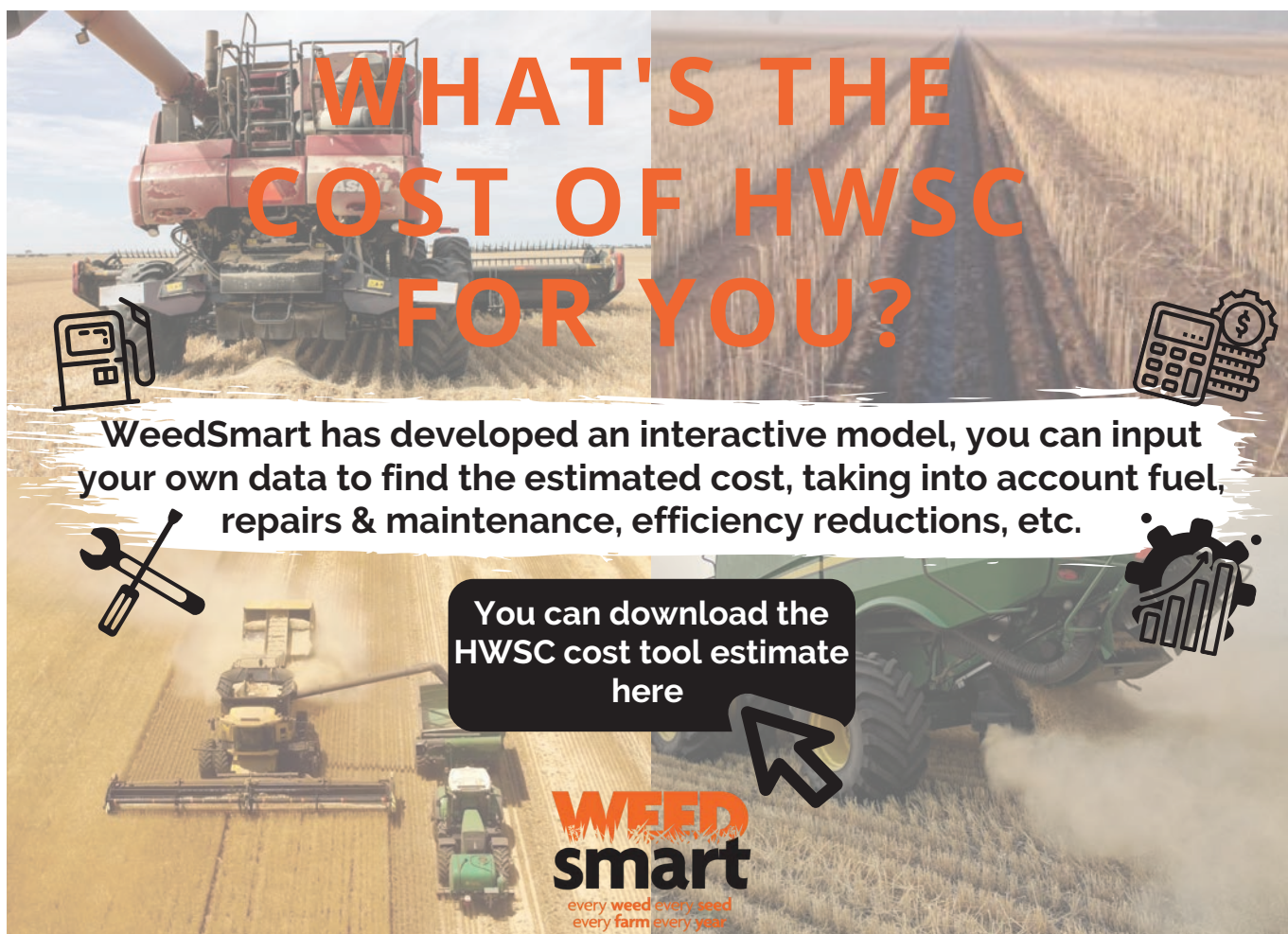


Chaff mill performance continues to improve in performance and reliability.



# Observations from the 2019 harvest


Kondinin Group engineers visited the owners and operators of around 24 mills working in the field over the 2019 harvest. All were current models or had recently been upgraded to 2019 specifications with update programs or replaced components.



## WHAT'S THE COST OF HWSC FOR YOU?

WeedSmart has developed an interactive model, you can input your own data to find the estimated cost, taking into account fuel, repairs & maintenance, efficiency reductions, etc.

You can download the HWSC cost tool estimate here





# Vertical HSD

**W**ith the hydraulic drive iHSD all but withdrawn, the mechanical-drive vertical HSD mill stepped in to fill its place and has performed very well in the 2019 harvest.

On the whole, mill life was reported favourably with few examples of significant wear available for illustration. Belt life was more problematic for one owner who modified the idler position to increase drive pulley wrap angles on a New Holland 9.90.

The move to a much smaller performance monitor was welcomed by those that had used the large display on the previous hydraulic iHSD. The new monitor on the

HSD comes in the form of a Farmscan Jackal multifunction monitor.

Two owners experienced uneven mill wear, reportedly as a result of machine setup, specifically, uneven sieve loading.

One owner mentioned that decals to specify drive belt tensioning could be clearer and another found a smoulder in the rock trap and suggested that needed to be something the manufacturer and owners should consider.

Those that had been on the development journey of the vertical HSD said that the stiffening parallel flange channel sections on the side of the mill had eliminated any cracking evident in a prototype model and made the unit significantly stronger. ▶

## WHAT WE LIKED

- ✓ High kill rates
- ✓ Simple to bypass mill – easy to evaluate sieve losses
- ✓ Simplicity of drivetrain, no gearboxes
- ✓ Service and backup

## WHAT COULD BE BETTER

- ✗ Chaff spread not as wide or uniform as others
- ✗ Installation can limit steering angles
- ✗ Belt removal required for disengaging
- ✗ No ISOBUS terminal integration option







Mill wear on a Case IH 9120 after 800ha barley averaging 1.4 t/ha, 1700ha of frost affected wheat averaging 1.3 t/ha.

Only one of the owners had installed a rubber mill bypass flap and opened the rear door when blocking became frustratingly frequent in green-stalk canola, opting instead for wide windrowing to keep the harvester rolling in this scenario.

Dust from the vertical HSD was specifically noted by three owners who said air filters needed to be cleaned more frequently, even more than once per day in some crop conditions.

The HSD has had a bumpy journey to get to where it is today but the mechanical

drive vertical mill option has been shown to achieve good kill rates in its new simple format.

The new design has seen several additional features incorporated over the previous hydraulic version, such as the rear access door enabling loss checks or loss monitor calibration and bypassing the mill completely.

There is also space, albeit tight, to remove the sieves without removing the mill, except on John Deere machines with one-piece sieves fitted.



Mill wear on a John Deere S680 after harvesting 650t of barley, 2580t of wheat, 225t of canola and 100t of oats.

A high moisture/ reduced kill mill is currently in development .

A point worthy of noting from our interviews was that every owner Kondinin Group researchers spoke to praised the service and backup from McIntosh.

With a purchase price of around \$85,000 the Vertical HSD arguably represents good value for money.

**More details:**

[www.mcintoshandson.com.au/ihsd](http://www.mcintoshandson.com.au/ihsd)



Mill wear after 1000ha canola at 1.2t/ha, 1000ha of barley at 3.5t/ha, 250ha wheat at 3t/ha.



Mill wear on a New Holland 10.90 after 900ha of canola at 1.3t/ha, 1200ha of barley averaging 3t/ha.



Lateral auger feeding each of the mills.





# Seed Terminator

Some of the seven Seed Terminator owners visited were on their third harvest with the chaff mill, having owned the mill since they were first released in 2017. Others were running a Seed Terminator for the first time.

All were running the 2019 version of the mill with all reporting improved mill wear and longevity. A number had a set of high-flow mills back in the shed but none had utilised them.

Power draw and capacity was still an issue for one owner who, part-way through harvest, installed a Steinbauer engine chip in a new New Holland 8.90 to take it up to around 9.90 equivalent power specifications. Post chip installation, the owner reported

the harvester had returned to an acceptable capacity, in line with what was expected from an 8.90 without a chaff mill fitted.

Two owners specifically noted they were happy with the width of milled chaff spread, saying that it made the full 12m working width even.

Two owners had issues with drive belts slipping. One found the wrong belt size had been supplied initially which was quickly rectified.

The Seed Terminator arguably has one of the highest kill rates of the mills on the market and since we last looked at it in detail in 2017, has been refined to reduce power draw while maintaining high levels of weed seed kill. ▶

## WHAT WE LIKED

- ✓ High kill rates
- ✓ Swapping mills takes only 20 minutes
- ✓ High flow reduced kill mill option
- ✓ Ongoing mill research and development

## WHAT COULD BE BETTER

- ✗ Bypassing and sieve loss check more complex than others (model dependent)
- ✗ Limited access to sieves (model dependent)
- ✗ Complexity of a gearbox (\$8956 replacement cost)
- ✗ No ISOBUS terminal integration option





Mill wear on a John Deere 9770 after harvesting 650t of barley, 2580t of wheat, 225t of canola and 100t of oats.



Mill wear on a Case IH AFS 7240 after 1000ha of frost affected wheat yielding 1.7t/ha, 500ha of canola averaging 1.2t/ha.

Significant research and development has gone into the mill design with numerous iterations to maintain performance but improve efficiency and mill longevity.

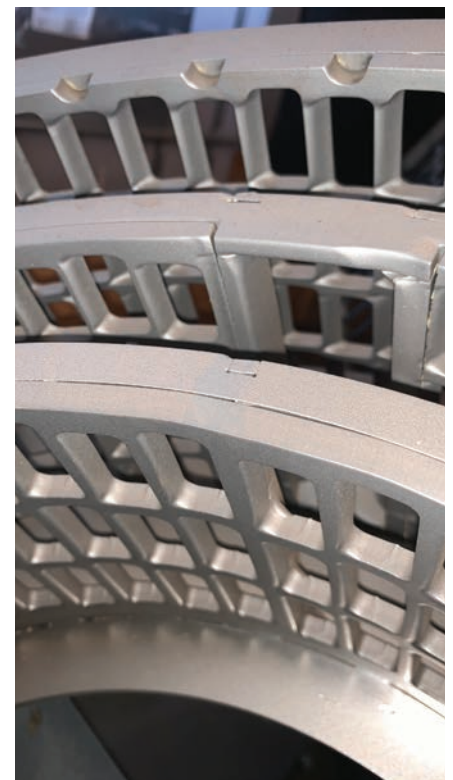
The Seed Terminator is probably the Rolls Royce selection, built with high level thinking and knowledge but the circa \$120,000 price tag reflects that also,

being significantly more expensive in the company of the competition.

**More details:** [www.seedterminator.com.au](http://www.seedterminator.com.au)



Mill wear on a John Deere S680 after 200ha of beans at 2t/ha, 400ha of canola at 1.5t/ha, 230ha of irrigated canola at 4t/ha, 550ha of barley at 5.5t/ha and 60 ha of wheat at 6t/ha.



Mill wear on a New Holland 8.90 after 2500ha of wheat yielding 1.3t/ha cut at under 100mm with significant sand and gravel ingress adding to wear rate.





# Redekop SCU

Owners and operators of Redekop SCU units were all happy with the reliability and ease of operation of the SCU. None reported any issues during operation, although the unit at this point has not had the same time in the field as the HSD and Seed Terminator

All owners found the chaff spread to be more than ample, particularly those running the Redekop MAV which helps spread the chaff as it is blown into the MAV air stream for the straw fraction.

Redekop has clearly worked closely with John Deere to refine simple things, including the ability for the SCU to be monitored through the Deere terminal in the cabin which makes the SCU look like a factory-fit option for John Deere harvester owners.

The SCU comes in two configuration specifications that relate more to the straw chopper than the chaff mill itself.

At \$110,000 for the SCU with a MAV chopper, or \$100,000 with a John Deere chopper, the neatly integrated SCU represents good value providing it makes the claimed kill rates.

At the time of press, substantial work had been done with canola to verify kill rates, but Australian farmers really need to know ryegrass seed kills tested using the same method as other mill kill test protocol. Redekop have reported that they working on this and official figures will be reportedly available in March.

The Redekop design incorporates several innovative features not found on other chaff mills. ▶

## WHAT WE LIKED

- ✓ Neat integration with John Deere harvester, ISO terminal and MAV straw chopper
- ✓ Simple mill bypass (on John Deere machines)
- ✓ Flippable mill design
- ✓ Even chaff spread when paired with MAV

## WHAT COULD BE BETTER

- ✗ No confirmed ryegrass kill figures available
- ✗ Most expensive mill replacement cost
- ✗ Design still evolving – currently only available for John Deere
- ✗ Added complexity of gearboxes





Mill wear on a John Deere S680 after 100ha lupins at 1.8t/ha, 600ha canola at 1.2t/ha, 700ha frost affected barley at 2t/ha (3.5t/ha stubble), 1100ha frost affected wheat at 2t/ha (3t/ha stubble).



A folded steel frame that bolts to the SCU for forklifting off is a neat arrangement making mounting and removal safer and more simple.

The unit can be quickly disabled by disengaging a dog clutch on the mill gearbox drive pulley. This allows the whole unit to be put out of action relatively quickly if encountering excessive blockages, in for example, green GM canola. The entire unit can be slid up out of the way on the John Deere straw chopper slide rails, allowing easy access to the sieves.

The drive system consists of a shaft which runs underneath the mills, driving the

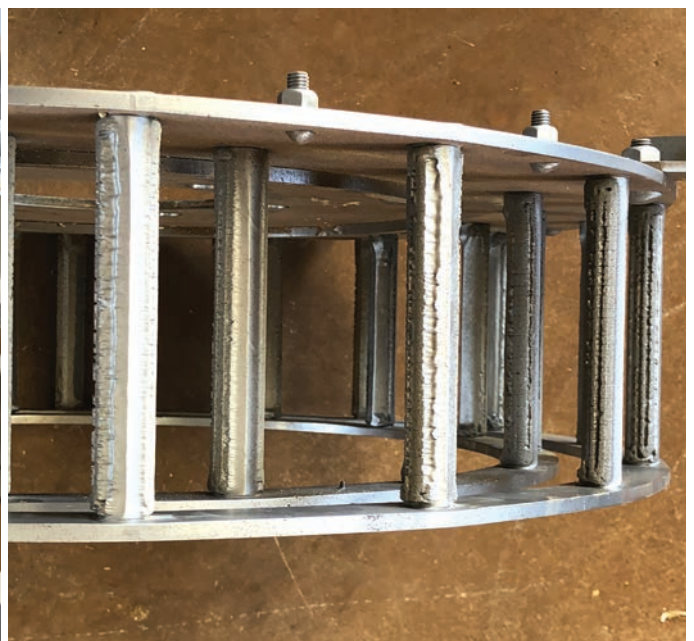
two mills in opposite directions. As they are wearing on different faces, the mill stators can be removed, flipped over and installed in the opposite mill, allowing wear on both sides. But at double the replacement price for a stator set, the benefit of flipping the mills is negated.

Only one owner we spoke to had put sufficient wear on the mills to warrant flipping the stators to wear out the other side of the stator elements.

Some issues with the process of laser-applied tungsten coating were identified in a batch in the 2019 harvest which was quickly addressed by the manufacturer. We have no doubt Redekop will continue to work on refining the SCU and will be competitive in the market with other brands in the next 12-18 months.

**More details:**

[www.harvestweedseedcontrol.com](http://www.harvestweedseedcontrol.com)



Mill wear on a John Deere S790 after 400 hours of operation at Wongan Hills, WA after 3700ha of wheat, barley, canola and lupins.





# TecFarm Weedhog in development

**A** novel design, the Weedhog, has been in development for a number of years and will be introduced to the Western Australian market in small numbers over the next 12 months.

Already working in the harvest weed seed control space, TecFarm is known for its chaff-carts, but has invested considerable research and development money into this chaff mill design.

In-field testing utilising the mill dosing tube method alongside prototype development has delivered a kill rate of

around 80 per cent. The unit would typically sit higher off the ground than pictured, but due to the limited availability of some components prior to harvest, a mounting angle compromise was made for this prototyping model.

Nevertheless, the two 585mm diameter stacks of rotor bars on two shafts rotate in the same direction with interaction of the mill and milled material at an open section of the housing. This interaction point sees chaff and weed seed material impacted between counter rotation of the rotors on at this point.

At a targeted market price of around \$50-60,000, the Weedhog is looking to attract a relatively large market segment of harvester owners with lower capacity or older machines.

It could be argued that alternatives like chaffling are offering higher rates of kill with less complexity, but nutrients are spread and kill rates with the Weedhog are likely to improve.

These developments will be watched with interest.

**More details:** [www.tecfarm.com.au](http://www.tecfarm.com.au)



Weedhog mills.



Internal fan blades on the Weedhog.





# A questionnaire for chaff mill manufacturers

Kondinin Group researchers offered manufacturers the opportunity to provide more detailed specifications and details in an in-depth questionnaire. Each manufacturer was sent the same questionnaire and each completed it with answers presented over the following pages. Growers looking to invest in a chaff mill should remember that some of the figures quoted, particularly weed kill rates, may need to be independently validated. But the consistent format responses are presented should assist in the comparison of chaff mill specifications.

**MILL MANUFACTURER:  
REDEKOP MANUFACTURING**

**MILL MAKE:  
SEED CONTROL UNIT**

Year model: 2020

1. Please list the standard specifications and options for each design variant of the chaff mill currently offered on separate questionnaire:

a. Drive: Mechanical

b. Cage/Rotor:

i. Design description including mill design and a description of the mechanism is used to damage the weed seeds?

The mill is a rotor and stator design with three stationary rings and two rotating rings. Weed seeds are damaged by impact. The rotors' central fan blades draw the weeds into the mill and centrifugally accelerate the weeds through the mill. Impacts between the rotor and stator bars result in the weed seed devitalisation. The mills, both rotor and stator, are reversible.

ii. Stator & rotor construction material/finish (eg: heat treatment/tungsten coating etc): Both rotor and stators are made from long life abrasion resistant steel that is coated with an internally developed extended life coating.

iii. Maximum rotor diameter: 660mm

iv. Total approximate mass of rotating components: The rotor weights about 37kg

v. Unloaded operating speed: 2850RPM

vi. Mill options available (eg. Hi flow/reduced-kill): Currently only one option available. High wear/high kill.



**b. Has power draw for the mill been measured?** Yes

**i. No load:** 26kW

**ii. Under load (example 30t/h in wheat):**  
Per example 45kW

**d. Can the mill be used on smaller class 7 harvesters?** Yes

**Details:** Yes, we have fitted and successfully run the SCU to a JD S670 combine.

**e. Can the mill be fitted to machines operating on 3m controlled traffic systems?** Yes

**Details:** Nothing in our configuration prohibits the 3m controlled traffic. No need to move the steering wheels to accommodate the SCU.

**f. In terms of overall harvester setup when fitting the mill, are there any other adjustments, modifications or considerations that need to be made? (e.g. threshing/separation/cleaning/engine chipping/remapping):** No other modifications needed.

**4. Availability: What harvesters do you manufacture a mill for? (List all)**

• John Deere S-Series combines; S670 – S790.  
Note, in 2020 we will be testing other brands in Australia, Europe and North America.

**5. What is the price excluding GST for the mill and does this vary by above machine list? Please detail:**

For the configuration with a Redekop MAV chopper, MAV SCU, \$110,000.  
For the configuration with a John Deere factory chopper, JD SCU, \$100,000 (Ex. GST)

**6. Warranty term and limitations:**  
1 year warranty.

**7. Seed kill:**

**a. What is the claimed annual ryegrass seed kill in standard configuration?** We have completed initial testing on ryegrass, but the final test have not yet been completed. The initial results show kill rates in the same range as both competitors – approx 95%.

**b. What mill speed range was this tested at?** 2850RPM

**c. Who undertook this testing and established this figure?** Testing to be completed by March 2020.

**d. When and where was the testing conducted?** See above.

**e. Please detail the weedkill validation and test procedure for the claimed weedkill % (eg chaff flow rates/lab or field testing/weed species/soil bin or agar admix/seed moisture levels etc):** We used a base line test of canola to evaluate the mill kill rates. Further weeds are in testing for the 2020 season. Ryegrass rates will be available in late March. Kill rates of greater than 98% on canola seed were achieved in both the internal testing and independent Agriculture and Agri-Food Canada testing. Testing was conducted with multiple chaff rates and moisture rates to simulate a wide range of harvesting conditions. Over 90 variations on the kill rate tests were completed on canola seed alone.

**8. What tools and process are required to remove the mill to revert to standard operation?**

**a. Mill does not need to be removed to revert to standard operation. Simply redirect the doors to direct all chaff into the chopper and disengage the mill drive coupler. No need to remove belts or other components. ~5 min process.**

**b. Approximately how much time is required to remove the mill?** 20 min to remove.

**c. Or can the mill be bypassed in the field for alternative chaff management? (for example when green canola blocks the mill)** Yes

**d. In these cases, what is required to bypass the mill?** See "a"

**9. Are sieve loss measurements possible with the mill fitted?** Yes

**a. Please provide details on how this can be done:** Mill is attached to the chopper. Simply slide the chopper back to measure sieve losses as you would do under conditions without the mill.

**10. Are there any machine warranty impacts or have these been addressed directly with harvester OEMs?** No

**Details:** The SCU comes fully tested and vetted by John Deere and has no impact on the harvester warranty.

**11. In terms of product support, in what areas is the mill supported by dedicated staff or a dealer network?**

We have a dealer network throughout the Australian market. We also have a full time employee in country to support the product and our dealers. In season, we have built on this support by training our dealers and sending engineers from Canada.

**12. Can the mill be transferred to a new harvester when machines are traded?** Yes

**a. What is the process and cost?** Major cost would be labor and is subject to dealer rates. Other costs would depend on the harvester.

**13. Will 2020 mill designs be altered as a result of learnings from the 2019 harvest?** Yes  
**Please detail changes:** Mostly minor changes to improve mill wear.

**14. How many of these systems do you now have operating in the field and where are they located?**

Over 20 in Australia.

**15. What measures are integrated into the design to stop stray material entering the mill? For example, rock traps or magnetic capture systems?**

Outside of the harvesters normal systems, none.

**16. How will chaff mills be used in the future and how might designs evolve?**

The sector will continue to evolve rapidly with new entrants and new designs. In the short term the focus will likely be on cost and power reduction.

**vii. Service requirements:**

Daily: Grease and visual inspection

Other: 100 hour gear box oil change after initial break in, periodic belt inspection, pre-season inspection and mill rotation (wear dependent)

**2. Replacement part costs:**

**a. Main drive belt(s):** \$260

**b. Other belts:** \$336/\$732

**Detail:** Chopper double rib/  
Upper double rib

**c. Rotors:** \$2340 each

**d. Stator set (separate if individual stages are replaceable):** \$2340 (outer), \$1921 (middle), \$1625 (inner)

**e. Hammers/Flails:** \$1097

**f. Gearbox:** \$3400

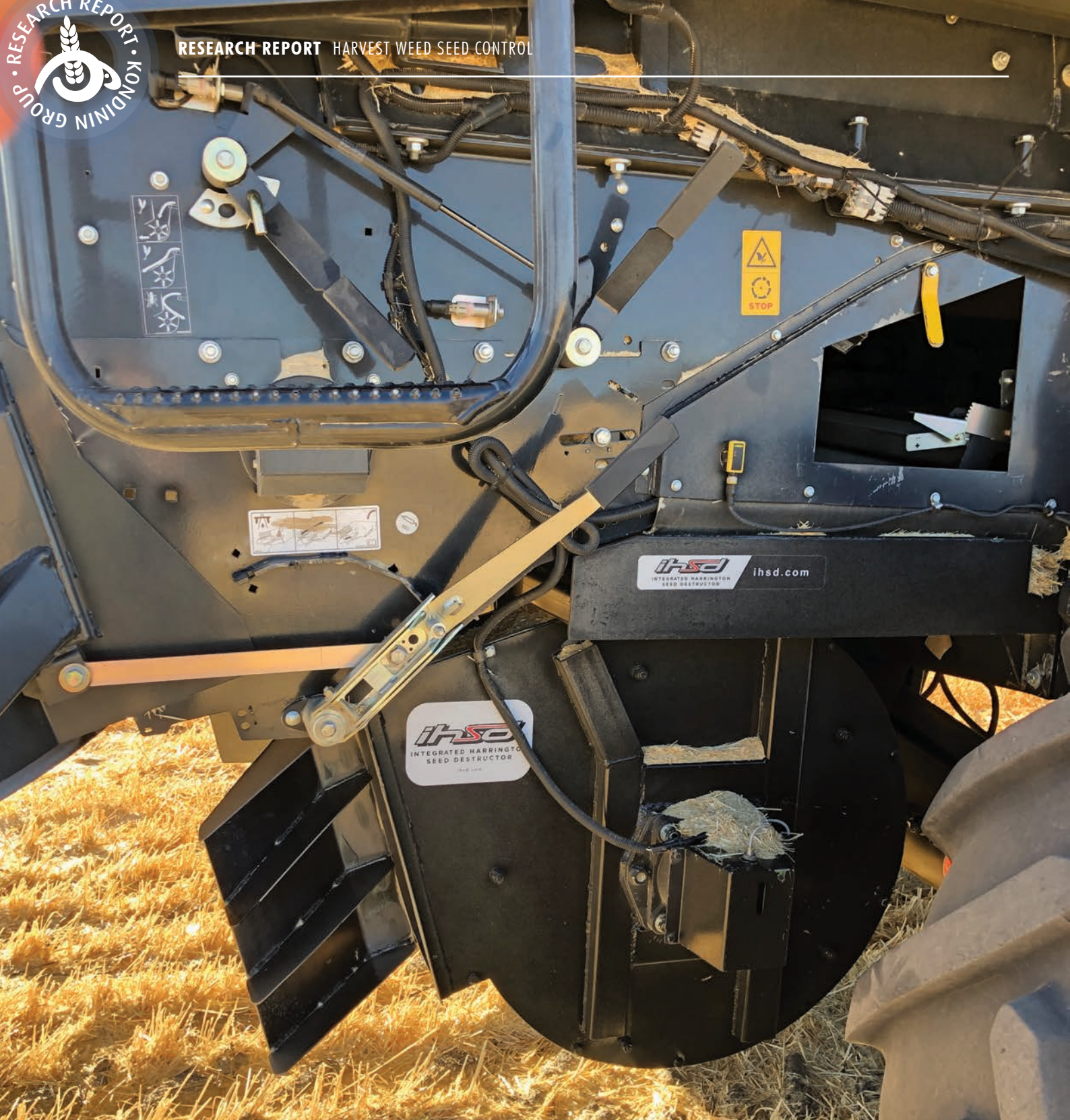
**g. Describe the process for replacing mill components. What techniques tools and time is required?** The SCU ships with a service frame. Attach the SCU to the service frame (4 bolts). Remove the 8 bolts holding the SCU to the chopper frame. Remove outer shoots and top plate. Pull rotor and stator and reverse or replace with new components. Mill replacement would take approximately 1-2 hours.

**3. Performance: Are there any estimates or examples of compromises in operation after fitment?**

**a. Steering limitations on some machines?**

On some tire configurations a stop is required.





**MILL MANUFACTURER:**  
**DE BRUIN ENGINEERING (DBE)**  
**MILL MAKE: HSD – HARRINGTON**  
**SEED DESTROYER**

Year model: 2019/20

1. Please list the standard specifications and options for each design variant of the chaff mill currently offered on separate questionnaire:

- a. Drive: Mechanical
- b. Cage/Rotor:
  - i. Design description including mill design and a description of the mechanism is used to damage the weed seeds?

2 x vertical rotating impact mills consisting of a rotational component (Rotor) and a stationary component (Stator). High volume chaff material flow is achieved with auger, fan and rotors working in series with the auger ensuring a consistent material feed rate. Weed seed in the mills experience high impact velocity of rotors and blunt impact of opposing stator blades, both actions work to achieving a scientifically verified minimum impact trauma, which devitalizes the weed seed.

- ii. Stator & rotor construction material/finish (eg: heat treatment/tungsten coating etc): BISALLOY 400
- iii. Maximum rotor diameter: 555mm

- iv. Total approximate mass of rotating components: 2 x 40kg each rotor/fan + 85kg auger shaft, 165kg in total
- v. Unloaded operating speed: 3050RPM
- vi. Mill options available (eg. Hi flow/reduced-kill): High flow/high kill. Mid speed/high kill. High moisture/reduced kill (TBC)

vii. Service requirements:

- Daily: N/A
- Other: 50 hours, measure wear of rotor and stator blade

2. Replacement part costs:

- a. Main drive belt(s): From \$627 + GST
- b. Other belts: \$247 + GST Detail: Step 1 belt





c. Rotors: \$5,625 + GST

d. Stator set (separate if individual stages are replaceable): \$3,891 + GST

Fans \$549 + GST

e. Hammers/Flails: N/A

f. Gearbox: N/A

g. Describe the process for replacing mill components. What techniques tools and time is required? Belt removal, bearing removal, bearing plate removal, 6 bolts to remove rotor and fan, 5 bolts to remove stators, 2 people, 2 hours, standard tools and C-spanner to remove and reinstall bearings.

### 3. Performance: Are there any estimates or examples of compromises in operation after fitment?

#### a. Steering limitations on some machines?

CLAAS Lexion models require steering limit, as supplied with unit.

#### b. Has power draw for the mill been measured: Yes

i. No load: 48kW

ii. Under load (example 30t/h in wheat): 72kW

#### Any notes for the above figures:

Load at maximum combine capacity, achieved > 60 t/hr class 10

#### c. Alternatively, what is the typical reduction in performance for a class 8 harvester (300-350kW 400-470hp): ~15%

#### d. Can the mill be used on smaller class 7 harvesters? Yes

Details: HSD installed and operating on class 6 and 7 machines. Examples include: John Deere S660, S670, S760, S770; New Holland CR9070, CR7.90; CASE IH 7230, 7240, 7250.

#### e. Can the mill be fitted to machines operating on 3m controlled traffic systems? Yes

Details: Depending on model. CLAAS with steering limit.

f. In terms of overall harvester setup when fitting the mill, are there any other adjustments, modifications or considerations that need to be made? (e.g. threshing/separation/cleaning/engine chipping/remapping): Chopper to run on high speed setting. Straw baffle configuration may need to be customised for a particular operation. Setup changes for windrowing straw may be required.

### 4. Availability: What harvesters do you manufacture a mill for? (List all)

- John Deere S660, S670, S680, S690
- John Deere S760, S770, S780, S790
- CASE IH 8120, 9120
- CASE IH 7230, 8230, 9230
- CASE IH 7240, 8240, 9240
- CASE IH 7250, 8250, 9250
- New Holland CR9070, CR9080
- New Holland CR7090, CR8090, CR9090
- New Holland CR7.90, CR8.90
- New Holland CR9.90, CR10.90
- CLAAS Lexion 770, 780 Merc OM473
- Other models successfully fitted with customised installation, e.g. CASE IH 8020

### 5. What is the price excluding GST for the mill and does this vary by above machine list?

Please detail: Average unit pricing \$85,000.

Pricing is based on make, model and variation required for fitting.

### 6. Warranty term and limitations:

12 month limited warranty, excluding wear items.

### 7. Seed kill:

#### a. What is the claimed annual ryegrass seed kill in standard configuration? 98%

#### b. What mill speed range was this tested at? 3000RPM

c. Who undertook this testing and established this figure? University of Sydney and Charles Sturt University (CSU), Michael Walsh and John Broster.

d. When and where was the testing conducted? De Bruin Engineering (test stand) 201819 and CSU (seed viability testing). Additional field testing was carried out in Broomhill, WA using the same test methodology on the Vertical Mill design. Results showed the effectiveness of weed kill was not dependent on the orientation mounting of the mills.

e. Please detail the weedkill validation and test procedure for the claimed weedkill % (eg chaff flow rates/lab or field testing/weed species/soil bin or agar admix/seed moisture levels etc): Annual ryegrass was used as the weed species for testing. Testing was conducted with a dedicated test stand with mill operating according to treatment requirements. Wheat chaff was delivered into the mill at 1.5kg/s equivalent to 5.4 t/hr. Processed chaff samples were weighed and thoroughly mixed before a before weighing out five 20 g subsamples. These subsamples were then mixed through the top 2.0 cm of potting mix (50% Sand, 25% peat moss and 25% bark) filled trays which were then watered and maintained near field capacity. Emerging seedlings were counted and removed over a 28 day period. DBE advocate for a standard efficacy test method or a certification programme.

### 8. What tools and process are required to remove the mill to revert to standard operation?

a. Common place tooling; spanner, rattle guns, shifters and forklift assistance is helpful to remove the unit quickly and safely.

b. Approximately how much time is required to remove the mill? Depending on model, from 2 to 6 hours

c. Or can the mill be bypassed in the field for alternative chaff management? (for example when green canola blocks the mill) Yes

d. In these cases, what is required to bypass the mill? To windrow chaff or effect manual grain loss assessment – install the supplied bypass mat, remove HSD drive belt, remove the rear access door and stone trap door. Total time 15 minutes.

### 9. Are sieve loss measurements possible with the mill fitted? Yes

a. Please provide details on how this can be done: OEM electronic sensors are not affected by mounting HSD unit. Manual grain loss can be assessed using the above bypass mechanism.

### 10. Are there any machine warranty impacts or have these been addressed directly with harvester OEMs? No

Details: DBE is working with major manufacturers to enhance design integration and product support. No objections to the installation of HSD units have been raised to date by manufacturer engineering teams. DBE anticipate drive kit manufacture, supply and support from several combine manufacturers in 2020/21.

### 11. In terms of product support, in what areas is the mill supported by dedicated staff or a dealer network?

National HSD dealer network plus, National Distributor offering additional 7 dedicated staff to support the local dealer network throughout Australia plus, engineering support from De Bruin Engineering, Australia.

### 12. Can the mill be transferred to a new harvester when machines are traded? Yes

#### a. What is the process and cost?

Removal and installation may be performed by local HSD Dealer. Model interchange components may be required. Cost varies depending on variations between old and new model.

### 13. Will 2020 mill designs be altered as a result of learnings from the 2019 harvest? No

Please detail changes: Designs and features are continually improved through in-field performance feedback. DBE is continually testing new designs and configurations of mill components.

### 14. How many of these systems do you now have operating in the field and where are they located?

Over 170 HSD mill systems are operating in Australia, USA and Europe.

### 15. What measures are integrated into the design to stop stray material entering the mill? For example, rock traps or magnetic capture systems?

A deep stone trap is integral to the design of the HSD.

### 16. How will chaff mills be used in the future and how might designs evolve?

The HSD is a greatly simplified design with a direct drive mechanism, fewer moving parts, an integrated stone trap and effective bypass mode. New model fitments, expanding retrofit options, including low capacity smaller combines. Advanced operational features for monitoring, mill disengagement and bypass are currently in development.





**MILL MANUFACTURER: SEED TERMINATOR**  
**MILL MAKE: SEED TERMINATOR**  
 Year model: 2019

**1. Please list the standard specifications and options for each design variant of the chaff mill currently offered on separate questionnaire:**

- a. **Drive:** Mechanical
- b. **Cage/Rotor:**
  - i. **Design description including mill design and a description of the mechanism is used to damage the weed seeds?**  
 Seed Terminators core design principles are clear 1) support harvest uptime 2) Kill weed seeds at the same time. Seed Terminators' multistage hammer mill is a stable belt-driven mechanical platform that isolates the gearbox from direct sudden load preventing failure. The high-efficiency gearbox requires no cooling and aerodynamic rotor design ensures applied power kills weed seeds rather than overcoming air resistance. Quick access and changeover of mills = uptime. All seed types and varying moistures are killed by a mill design with 4 modes of kill (crush, shear, grind, impact). Seed Terminators' continuously improved mill designs are backwards compatible so our customers benefit.
  - ii. **Stator & rotor construction material/finish (eg: heat treatment/tungsten coating etc):** Rotors are manufactured with case hardened steel that is then coated with tungsten. Screens are manufactured from heat treated Australian steel.
  - iii. **Maximum rotor diameter:** 615mm
  - iv. **Total approximate mass of rotating components:** Rotors are 49kg including flails. There are two rotors per machine.
  - v. **Unloaded operating speed:** 2950/2750RPM (high/low speed)
  - vi. **Mill options available (eg. Hi flow/reduced-kill):** Maximum kill (standard option). High Capacity options (85-90% ryegrass destruction) for green material. Low inertia options for small harvesters.
  - vii. **Service requirements:**  
 Daily: Daily clean and look over.  
 Other: Grease nipples on tensioner arms 200 hours.

**2. Replacement part costs:**

- a. **Main drive belt(s):** \$507

- b. **Other belts:** \$485/\$591 (left/right mill)
- c. **Rotors:** \$4668 ex GST
- d. **Stator set (separate if individual stages are replaceable):** \$5207
- e. **Hammers/Flails:** \$821
- f. **Gearbox:** \$8956
- g. **Describe the process for replacing mill components. What techniques tools and time is required?** Only a 20 minute process for stator (screen changeover) involving basic tools and 5 bolts, all designed to maximise harvester uptime. For a complete swap out (which wasn't required at all during 2019 harvest) which includes the rotors, requires the removal of 6 wheel nuts and we suggest allowing 60 minutes. All components are accessible once the chutes are removed by simply releasing 3 over centre latches. Quick changeover enables swapping mills in case of uneven wear (L v R).

**3. Performance: Are there any estimates or examples of compromises in operation after fitment?**

- a. **Steering limitations on some machines?**  
 Steering stop on John Deere for 3m CTF.
- b. **Has power draw for the mill been measured:** Yes
  - i. **No load:** 25kW
  - ii. **Under load (example 30t/h in wheat):** 70kW**Any notes for the above figures:**  
 Data above is for both mills types.
- c. **Alternatively, what is the typical reduction in performance for a class 8 harvester (300-350kW 400-470hp):** 10-15%
- d. **Can the mill be used on smaller class 7 harvesters?** Yes  
**Details:** Low no load power enables smaller machines to effectively operate the terminator. Less chaff mass flow means less power. The use of stripper fronts also can significantly reduce total engine power requirement.
- e. **Can the mill be fitted to machines operating on 3m controlled traffic systems?** Yes  
**Details:** John Deere machines can, with slightly reduced turning circle. Case IH and New Holland cannot, this is an ongoing project we are working on. CLAAS can.
- f. **In terms of overall harvester setup when fitting the mill, are there any other adjustments, modifications or considerations that need to be made? (e.g. threshing/separation/cleaning/engine chipping/remapping):** The harvester setup has a big impact on the outcome of both ability to

capture grain and kill seeds. Threshing setup is most important to get grain and weed seeds out without overloading the sieves. Overloading sieves can mean grain loss and unnecessary mill processing power. Appropriate threshing setups can save a lot of power as well. Sieve setup as normal and balanced across width. This year we have taken on Joe Limbaugh and Brett Asphar, both harvester experts. What has been evident is that the Seed Terminator and harvester are a system. Setup of the system is crucial. First pass threshing is key, straw quality is key. We've noticed that modifying engine power isn't absolutely necessary if the harvester is set up correctly.

**4. Availability: What harvesters do you manufacture a mill for? (List all)**

- CASE IH AFX 20, 30, 40 and 50 series
- John Deere S series 600 and 700
- John Deere STS 70 series.
- CLAAS – 600, 760, 770, 780
- Massey 9560 9565
- New Holland CR 9090, 8090, 1090, 8.90, 9.90, 10.90
- Many models under development

**5. What is the price excluding GST for the mill and does this vary by above machine list?**

**Please detail:** \$120 000 fitted including everything. It does depend slightly on machine type. Early order programs are available and matched to reduced manufacturing cost with units from \$103,500 fitted.

**6. Warranty term and limitations:**

12 month is standard. We cover driveline (gearboxes and mill spindles) for 24 months. As a development company we review our warranty on a case by case basis.

**7. Seed kill:**

- a. **What is the claimed annual ryegrass seed kill in standard configuration?** 98%
- b. **What mill speed range was this tested at?** 2250-3000RPM
- c. **Who undertook this testing and established this figure?** Testing is performed extensively every year with the University of Adelaide, Trengrove Consulting (SAGIT project), Prof Michael Walsh iHSD vs Seed Terminator.
- d. **When and where was the testing conducted?** Annual independent testing program with The University of Adelaide Waite Campus April – September yearly. University of Hohenheim Europe crops and weeds. University of Missouri, USA crops and weeds.





**e. Please detail the weedkill validation and test procedure for the claimed weedkill % (eg chaff flow rates/lab or field testing/weed species/soil bin or agar admix/seed moisture levels etc):** The development of the Seed Terminator testing procedure has been a major collaboration Trengrove Consulting (SAGIT project TC117) the University of Adelaide Weeds Research group David Brunton, Sam Kleeman, Gurjeet Gill, Chris Preston and Peter Boutsalis and Seed Terminator's own Nick Berry's PhD thesis. TC117 validated kill across a spectrum of weed seeds and showed that annual ryegrass needed to be the focus for future testing; not only because of its prevalence in Australian agriculture but also because it is smaller, lighter and tougher than most seeds to kill. Wild oats, brome grass, radish and volunteers (canola, wheat, barley) are straightforward to kill. Testing procedure involves 2kg wheat chaff samples being laced with 10g ryegrass seed. Chaff is then processed at a rate of 1.5kg/s (~40t/h grain). These samples are spread in soil bins at low density to not impact seedling growth. Blind germination counts are made weekly by the Uni. Samples are compared to a control (unprocessed sample) to give a % kill value AND compared to a reference mill sample. The % kill value depends on seed batch properties (eg moisture%, seed size & weight) that vary wildly. % kill is not comparable from different sources. Reference mill is comparable and allows us to improve our tech year on year. To validate the Seed Terminator in a range of operational conditions, weed species, chaff types. Also testing has been performed by Michael Walsh using agar propagation processes that he and others developed at University of Western Australia. We have also had testing performed in Germany by the University of Hohenheim, validating in greener conditions and killing black grass. We have also been working with University of Missouri on local species.

**8. What tools and process are required to remove the mill to revert to standard operation?**

- a. Seed Terminator is mounted using 6 bolts. Belt and electrical cable must be removed. Lower machine using forklift.
- b. **Approximately how much time is required to remove the mill?** 1-2 hours.
- c. **Or can the mill be bypassed in the field for alternative chaff management? (for example when green canola blocks the mill)** Yes
- d. **In these cases, what is required to bypass the mill?** John Deere 2 minutes: chopper drive out, drop bypass door down, disconnecting the belt is optional. A 20 minute procedure for all other makes, details below. Case IH – remove inlet chutes, put standard chaff tray back in. Massey Ferguson chaff – use standard spinner bypass door. New Holland & CLAAS – remove screens run in spreader mode.

**9. Are sieve loss measurements possible with the mill fitted? Yes**

**a. Please provide details on how this can be done:** See above, Bypass mill, keep the airflow similar by not creating large opening for chaff and air to escape but rather spread as per as per OEM design, replicating "true grain loss". As the characteristics within the cleaning shoe can be heavily influenced by modifying airflow within the cleaning shoe resulting with increased losses or poor cleaning shoe performance.

**10. Are there any machine warranty impacts or have these been addressed directly with harvester OEMs? Yes**

**Details:** Attachment warranty applies. Similar to putting any non-OEM attachment to a tractor. With CASE IH machines, customers are able to purchase genuine drive kit specifically designed for driving the Seed Terminator.

**11. In terms of product support, in what areas is the mill supported by dedicated staff or a dealer network?**

We are using a dealership model. We do not want to interrupt the harvester market. Buy your Seed Terminator where you buy your harvester. Get it serviced with the harvester. Harvesters that kill weed seeds is a complex interaction, to get the best outcome for the dual purpose machines so we are investing heavily in field harvester specialists to help dealers and provide support; Joe Limbaugh (WA), Brett Asphar (WA) and Keagan Grant (SA).

**12. Can the mill be transferred to a new harvester when machines are traded? Yes**

**a. What is the process and cost?** We have learnt so much about the total ownership cost. Fitup cost and swapping cost is very important, as is machine depreciation. The process and cost depends on the machine type. JD we have got fit-up times down to 6 hours for two people. We are pushing this time down on all machines.

**13. Will 2020 mill designs be altered as a result of learnings from the 2019 harvest? Yes**

**Please detail changes:** We always make improvements to mill technology as we will offer the best technology possible. We are working on our MY20 mill tech at the moment.

**14. How many of these systems do you now have operating in the field and where are they located?**

There are over 150 Seed Terminators operational. We have 3 units in the USA, 2 in Canada and 1 in Germany.

**15. What measures are integrated into the design to stop stray material entering the mill? For example, rock traps or magnetic capture systems?**

Seed Terminators now come standard with our patent pending magnetic capture system to prevent ferrous material entering the mill. The mill is designed to be highly robust. When you have 150 machines out there you would be amazed by the crazy things that end up in the mill, so capturing what we can is important.

**16. How will chaff mills be used in the future and how might designs evolve?**

Our vision is that every harvester on the planet is not spreading weed seeds to become next year's problem. Global adoption is a massive challenge and we have certainly learned a huge amount about the diversity of agricultural crop types and conditions by entering into the United States, Canada and Europe. We have also found that with scale (150 units to date) random conditions begin to occur. We invest everything we have back into research and development to create new solutions for these challenges. We have developed a range of different mill options for different conditions and requirements to kill seeds and we see this only evolving in the future. You set the harvester up for different crop types so why would the mill be any different? The mills are only as good as what you get into them. We see a future where harvesters are redesigned to target weed seeds – get more in the front and more into the mill. Also our milling technology has improved every year and we are not done yet. We work on making future proof tech, so you can always upgrade to the latest mill tech.

**Other notes:** When looking at what to do with your weed seeds remember that nothing is for free. You cannot kill weed seeds without using power, in the case of ryegrass, a lot of power. Think of power use and wear like a chemical rate application. It is an investment in control. The last few surviving weed seeds are hard to kill but letting them go free is possibly a low dose experiment. We have developed lower power versions for the scenario when you are tempted to bypass the machine. Something is way better than nothing. But high kill is worth a lot more in the long run.

Harvester set up: Good harvester setup has a huge implication on the overall performance of the harvester-Seed Terminator system. There are threshing system setup which effectively reduce the drag of the rotor and free engine power to run the mill. First pass threshing is key as it minimizes both rotor(s) losses (weed seeds and grain) and cleaning shoe losses, as straw exiting the separator body is more intact while being fully threshed and free grain separated from the straw load. Blank separator grates have been used to further reduce shoe loading on some machines. With less material on the sieves, the Seed Terminator has less material to process and hence uses less power. Detailed airflow measurements confirm that the Seed Terminator is not impacting the sieves under varied loads and setups, hence our recommendation is to run with the same fan speeds as without the Seed Terminator. It is important to ensure that the cleaning shoe is balanced across width. There have been times when mill speed has dipped on one side and has identified an unbalanced cleaning shoe. While cleaning shoe loads will also be reduced of MOG (material other than grain) allowing for the grain savings effect of the cleaning shoe to take place. With this approach overall harvester performance/optimization will be reached, which reduces the load on the Seed Terminator making it seem as if its not there.





**MILL MANUFACTURER:  
TECFARM PTY LTD**

**MILL MAKE:  
TECFARM WEEDHOG**

Year model: 2019

**1. Please list the standard specifications and options for each design variant of the chaff mill currently offered on separate questionnaire:**

- a. Drive: Mechanical
- b. Cage/Rotor:
  - i. Design description including mill design and a description of the mechanism is used to damage the weed seeds?  
Chaff enters a central plenum chamber and is drawn through openings into left and right mills, each comprised of a pair of circular conjoined housings. The four housing sections each contain an array of laser cut radial impact bars arranged on the splined ends of two horizontal shafts. Milling is achieved in an open interaction zone where the circumferences of each

- pair of housings overlap slightly. Seeds are subject to high velocity impact as they are flung tangentially by rotor bar tips in the upper housing into the opposing path of rotor bar tips in the adjoining lower housing (& vice versa), at the opening between them.
- ii. Stator & rotor construction material/finish (eg: heat treatment/tungsten coating etc): C250-350 steel on test machines. This appears to have suffered minimal wear but bars will be weighed and evaluated for wear rate. Harder material will be employed if deemed necessary. eg. Hardox/Bisalloy.
- iii. Maximum rotor diameter: 585mm
- iv. Total approximate mass of rotating components: 200kg
- v. Unloaded operating speed: 2400RPM as tested
- vi. Mill options available (eg. Hi flow/reduced-kill): The mill design is inherently open and free flowing with a lower standard kill percentage however the number and arrangement of rotor bar

- impact members is easily changed at any time, which, together with overall dimensions and RPM, provides scope for differing configuration options.
- vii. Service requirements:  
Daily: General servcibility check eg. belt tensions, bolt traps.  
Other: Grease main shaft bearings every 100 hrs. Monitor bar wear and flip or replace as required (500 hr intervals expected but yet to be confirmed).

- 2. Replacement part costs:**
- a. Main drive belt(s): \$500
  - b. Other belts: \$70 Detail: 1x3B and 1x2B
  - c. Rotors: \$2000-3000
  - d. Stator set (separate if individual stages are replaceable): \$4000 for conjoined mill housing pairs after approximately 2500 hrs
  - e. Hammers/Flails: N/A
  - f. Gearbox: N/A
  - g. Describe the process for replacing mill components. What techniques tools and time is required? Rotor bars are held in place on either end of two independent splined





shafts, (with main bearings inboard of rotors) secured with 2 left and 2 right hand nuts. Near side (left) mill rotor bars require removal of the drive pulleys and belts while off side bars are not impeded and can be simply slid off the end of the spline shaft to be flipped or replaced. Only standard tools are required. Time factor is yet to be fully established but estimated at 1.5hrs. Laser cut rotor bars are self centering on the splined shafts, eliminating the need for specialist balancing. This has been verified on all prototypes and during field testing.

### 3. Performance: Are there any estimates or examples of compromises in operation after fitment?

**a. Steering limitations on some machines?** Steering is not limited when set on common axle width

**b. Has power draw for the mill been estimated:** Yes

**i. No load:** N/A

**ii. Under load (example 30t/h in wheat):** 26 – 34kW

**Any notes for the above figures:**

Estimate based on percentage power use read-out on harvester

**c. Alternatively, what is the typical reduction in performance for a class 8 harvester (300-350kW 400-470hp):** 5-8% observed

**d. Can the mill be used on smaller class 7 harvesters?** Yes

**Details:** While more power testing is required, the low observed power usage for the mill leads us to believe it will be suitable for smaller harvesters in an appropriate variant.

**e. Can the mill be fitted to machines operating on 3m controlled traffic systems?** Yes

**Details:** As long as steering ram collars are fitted to limit very tight turns

**f. In terms of overall harvester setup when fitting the mill, are there any other adjustments, modifications or considerations that need to be made? (e.g. threshing/separation/cleaning/engine chipping/remapping):** No modifications to the engine were necessary on the Case 7240 test harvester and no adjustments were made to normal threshing, sieve or fan settings. Harvest was completed with minimal operational compromise attributed to mill operation.

### 4. Availability: What harvesters do you manufacture a mill for? (List all)

- Case as tested
- New Holland
- Other makes to follow

### 5. What is the price excluding GST for the mill and does this vary by above machine list? Please detail:

Approximately \$50,000 – \$60,000

### 6. Warranty term and limitations:

Standard warranty on materials and workmanship.

### 7. Seed kill:

**a. What is the claimed annual ryegrass seed kill in standard configuration?** 80%

**b. What mill speed range was this tested at?** 2400RPM

**c. Who undertook this testing and established this figure?** An Agricultural Scientist (Agtech Innovations) contracted as a testing consultant working in conjunction with Tecfarm personnel.

**d. When and where was the testing conducted?** Static testing at Bruce Rock Western Australia on several prototypes over five years and harvest trials in 2018 at Bruce Rock and 2019 at Beverley WA.

**e. Please detail the weedkill validation and test procedure for the claimed weedkill % (eg chaff flow rates/lab or field testing/weed species/soil bin or agar admix/seed moisture levels etc):** Static and field testing used similar procedures. A known quantity of colored annual rye grass seed was introduced into the chaff stream prior to it entering the mill. In the case of static testing this was done on an extended conveyor belt (with chaff introduced at rates up to 3 kg/sec). In the case of field testing, the seed was introduced into the plenum chamber via two air seeder hoses in the last 20 m of a 60 m run (it was found that the first 40m were needed to “load” the harvester up to normal operating capacity). Milled material was collected using Anti Virus mesh bags that allowed air to pass through but not seed or chaff. Samples were taken from milled material and coloured seed separated over a light box using a magnifier. Germination was then tested in petri dishes in a germination cabinet under ideal conditions and percentage kill worked out using the same formula used in testing the HSD. Ungerminated but intact seed was dissected under a binocular microscope to see if the embryo was dead or dormant. Dormant seed was considered still viable. More basic testing of field results was also done in peat trays, field plots and counts in the field with similar results being obtained.

### 8. What tools and process are required to remove the mill to revert to standard operation?

**a. Mills are provided with a freestanding frame with fork ports to assist with installation and removal from the harvester. No specialist tools are required. Fitting to the harvester is achieved by a simple three point attachment.**

**b. Approximately how much time is required to remove the mill?** 30 to 60 minutes

**c. Or can the mill be bypassed in the field for alternative chaff management? (for example when green canola blocks the mill)** Yes

**d. In these cases, what is required to bypass the mill?** The mill has an integral windrow facility which is easily engaged by manually moving a baffle to bypass material.

2020 production models will allow for remote actuation of this function from the cabin.

### 9. Are sieve loss measurements possible with the mill fitted? Yes

**a. Please provide details on how this can be done:** The mill bypass windrow function allows a suitable receptacle to be placed to capture sieve material.

### 10. Are there any machine warranty impacts or have these been addressed directly with harvester OEMs? N/A

### 11. In terms of product support, in what areas is the mill supported by dedicated staff or a dealer network?

Limited numbers are to be made available in 2020 within Western Australia to ensure a good level of support can be provided directly by the Manufacturer.

### 12. Can the mill be transferred to a new harvester when machines are traded? Yes

**a. What is the process and cost?** The machine itself is designed to be universal with header specific replaceable mounting arms. Changing these arms will allow simple and cost effective transfer between makes.

### 13. Will 2020 mill designs be altered as a result of learnings from the 2019 harvest? Yes

**Please detail changes:** Production machines will have small changes made to enable several extra features including: simplified fitting and removal of the unit, easy access to sieves for inspection/removal, improvement of mill bypass mechanism to allow for remote actuation from the cabin, increased ground clearance.

### 14. How many of these systems do you now have operating in the field and where are they located?

N/A – Preproduction prototypes only

### 15. What measures are integrated into the design to stop stray material entering the mill? For example, rock traps or magnetic capture systems?

A bolt/rock trap is integrated into each side of the plenum chamber prior to left and right mill entry points.

### 16. How will chaff mills be used in the future and how might designs evolve?

The task of rendering a very high proportion of weed seeds inviable is exceptionally demanding due to limited header power/capacity and high volumes of material to be processed so it will be important to reach a compromise between a good consistent level of seed kill and operational factors such as simplicity, low power use and minimal overall cost. Chaff mills, now proven practical, will likely evolve in the direction of greater efficiencies and the exponential relationship between power use and kill percentage may mean that 100% seed kill becomes economically unviable - particularly so in cases where a harvester upgrade is required to gain sufficient excess power to run a mill.



# WEEDSMART



WeedSmart is the industry voice that delivers science backed weed control solutions to growers & advisors for long-term profitability in Australian Agriculture.

WeedSmart delivers a national stewardship campaign for key stakeholders to focus on encouraging attitudes and actions aimed at minimising crop weeds and sustaining herbicide use through the implementation of **WeedSmart's Big 6**.

## THE WEEDSMART BIG 6

The **WeedSmart Big 6** provides practical ways for growers to fight herbicide resistance by farming with diverse tactics within both summer and winter cropping systems.

1. ROTATE CROPS AND PASTURES
2. DOUBLE KNOCK
3. MIX AND ROTATE HERBICIDES
4. STOP WEED SEED SET
5. CROP COMPETITION
6. HARVEST WEED SEED CONTROL

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Check out the **WeedSmart Big 6** here 

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