Making quality silage and hay from pastures containing weeds.

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Introduction

Australian agriculture is under pressure to increase productivity and improve the sustainability and environmental sensitivity of farm practises. Making better use of resources, especially rain fed pasture, and reducing the use of chemicals, such as herbicides, are two areas in which Australian farmers are making changes.

Potential for forage conservation

Australia is a country with marked seasonality of pasture growth. In many areas 60–70% of pasture growth occurs within a 3–4 month period. Hay or silage, if managed correctly, can be used successfully to transfer surplus forage from periods of plenty to times of deficit during the year. Recent drought conditions across much of the country have also highlighted the advantages of having stored fodder reserves.

Concurrent with this has been a push towards integrated weed management and reducing the quantity of herbicides used to control weeds. Forage conservation, as discussed by Bowcher (2006), can play an important role in weed control. Anecdotally forage conservation, in particular silage making, is believed to reduce the incidence of weeds in pasture.

Hay vs silage

Compared to hay, silage offers a number of additional benefits. It allows forage to be conserved earlier in the season when pasture quality is higher. This results in a higher nutritive value of the conserved forage, which is suitable for either maintenance or production feeding. Further, there is often significant pasture regrowth following silage making which can provide high quality forage for grazing later in the season. In addition, silage preservation is assumed to render most, if not all, weeds seeds unviable (Blackshaw and Rode, 1991).

Conservation benefits

The benefits of forage conservation can be significant and include:

- manipulation of pasture composition, with reduced reliance on the use of herbicides to control weeds;
- an increase in the total amount of pasture utilised;
- an increase in the average quality of pasture utilised; and
- increased production of meat/wool/milk per hectare.

Weeds in conserved forage

Unfortunately very little research has been conducted on the impact of pasture weeds on hay or silage quality, or on the effect of weeds on the actual conservation process. Weeds can potentially cause problems at all stages of the forage conservation process (mowing, wilting, harvesting and/or storage).

Weeds can have a negative impact on hay and silage quality if they:

- lower the quality, specifically the digestibility or metabolisable energy (ME) content (MJ/kg DM), of the hay or silage;
- make the preservation process more difficult; and/or
- have a detrimental effect on animals that consume them.

Therefore weeds of crops and pasture may not necessarily be weeds of conserved forage. Annual ryegrass (*Lolium rigidum*), for example, is a weed in cereal crops, however annual ryegrass within pasture is a desirable high quality grass. Similarly annual ryegrass is an excellent species in silage and early cut hay.

Forage quality

Forage quality is a general term used to describe the feed value of forages. It encompasses the energy (ME), crude protein (CP), minerals and vitamins required by livestock for maintenance, reproduction and production of meat, milk and wool. In most instances with pasture hay and silage it is inadequate ME content that limits animal production. With silage, which is a fermented feed, forage quality also includes fermentation quality.

The key ways in which weeds can reduce pasture hay or silage quality are:

- the digestibility or ME of the weed(s) present is lower than that of the preferred pasture specie(s); and/or
- the digestibility or ME content of the weed(s) is similar early in the season but are of lower quality at the preferred time of harvest.

There are several studies where these two factors have been demonstrated. Temme *et al.* (1979) in the USA produced dried forage from lucerne (*Medicago sativa*), weeds (forbs and grasses) and a mixture of both lucerne and weeds. On average weeds had lower dry matter digestibility (DMD) and crude protein (CP) levels compared to lucerne with the mixture intermediate. In this study Shepherd's Purse (*Capsella bursa-pastoris*), harvested at the seed growth stage, had the lowest DMD (53.3%) of all species, compared to 69.6% for lucerne at the same time. Voluntary intake of the weeds and weed/lucerne forage by sheep was lower and reflected the differences in quality.

In addition, Martin and Anderson (1975) and Temme *et al.* (1979) found that the rate of decline in DMD with time was generally greater for weeds than for lucerne. Further, Cords (1973) found a negative correlation between the proportion of winter weeds and the protein content of lucerne hay. These winter weeds, which included grasses and broadleaf species,

Table 1 Digestibility of subclover pasture and three broadleaf weeds.

	Subclover pasture	Capeweed	Paterson's curse	Variegated thistle
DM at cutting (%)	15.4	12.1	12.9	13.0
Organic matter digestibility (%)	71.1	68.0	62.6	68.9
Crude protein (% DM)	16.2	12.0	12.6	12.6

Source: Kaiser (unpublished data)

were more mature at the time of first harvest in spring than the lucerne.

In contrast, Marten *et al.* (1987) reported that at the vegetative and bud stages most broadleaf (forb) weeds had digestibility levels equal to, or higher than, lucerne. Dandelion for example had an average DMD of 78.4% compared to an average of 70.8% for lucerne across the same harvests. Similarly, Bosworth *et al.* (1986) reported that the DMD of most weeds (grasses and forbs) was usually high at the vegetative stage of maturity, and similar to that of rye (*Secale cereale*) and white clover (*Trifolium repens*). There was a tendency for the DMD of weeds to decline more rapidly and at the later stages of maturity and in general the grass weeds were less digestible than rye.

Table 2 Typical dry matter, metabolisable energy and crude protein analyses for a range of feedstuffs.

	Dry matter (%)		Metabolisable energy (MJ/kgDM)		Crude protein (%)	
	Average	Range	Average	Range	Average	Range
Clover silage	41.9	20.9–79.5	9.6	8.1–10.6	19.3	12.4–27.2
Clover hay	86.6	61.3–93.2	8.9	6.2–11.2	17.6	6.3–26.1
Grass silage	43.2	17.1–89.3	9.3	4.8–12.0	13.2	5.1–26.6
Grass hay	86.3	51.9–94.0	8.0	4.9–10.5	8.0	0.7–17.7
Lucerne hay	87.8	36.0–96.1	9.3	5.3–11.3	18.9	5.7–29.7
Oaten silage	40.9	18.1–82.2	8.7	5.9–11.2	9.8	3.8–19.4
Oaten hay	88.9	40.2–96.4	8.4	4.5–11.3	6.9	1.1–16.3
Oaten straw	89.4	80.2–93.8	6.2	4.3–10.0	2.8	0.1–11.9
Wheat grain	89.4	80.2–92.9	13.1	10.5–14.1	12.9	7.4–22.7
Barley grain	88.7	81.2–97.0	12.3	8.6–13.5	10.8	6.3–19.0
Oats	91.1	80.0–93.3	10.3	5.9–14.2	9.0	4.0–15.4
Triticale grain	89.4	80.3–96.9	13.0	11.6–13.5	11.4	6.6–18.8
Lupin seed	91.6	86.1–95.5	12.6	11.2–14.9	32.0	21.3–43.2

Source: Data adapted from Victorian Department of Primary Industries website

In an Australian study Kaiser (unpublished data) reported that capeweed (*Arctotheca calendula*) and variegated thistle (*Silybum marianum*) had similar organic matter digestibility (OMD) to subterranean clover pasture (*Trifolium subterraneum*). However the OMD of Paterson's curse (*Echium plantagineum*), a significant component of many pastures was lower than subterranean clover. All three broadleaf weeds had lower protein content that the subterranean clover pasture (Table 1).

At first glance it would be reasonable to assume that as the reported digestibility of these broadleaf weeds is similar to introduced species they are equally valuable in conserved forage. However Jones *et al.* (1971) reported that some broadleaf weed species have higher mineral contents than introduced temperate pasture species. These weeds included Paterson's curse, capeweed, variegated thistle and milk thistle (*Sonchus oleraceus*).

Increasing mineral (ash) content reduces energy content, without necessarily changing either DMD or OMD. An increase in ash content from 10 to 20% (DM basis) equates to a decline in ME of approximately 1 to 1.5 units across the range from dry mature grass to lush vegetative pastures. Temperate pasture species are generally in the range 9–12% ash content. To put this into perspective, most feedstuffs fall within a narrow ME range of between 7 and 12 (Table 2). The ME and CP requirements of sheep and cattle varies with class of livestock. Table 3 provides a guide to the minimum requirements for cattle.

The conservation process

The physical structure of some weeds can make hay and silage production more difficult. Others reduce ensilability, i.e. their chemical composition makes silage making more difficult. While a third group have no impact on the efficacy of the forage conservation process either for hay or silage.

Table 3 Recommended minimum metabolisable energy and crude protein requirements for various classes of cattle and sheep.*

Livestock class	Metabolisable energy (MJ/kg DM)	Crude protein (%)
Maintenance	7.5–8	9–11
Young growing animals	10–11	12–14
Late pregnancy	9–10	12
Lactating	10–11	14–16

* Minimum requirements for sheep tend to be higher than for cattle.
Source: Bell *et al.* (2004); Exton (personal communication)

Table 4 Water soluble carbohydrate content (g/kg DM) and buffering capacity (meq/kg DM) of common pasture and weed species.

Forage type	Water soluble carbohydrate content (meq/kg DM)		Buffering capacity (g/kg DM)	
	Mean	Range	Mean	Range
Cocksfoot	7.9	5.0–19.1	302	209–438
Perennial ryegrass	19.6	4.6–34.1	313	231–428
Subclovers	10.2	6.3–13.7	647	420–877
Berseem	9.2	6.4–12.1	696	638–790
White clover	6.7	5.1–9.1	–	512
Arrowleaf	11.1	9.9–12.0	548	484–588
Medics	6.6	4.2–10.6	614	496–720
Kikuyu	4.5	2.3–6.8	351	225–496
Rhodes grass	3.0	3.5–6.2	–	435
Capeweed	–	17.2	–	1082
Variegated thistle	–	14.7	–	682
Paterson's curse	–	11.9	–	1013

Source: Adapted from Piltz and Kaiser (2004)

A number of broadleaf weeds, such as capeweed and Paterson's curse, are usually high in moisture content and difficult to wilt due to their physical structure – they have thick stems which retain a lot of moisture. Slower wilting means increased overall losses in the field due to respiration and mechanical operations. Where clumps of broadleaf weeds occur in the paddock, it can result in poorly fermented pockets of wet material in baled silage or impact on entire bales. Forage harvested silage does not tend to be as affected because the material is more evenly spread throughout the bunker. In hay bales it can result in damp pockets which are prone to heating and going mouldy.

A number of broadleaf weeds have a low water soluble carbohydrate (WSC) content, i.e. plant sugars, and/or a high buffering capacity (BC). During ensiling these WSC's are fermented to acid which preserves the silage. Buffering capacity is a measure of how much acid is required to successfully preserve the silage. The lower the BC value the less acid is required. Therefore low WSC content and high BC both operate to increase the difficulty of ensiling (i.e. ensilability) of a species.

A rapid wilt to a minimum DM content of 30 to 35% is the recommended strategy to ensure a successful fermentation when ensiling forage that is characterised by low WSC content and/or high BC. Otherwise there is a substantial risk of a poor quality silage fermentation. A poor quality silage fermentation will result in a greater loss of energy and DM, degradation of the protein fraction, and the silage will be unpalatable to livestock. A comparison of the WSC and BC of several pasture and weed species is presented in Table 1 and Table 4.

In general temperate grass pastures which are characterised by moderate to high sugar content and low BC are easier to ensile than legume dominant pastures which have lower WSC contents and intermediate BC values. Tropical grasses that have very low WSCs, and broadleaf weeds which have very high BCs, are more difficult.

Differences between temperate and tropical pasture species

Tropical grasses are of inherently lower digestibility, and quickly become rank and decline in ME faster than temperate species (Griffiths and Burns 2004). For this reason forage conservation is a useful management tool to maintain tropical pastures in a vegetative state during periods of rapid pasture growth. When making hay or silage from tropical pastures, such as kikuyu (*Pennisetum clandistinum*) or Rhode's grass (*Chloris gayana*), cutting should occur when pastures are still lush and vegetative.

Where tropical grasses have invaded temperate pastures the decision on when to harvest will depend on the proportion of tropical to temperate species and stage of maturity of the respective species.

Tropical species are also characterised by low WSC content which reduces the ease of ensiling. A rapid wilt to a minimum DM content of 30% (chopped silages) or 35% (baled silages) is recommended to ensure a successful fermentation.

Weeds and livestock

Weeds can reduce animal production from conserved forages either due to the toxic or anti-nutritional compounds they contain, or by reducing palatability and voluntary intake.

The effect of either hay or silage making on toxic or anti-nutritional compounds in most forages is not known. There may be some reduction in levels due to respiration during wilting but this has not been confirmed. With silage there may be additional breakdown due to the fermentation process. In the absence of data to support this, it cannot be assumed that either hay or silage making alters the amount of undesirable compounds in forages/weeds.

Some plants are unpalatable and this may be due to either a chemical or physical attribute. Unpalatable weeds reduce voluntary intake even if these weeds are of similar ME and CP to desirable species, livestock production will be reduced.

Pastures that are cut late often contain mature seed heads from grass and broadleaf weeds such as barley grass (*Hordeum leporinum*) and crowsfoot (*Erodium* spp.). When fed to sheep the seeds can cause rejection of the hay/silage, wool contamination and even skin damage. Barley grass seeds can also cause damage to eyes and cause mouth and gum problems in cattle. In experiments at Wagga the authors have had first hand experience of the latter. In an experiment in which an oaten silage was fed to steers, barley grass seed heads impacted in the mouths causing severe lesions which prevented the steers from eating and consequently reduced production.

One weed species that does benefit from ensiling is Yorkshire fog (*Holcus lanatus*). Yorkshire fog is unpalatable to grazing animals, probably due to its hairy leaves and stems. Ensiling appears to reduce or eliminate the problem. In addition Yorkshire fog seems to have a reasonable ME and CP content, similar to other perennial temperate grasses and anecdotally farmers have reported that ensiling reduces the content of Yorkshire fog grass in perennial pastures.

Conclusion

Forage conservation, especially silage making, can be used as a weed management tool. However producing quality silage/hay is critical to a profitable conservation program; therefore farmers need to consider the impact that weeds can have on their hay and silage.

In the absence of further data it is recommended that:

- A maximum level of 25–30% broadleaf weeds be included in hay and silage in order to maintain acceptable quality and production potential. If feasible avoid heavily contaminated areas within conservation paddocks.
- Unless there is information to prove otherwise, it cannot be assumed that either hay or silage making will destroy, or reduce the level of, toxic and/or anti-nutritional compounds present in forages.
- Timing of the harvest should occur to maximise forage quality and regrowth potential rather than yield of conserved forage. Grass weeds normally mature before introduced grasses and legumes, therefore stage of maturity of the grass weeds

should be used to determine optimum stage to harvest when they represent over 25% of the DM available. The same principle should apply to invasive tropical species.

- Physical damage to animals can be a risk from some grass and broadleaf weed seeds. Where these weeds exist, harvest before seed set. If not, try to avoid heavily contaminated paddocks or mow around the worst affected areas to minimise risk.

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