



## Winter cereals for silage

### In brief

The 3030 Project evaluated the potential to use winter cereals for silage on southern Australian dairy farms using plot experiments and farmlet studies as well as experiences on commercial farms. This information sheet summarises the main practical lessons and research outcomes from the six years of research. The winter cereals investigated were: wheat (*Triticum vulgare*), oats (*Avena sativa*), triticale (*Triticale hexaploide*) and barley (*Hordeum vulgare*).

### Winter cereals vs. annual ryegrass

**Main advantages:** Winter cereals can provide feed earlier than annual ryegrass (early autumn) because they are generally more adaptable to early sowing due to higher tolerance of dry conditions. Cereals are also better suited to single-cut silage-making, whereas annual ryegrass requires multiple cuts or grazings to be fully utilised.

**Main disadvantages:** The nutritive value of winter cereals is similar to ryegrass in the tillering stage but declines during the later stages of growth. Maximum yields of cereals can only be obtained by single-cut silage-making (with or without being grazed once during the early stages). However, the losses from harvest to feeding out cereal silage can considerably increase the cost per kilogram of feed consumed by the cows compared to fully grazed annual ryegrass particularly for whole crop silage cut at the late milk-soft dough stage.

### System fit

Winter cereals can fill the early-autumn feed gap that exists in perennial ryegrass-based systems, and are able to produce more feed over winter than most perennial pastures. They can also combine with summer crops as part of a double-crop rotation in a paddock renovation program. High potential for use of winter cereals was identified in low rainfall regions (450–600 mm/year), where perennial ryegrass is not as persistent. Winter cereals may also be grown effectively on run-off or lease blocks then harvested and used on the milking platform.

### New specific information

- Cutting for silage at 'boot stage' offers the best balance between yield, nutritive value and the time of sowing a following summer crop.
- Grazing cereals once at the early to mid-tillering stage does not affect final silage dry matter (DM) yield.



## How do winter cereals compare to annual ryegrass?

### Advantages

- **Better suited to single-cut silage-making:** The reliability and grazing performance of annual ryegrass is well known, but most varieties tend to lodge severely when paddocks are locked up for an extended period before making silage. This causes considerable losses of nutritive value and harvestable plant material. For this reason, annual ryegrass needs multiple cuts or grazings before any lock-up period in order to be utilised efficiently, whereas winter cereals can be harvested in a single cut.

Most forage cereals are able to remain as a standing crop without lodging for a longer period than annual ryegrass (from early September to mid-November), even when a high biomass has accumulated (more than 8 t DM/ha). In this respect, wheat and triticale were more reliable than barley and oats. In the late stages of growth, depending on the weather, barley can be seriously affected by rust and oats has a higher tendency to lodge than the other cereals. This information was obtained from both replicated trials and on-farm monitoring in South-West Victoria during 2005, 2006 and 2007 as part of the 3030 Project.

- **Early feed:** Cereals have proven more reliable than annual ryegrass for early sowing because they have a higher tolerance to moisture stress during establishment. Being a larger seed, and usually sown at 2-4cm depth, cereal germination and seedling survival is superior to annual ryegrass and they are less likely to be affected by a 'false break'. This provides more flexibility in sowing time and more reliable production of feed early in autumn. Oats, in particular, can be sown as early as February in some regions because it can germinate when the soil temperature is as high as 25°C, provided some moisture is present.

The 3030 Project experiments at Terang confirmed these production benefits, as shown in Table 1. In 2005, when autumn rainfall was 40% below historical average, the yield of oats at first grazing was significantly higher than for annual ryegrass. In 2006, autumn rainfall was 26% above average and there were no significant differences between the yield of oats and annual ryegrass at first grazing.

**Table 1.** Yields at first grazing (tillering stage, mid-June) of oats and annual ryegrass in 2005 and 2006, and autumn rainfall for each year.

	2005		2006	
	Yield at 1st grazing (t DM/ha)	Rainfall March–May (mm)	Yield at 1st grazing (t DM/ha)	Rainfall March–May (mm)
Oats	0.79	70.5	1.13	149.6
Annual ryegrass	0.53		1.22	

- **Higher water use efficiency:** Cereals typically use autumn-winter rainfall more efficiently than annual ryegrass, producing more DM/mm of water. In on-farm observations in South-East Gippsland (Yarram), cereals yielded 7–8 t DM/ha with only 400 mm rainfall. The increased capacity of cereals (wheat in particular) for DM production during the cool months of the year means that the winter rainfall can be converted into more feed. Irrigated studies have also shown higher water use efficiency for cereals compared to ryegrass (Neal et al., 2009).

### Disadvantages

- **Nutritive value:** Annual ryegrass has the ability to provide feed with excellent nutritive characteristics through winter and into late spring, while cereals tend to decrease their nutritive value as the season progresses. A comparison of nutritive characteristics between silage of cereals and annual ryegrass is shown in Table 2, where all species were cut at the same time ('soft dough' stage).

**Table 2.** Average metabolisable energy (ME), crude protein (CP), neutral detergent fibre (NDF) and water soluble carbohydrate (WSC) content of silage made at the 'soft dough' stage from two studies in south-west Victoria (Jacobs et al., 2009a, b).

	ME (MJ/kg DM)	CP (%DM)	NDF (%DM)	WSC (%DM)
Triticale	8.2	8.0	55.5	17.8
Wheat	8.7	10.3	54.5	16.3
Oats	7.6	8.3	61.9	11.2
Barley	6.6	9.2	67.8	3.4
Annual ryegrass	10.2	13.1	55.5	12.4

- **Losses:** In the silage making and feeding process losses of either dry matter or nutritive value can occur at the field level (cutting, mowing, wilting, chopping/baling), when ensiling (fermentation) or feeding out (aerobic spoilage, wastage, poor utilisation). All these losses can increase the cost per tonne of DM or megajoule (MJ) of ME consumed. The magnitude of these losses are difficult to determine in practice but, as an extreme example, cereal losses in the first year of the 3030 farmlet studies were close to 40% as a result of late harvesting, poor field techniques and feed-out losses.

Annual ryegrasses offer more flexibility to avoid the losses that occur when using silage because they can be fully utilised by grazing. Winter cereals, on the other hand, can only be partially utilised by grazing and must be made into silage to obtain maximum yield.

- **Grazing:** Annual ryegrass adapts better to grazing conditions than most of the winter cereals. It is normally more resilient (capacity to resist and recover) to intensive grazing because it maintains a higher proportion of green leaf after grazing compared to most cereals.

In addition, annual ryegrass does not lose nutritive value as rapidly as most winter cereals if grazing is delayed passed the optimum time. This loss of nutritive value mainly occurs when the reproductive growth stage commences. The higher proportion of fibre with low digestibility in the reproductive stems can reduce the quality of the herbage consumed rapidly if it is not grazed on time. Cereals can enter the reproductive phase in mid-winter, whereas ryegrass enters it later in spring, allowing more opportunities for grazing.

Winter cereals do not tolerate water logging for more than a few days and should not be grazed if pugging is likely. If this occurs yields will be greatly decreased.

### Where do winter cereals fit into your feed plan?

#### Filling perennial ryegrass feed gaps

Winter cereals, utilised either by direct grazing or fed as silage, can produce valuable home-grown feed to complement the typical production curve of a perennial ryegrass-based dairy system. Figure 1 shows how feed gaps in a perennial ryegrass based system occur mainly in late autumn-early winter and summer, and are more pronounced at high stocking rate systems. The use of alternative forage crops, such as winter cereals, can provide high quality grazable feed and home-grown silage to fill those feed gaps (in combination with other feeds to balance the ration), and reduce the exposure of the system to the volatility of purchased feed prices.

The capacity of cereals (particularly oats and wheat) to provide reliable feed in early autumn can allow better management of the existing or newly sown perennial ryegrass. Having a proportion of the milking area sown to winter cereals reduces the pressure on the existing pasture during autumn when it is crucial to establish pasture cover, leading into winter. There is also less pressure to graze the establishing pastures too early and/or too hard.

#### Where perennial ryegrass does not persist

In North-East Victoria, for example, the growing seasons are too short for perennial ryegrass to persist without irrigation. On commercial farms within the 3030 Project, cereals sown on up to 10% of the milking area in late February to early March (typically oats) were able to consistently provide the

first autumn grazings, provided they were not sown too shallow (recommended depth 3–4 cm). Following paddocks through summer to conserve moisture (reducing the reliance on autumn rainfall) showed the best results for establishment success and weed control.

Wheat, oats, triticale and barley were evaluated on-farm in a low rainfall environment (650 mm/year) in Yarram, Gippsland as part of the 3030 Project. Estimated yields of 8–9 t DM/ha were obtained cutting at the 'boot stage' (stage of growth immediately before head emergence) with the crop receiving only 400 mm of effective rainfall during its growing season. This was despite the crops being sown in autumn when the soil was still dry. Interestingly, on more than one occasion these crops 'restruck' with a rainfall event after the silage cut, giving the opportunity for an additional cut for hay (estimated yields of up to 4 t DM/ha). This was possible because a proportion of the tillers of each plant did not have an elongated reproductive stem at the time of the cut and, therefore, the growing point remained below cutting height.

#### Pasture renovation program /double cropping

Winter cereals can be used as part of a one or two-year perennial pasture renovation program, where winter cereals are sown after the deteriorated pasture is sprayed out and prior to establishing a summer crop.

From the range of summer crops used after winter cereals, the Brassica species (forage rape, turnips and hybrids) are more efficient in capturing any remaining N in the soil from the previous cereal crop than the summer forage cereals (millet, sorghum). The strengths and weaknesses of summer and double cropping options are discussed in the 'Turnips', 'Regrowth brassicas', 'Millet and sorghum' and 'Double cropping' Information Sheets in this series.

In low-rainfall environments, e.g. at Yarram, millet was shown to be a convenient option used in combination with the single-cut winter cereals in a low-cost double crop system. This has proven reliable even in dry years.

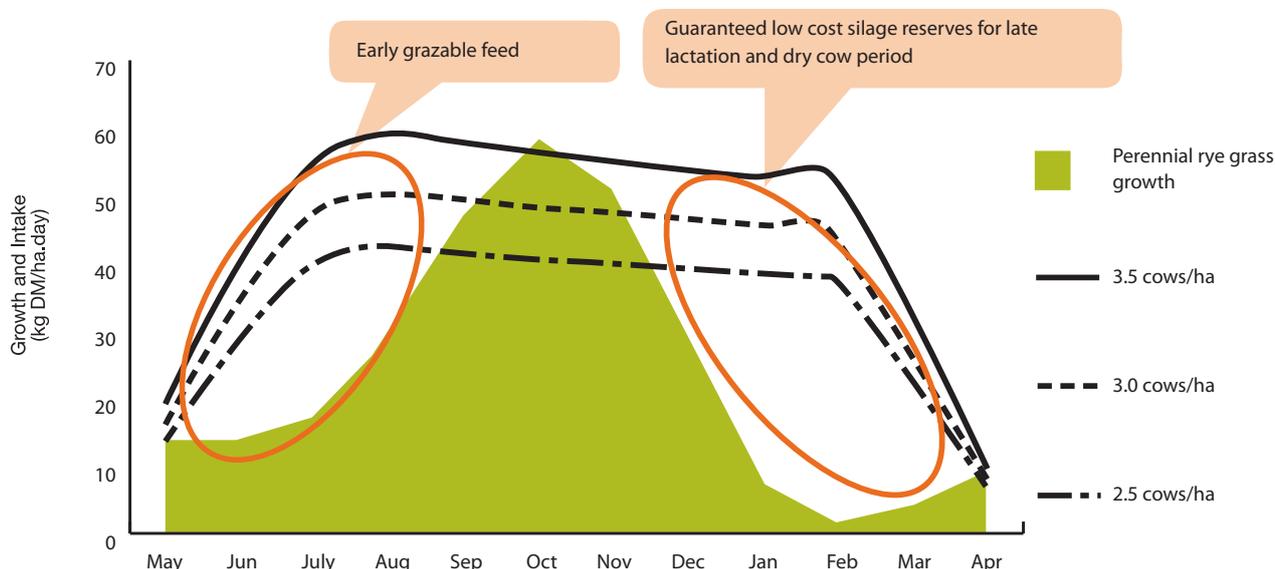


Figure 1. Average perennial ryegrass growth rate (kg DM/ha.day) at Terang, Victoria, and potential intake requirements (kg DM/ha.day) for a dairy herd (May-July calving) at different stocking rates.

## Sowing mixes

In situations where there is a high demand for autumn and early winter feed (e.g. early/mid-autumn calving herds), mixtures of cereals with annual ryegrass offer an all-grazing, high-quality alternative to straight annual ryegrass or straight cereal.

On a 3030 Project partner farm in North-East Victoria, a mixture of oats and annual ryegrass showed high potential yield (estimated at 16 t DM/ha) and nutritive value comparable to ryegrass alone, with early growth available for grazing. However, the sowing date seemed to be a key factor in establishing this mix: if sown before March, oats are likely to completely dominate, so sowing later than March is recommended to ensure a better balance of species.

On the same farm in North-East Victoria, a mix of annual ryegrass with an autumn-sown hybrid Brassica (Winfred) was evaluated at the paddock level for three years in a row. Yields varied according to rainfall from 6.7 to 9.3 t DM/ha and were always similar to or higher than the paddocks sown to annual ryegrass alone.

Compared to annual ryegrass alone, this mix has the advantage of the earlier growth of the Brassica.

## Establishment

Sowing cereals using direct drilling or full cultivation resulted in similar establishment rates. On-farm trials using oats showed successful establishment with direct drill (Figure 2) and no apparent differences in total ME yield per ha between direct drill and cultivation (Mickan, pers. comm.). Direct drilling is recommended because of lower costs and allows for earlier grazing compared to full cultivation where grazing may be limited by soft ground. However, when cereals are sown into paddocks that have been in pasture for several years, a full cultivation is recommended in order to take advantage of the nitrogen from the mineralisation of the organic content of the soil and reduce fertiliser costs.

Sowing rates of 80–100 kg/ha appeared optimum. However, triticale trials show no differences in final yield between 60 and 160 kg/ha, due to tillering compensation. Once sown, the availability of herbicides for the control of grass weeds in some cereals is low. Following over summer in dry regions was necessary to reduce weed risks and conserve some soil moisture prior to sowing.



**Figure 2.** Height of direct-drilled oats two weeks after sowing (sown 5 April 2007) at 3030 Project on-farm trial near Warragul.

Normally, a combined fertiliser such as diammonium phosphate (DAP) is used at sowing at the rate of 100–150 kg/ha to supply both phosphorus and nitrogen. If the paddock was previously under improved pasture with good soil fertility and fully cultivated, the response to further applications of nitrogen during the season is minimal and may not be required. This was found at Terang as part of forage cereal research carried out in 2005 and 2006. There were small improvements in CP content (0.08% to 0.33% per 10 kg N applied) but without a corresponding DM yield increase it is likely that these applications would not be cost effective. N is most likely to be needed if cereals are sown on run-off or lease blocks.

## Grazing option

Grazing cereals once during late-autumn/early-winter does not affect total DM yield. However, grazing twice (once at tillering and again after stem elongation) affected final yields significantly (Table 3). This was found at 3030 Project replicated trials at Terang, and further evaluated on partner farms. If crops are sown very early they may be grazed two, or possibly three, times before stem elongation occurs.

Early grazing of the cereal should be before stem elongation and leave a residual of not less than 5 cm height (see Figure 3). Triticale and wheat were the cereals more suitable for this practice, as their final yield was less affected by the initial grazing than that of oats and barley. Figure 5 shows the effect on the regrowth of an oats crop that was grazed when stem elongation had already commenced.

The nutritive characteristics of the forage grazed is normally high (12 MJ ME/kg DM and 20% CP or higher) and up to 1 t DM/ha can be consumed with this practice without affecting yield.

In all cases, excessive trampling should be avoided. Crops should be strip grazed to a 5–10 cm residual, but remove cows earlier if pugging occurs.

**Table 3.** Final silage yield of winter cereals and annual ryegrass after being grazed once, twice or not grazed (Jacobs et al. 2009a).

	Grazed once (tillering)	Grazed twice (tillering + elongation)	Not grazed
	(t DM/ha)	(t DM/ha)	(t DM/ha)
Triticale	11.2	6.1	11.3
Wheat	6.7	5.4	7.6
Oats	11.6	7.9	13.7
Barley	5.9	3.9	5.2
Annual ryegrass	16.5	12.5	17.7



Figure 3. Grazing at early tillering stage (3030 Project study at Terang).

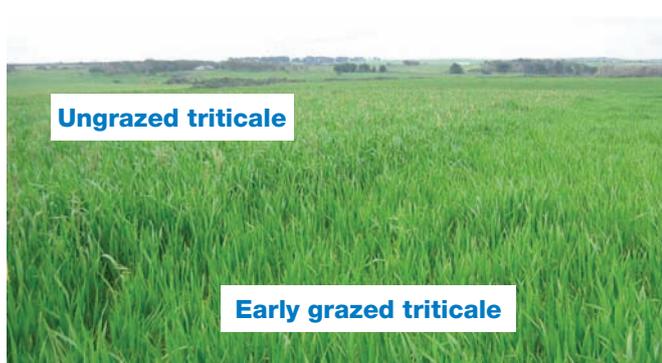


Figure 4. Ungrazed and early grazed triticale (above) and wheat (below) crops at 3030 trials in Timboon (17 August 2007).



Figure 5. Ungrazed and late grazed oats crop at 3030 trials in Yarram (29 September 2007).

### The cutting time trade-off: Yield vs. ME

The nutritive value of the silage from winter cereals is usually moderate (8–10 MJ ME/kg DM, 10–17% CP). This nutritive value of silage is lower than when the same crop is consumed by grazing.

There is a trade-off between yield and ME content with cutting time when making cereal silage. Generally yields tend to increase with stage of growth at cutting, but ME and CP content tends to decrease. The yields and ME content of triticale, oats and wheat cut at boot, anthesis, milk and soft dough stages (Figure 6) at Terang are shown in Table 4. These results illustrate that this trade-off occurs in all the cereals, but it happens more sharply for triticale than for wheat and oats.

Crude protein content also declines markedly for all cereal crops when cut after 'boot stage' (from 12-17% CP content at the 'boot' stage, declining to 6-10% DM at the 'late milk-soft dough' stage).

In a single crop situation, cutting late ('soft dough') is a feasible option if the objective is to maximise yield. Although cutting early ('boot stage') results in lower yields, it results in higher nutritive value. In a double-cropping situation, an early cut is preferable to conserve soil moisture and allow for an early sowing of the summer crop.

Sowing wheat or triticale mixed with field peas (50% of sowing rate) can improve the quality of the silage. Cutting at the 'boot' stage is recommended to optimise quality.

If there is a frost during flowering, the grain filling will be poor and, if severe enough, can even lead to no grain production. In this case, an early cut for silage would be recommended.

Table 4. Yield and ME content of triticale, oats and wheat silage cut at the boot, anthesis, milk and soft dough stage at Terang.

Crop	Stage	Yield	ME
		(t DM/ha)	(MJ ME/kg DM)
Triticale	Boot	5.1	10.4
	Anthesis	11.9	8.6
	Milk	13.8	8.7
	Soft dough	17.9	8.8
Oats	Boot	7.5	10.4
	Anthesis	7.7	10.5
	Milk	10.3	9.9
	Soft dough	10.4	8.9
Wheat	Boot	7.9	10.2
	Anthesis	8.4	9.6
	Milk	10.1	9
	Soft dough	10.9	9.3



Figure 6. Cereals at the boot, anthesis, milk and soft dough stages.

### Silage-making tips

- Wilting for 24-48 hours is recommended when cutting cereals for silage at the 'boot' as the %DM of the standing crop is usually 20–23%DM. For baling at this stage of growth a DM content between 38 and 50% should be targeted; for a stack/pit silage, a DM between 33 and 40% is acceptable.
- Precision chopping is necessary for high-quality silage, as it improves silage compaction and allows a more stable fermentation. This is especially important when the crop is cut at the 'milk' or 'soft dough' stages with high yields and high proportion of stem (see Figure 6). A chop length of <2 cm is recommended.
- Silage additives are recommended to enhance the fermentation process (see Jacobs et al., 2009b for more details). Their use is critical when cutting at early stages ('boot stage') and if below the target range of DM content. In trials testing wheat, triticale and oats silage cut at different stages, additives have proven effective in reducing the silage's final pH and the likelihood of deterioration in the pit/stack or on opening. Aerobic spoilage inhibitor type silage additives are recommended to be applied to the late cut silage at ensiling of stack/bunker silages to minimise heating, moulding and DM and quality losses at opening.
- In general, there are greater losses when conserving drier material. Overseas studies have shown that losses during baling were 3–4 times greater when cutting at 60% DM content than when cut just after 'boot stage'. This is because the drier material loses a much higher proportion of the remaining leaves and grain during the raking, picking up and actual baling operations compared to its more moist state as silage.



**Figure 7.** Triple mower–conditioner used for wheat in 3030 Project on-farm trials in Foster (2006).

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## About 3030

PROJECT 3030 aims to help farmers achieve a 30% improvement in farm profit by consuming 30% more home-grown forage (pasture plus crop). It is aimed at dryland farmers in southern Australia who have mastered the challenge of growing and using ryegrass pasture for dairy-cow feeding.

## For further information

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