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PROFITABLE & SUSTAINABLE PRIMARY INDUSTRIES www.dpi.nsw.gov.au
NOVEMBER 2005 PRIMEFACT 52

Yield and digestibility of legume and oat forages

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INTRODUCTION

Pasture and grain legumes can be sown to produce high yielding forage crops which are later conserved in spring as either silage or hay. The species selected and the timing of the cut will have a large influence on both the yield and quality of the conserved fodder.

The quality of conserved fodder is determined by the inherent quality of the pasture or crop at the time of harvest and the efficiency of the conservation process. The quality of the forage is mostly affected by the plant species and plant maturity at the time of harvest. Typically forage quality declines as plants progress from the vegetative stage through the reproductive stages whereas forage yield increases till after anthesis (flowering). The data provided in this report describes the change in yield and quality of a large range of legume species, oats and ryegrass cut at three different stages of maturity.

Values are provided for both pure swards and mixtures of legumes and oats or ryegrass.

SPECIES COMBINATIONS AND CUTTING TIMES

Ten different species of legume were grown at Wagga Wagga, either alone or in combination with oats or ryegrass, to simulate forage crops. The oats was added to provide a climbing frame for the legumes and to increase the bulk of feed produced. The species, cultivars and sowing rates used in the study are described in Table 1. The oat variety Kalgan was selected for use in mixtures due to its short stature and strong stems to resist lodging in comparison to the variety Cooba which is a more vigorous grazing–grain dual purpose oat variety more likely to compete strongly with the legumes.

The three cutting times in spring were selected to coincide with typical cutting times for making either early silage (2 October), late silage (23 October) or hay cut (6 November) in southern New South Wales.

The early cut corresponds to the 'booting' stage in oats, the second cutting time to the 'anthesis' stage and the final or late cut to the 'milk' stage in oats.

The legume sowing rates selected were based on best knowledge at the time of the experiment. Increasing the seeding rate is likely to increase early winter–spring forage production but is less likely to increase yields in late spring. There is little information on which to base oat sowing rates when used in mixtures with legumes. The 40 kg/ha rate used was in retrospect too high and lower rates around 25 kg/ha may give a better proportion of legume and oats in the harvested forage. Farmers wanting a legume dominant forage would need to further lower the oat seeding rate to no more than 15 kg/ha.

Table 1. Species, cultivars and sowing rates

Species	Cultivar	Sowing rate (kg/ha)	
		Sowing rate alone	Sowing rate in combination
Oats – high N	Kalgan	80	-
– high N	Cooba	80	-
– low N	Kalgan	80	40
Ryegrass – high N	Richmond	10	-
– low N	Richmond	10	5
Berseem clover	Big Bee	15	10
Sub clover	Clare	15	10
Sub clover	Karridale	15	10
Balansa clover	Paradana	10	6.7
Arrowleaf clover	Seelu	10	6.7
Murex medic	Zodiac	15	10
Barrel medic	Sephi	15	10
Purple vetch	Popany	45	30
Common vetch	Golden Tares	45	30
Field peas	Dundale	100	66.7

Table 2. Yield of forage crops harvested at three stages of growth, early (2 October), mid season (23 October) and late (6 November). Values are adjusted for a mean legume content of 30% in all oat–legume mixtures and 90% legume in legume monocultures.

Forage	Dry matter yield (t/ha)		
	Cut 2 Oct.	Cut 23 Oct.	Cut 6 Nov.
Pure forages			
Kalgan oats – high N	7.33	12.17	13.43
Cooba oats – high N	4.94	12.61	17.68
Kalgan oats – low N	6.34	9.83	10.52
Ryegrass – high N	7.70	11.20	8.51
– low N	6.06	8.95	9.86
Berseem clover	3.86	7.45	5.39
Clare sub clover	3.98	5.56	5.97
Karridale sub clover	4.83	6.16	6.60
Balansa clover	5.74	6.52	6.17
Arrowleaf clover	4.71	7.47	7.34
Murex medic	4.87	8.77	7.82
Barrel medic*	3.67	3.67	3.76
Purple vetch	6.24	9.89	8.68
Common vetch	5.64	6.81	6.64
Field peas	6.86	11.58	12.28
Mixtures			
Oats**/Berseem clover	5.96	10.89	13.20
Oats/Clare sub clover	5.76	11.11	9.84
Oats/Karridale sub clover	7.13	10.36	8.30
Oats/Balansa clover	6.84	11.20	9.14
Oats/Arrowleaf clover	6.81	9.34	8.79
Oats/Murex medic	6.73	9.41	10.55
Oats/Barrel medic	7.70	8.97	8.60
Oats/Purple vetch	8.45	15.17	11.00
Oats/Common vetch	6.96	13.27	13.37
Oats/Field peas	9.48	14.68	12.71
Ryegrass/Berseem clover	5.75	8.31	8.24
Ryegrass/Clare sub clover	5.79	8.86	8.28
Ryegrass/Common vetch	6.97	10.62	9.84

* Barrel medic was not suited to this soil type. **Kalgan oats was sown in all legume mixtures.

Arrowleaf clover is a high yielding annual legume capable of producing 7 to 9 tonnes dry matter/ha when sown in early autumn.

Nitrogen fertiliser was added at two rates to the pure oat and ryegrass treatments but not to the legumes. All forages were sown on 29 May. This sowing time was optimum for peas and vetches but late for small seeded pasture legumes.

FORAGE YIELDS

The yields of particular forages will vary with seasonal conditions, soil type, drainage and location. The yields in Table 2 give a guide to expected yields at Wagga Wagga under average rainfall conditions. Legume species and cultivars should be chosen which are known to yield well on the soil type where the forage will be grown.

Yields of most species generally increase with time up to anthesis, after which yields either level off or decline due to increased losses from shading and respiration. In the year of the experiment, growing conditions were curtailed in spring due to dry conditions.

Some forages, such as pasture legumes, can be grazed over winter before being closed up for forage harvesting later in spring. Other forages, such as peas and vetches, do not recover well from grazing and are best left ungrazed until cut for forage.

Small seeded pasture legumes are likely to perform best when sown in early autumn. If sowing is delayed until June, either because of seasonal conditions or the need for weed control, larger seeded legumes such as peas and vetch may be more suitable.

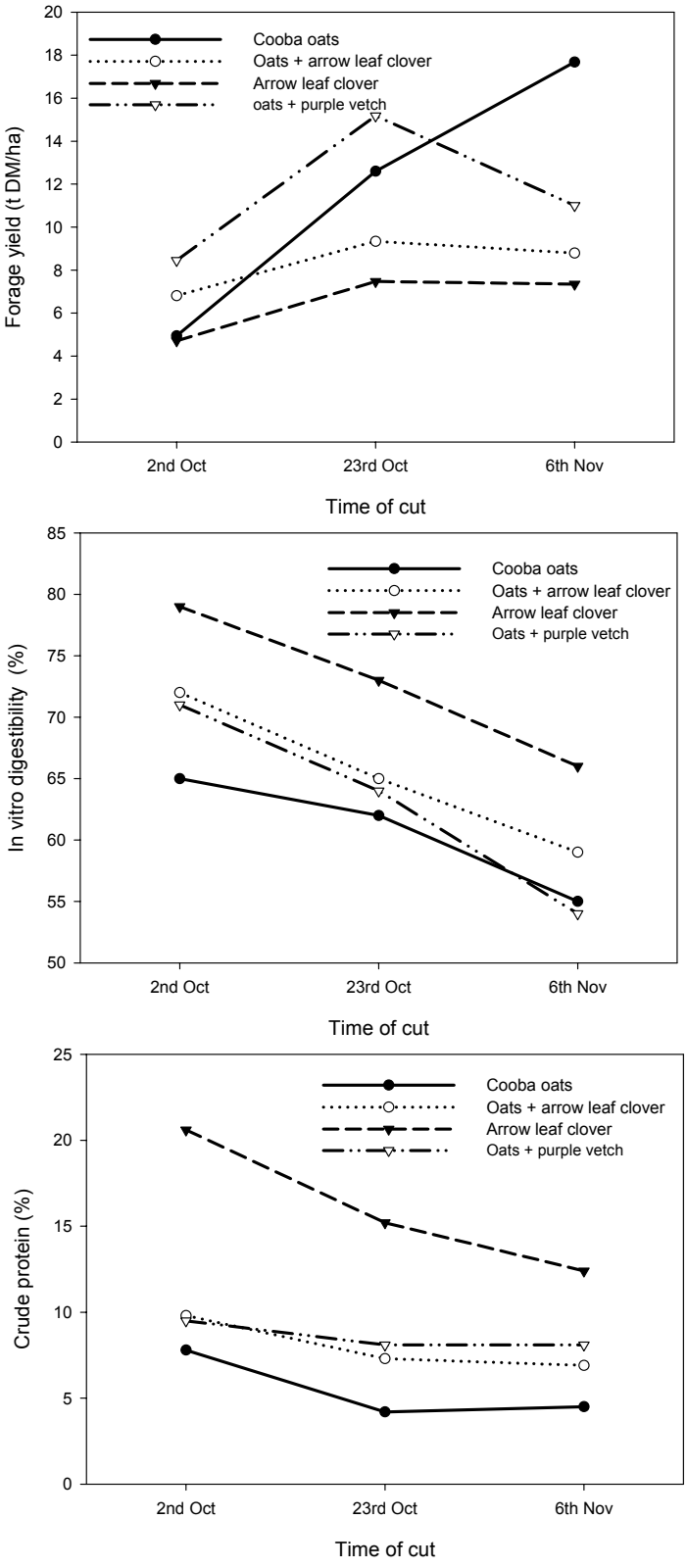

Figure 1. The changes in yield, digestibility and crude protein during spring in oats, legumes and oat–legume mixtures. Growing legumes with oats increases the digestibility and crude protein of the forage compared to pure oats but total forage yield is likely to be less.

Table 3. Digestibility of forage crops harvested at three stages of growth, early (2 October), mid season (23 October) and late (6 November). Values are adjusted for a mean legume content of 30% in all oat–legume mixtures and 90% legume in legume monocultures.

Forage	In vitro organic matter digestibility (%)		
	Cut 2 Oct.	Cut 23 Oct.	Cut 6 Nov.
Pure forages			
Kalgan oats – high N	70	64	56
Cooba oats – high N	65	62	55
Kalgan oats – low N	71	61	59
Ryegrass – high N	75	60	49
– low N	73	64	65
Berseem clover	77	69	65
Clare sub clover	79	73	69
Karridale sub clover	76	72	69
Balansa clover	83	72	65
Arrowleaf clover	79	73	66
Murex medic	77	70	57
Barrel medic	78	71	55
Purple vetch	71	68	63
Common vetch	74	68	61
Field peas	71	72	69
Mixtures			
Oats/Berseem clover	69	61	58
Oats/Clare sub clover	77	68	61
Oats/Karridale sub clover	73	68	61
Oats/Balansa clover	75	65	59
Oats/Arrowleaf clover	72	65	59
Oats/Murex medic	74	66	55
Oats/Barrel medic	73	66	59
Oats/Purple vetch	71	64	54
Oats/Common vetch	72	61	56
Oats/Field peas	74	66	59
Ryegrass/Berseem clover	73	66	58
Ryegrass/Clare sub clover	76	63	56
Ryegrass/Common vetch	74	62	56

FORAGE QUALITY

The quality of most forage species progressively declines as plants mature from the vegetative stage through the reproductive stages and this is reflected in the digestibility values in Table 3.

All the pure legume forages produced relatively high digestibility values compared to oats. Oat–legume mixtures generally had higher digestibility values than pure oats.

A 1% increase in diet digestibility can result in a 3 to 5% increase in liveweight gain for young growing livestock. In production feeding where maximising liveweight gain is a priority, pure legumes may have an advantage over oat–legume mixtures.

CRUDE PROTEIN CONTENT

The crude protein values of oats and ryegrass were typically very low compared to the pure legumes or legume–oat mixtures (Table 4). Low protein levels in cereal forage is not uncommon and highlights the need to have cereal forages tested for protein to check whether a protein supplement is required. Adding nitrogen fertiliser did little to increase the N content of oats. The crude protein levels of most forages declined over time.

CONCLUSIONS

- The maximum yield was reached in most cases by the second cut corresponding to a cut around 23 October. Delaying cutting beyond this time

Table 4. Crude protein (%) of forage crops harvested at three stages of growth: early (2 October), mid season (23 October) and late (6 November). Values are adjusted for a mean legume content of 30% in all oat–legume mixtures and 90% legume in legume monocultures.

Forage	Crude protein (%)		
	Cut 2 Oct.	Cut 23 Oct.	Cut 6 Nov.
Pure forages			
Kalgan oats – high N	7.5	4.5	4.5
Cooba oats – high N	7.8	4.2	4.5
Kalgan oats – low N	5.8	3.9	4.3
Ryegrass – high N	5.8	5.5	3.4
– low N	6.3	4.3	4.1
Berseem clover	18.3	13.1	14.1
Clare sub clover	20.5	15.1	11.2
Karridale sub clover	19.8	13.3	11.8
Balansa clover	16.7	13.6	10.8
Arrowleaf clover	20.6	15.2	12.4
Murex medic	21.9	13.8	12.4
Barrel medic	20.0	15.5	12.7
Purple vetch	25.1	20.3	18.9
Common vetch	20.8	22.3	16.9
Field peas	17.3	16.8	14.8
Mixtures			
Oats/Berseem clover	9.3	6.9	5.4
Oats/Clare sub clover	9.1	6.8	6.0
Oats/Karridale sub clover	10.5	7.9	6.3
Oats/Balansa clover	7.5	4.5	5.9
Oats/Arrowleaf clover	9.8	7.3	6.9
Oats/Murex medic	10.2	6.4	6.6
Oats/Barrel medic	8.4	7.3	6.6
Oats/Purple vetch	9.5	8.1	8.1
Oats/Common vetch	11.8	7.9	6.4
Oats/Field peas	11.0	9.4	6.9
Ryegrass/Berseem clover	10.8	8.7	8.6
Ryegrass/Clare sub clover	11.1	8.4	5.4
Ryegrass/common vetch	13.0	8.3	8.9

often resulted in lower yields due to losses from respiration as result of shading or senescence.

- The quality of the conserved material generally declined with time. The only exceptions to this were vetch and field peas where quality remained relatively high at all 3 cutting times.
- The nitrogen content of oats and ryegrass was low at all harvest times and did not increase greatly with applied nitrogen. If silage or hay produced from these crops comprised a major component of the diet, supplementary protein would be required to sustain growth and lactation in cattle and sheep.
- Pure legumes were generally lower yielding than oats. Adding oats to legumes increased the total forage yield.
- Pure legumes had a higher digestibility and protein content than oats. Growing legumes in mixtures with oats increased the digestibility and protein content of the harvested forage compared to pure oat crops.
- The crop grain legumes (vetches and peas) are a good option when sowing late (late May–June) due to seasonal conditions or to allow an extended period of weed control. However, they are only suited to a single cut or grazing and are best sown with oats, as alone they are likely to lodge predisposing them to disease and loss of herbage quality.
- Some legumes such as balansa clover can be harder to wilt due to their hollow stems, significantly extending the time required between cutting and baling. Mechanical

conditioning and tedding can be used to speed up wilting rates. Consult the *Successful Silage* book (see further reading) or www.topfodder.com.au for details on silage making.

- Where the aim is to produce the highest quality forage for finishing livestock, pure legumes harvested earlier would produce the highest quality forage. As legumes have lower water soluble content values than grasses or cereals and therefore produce a poor fermentation, field wilting is essential to ensure good preservation.
- Where a higher yield of intermediate quality forage is required, an oat/legume mixture harvested in late October would be the better option as it produces a greater bulk of good quality feed.
- Based on the yield and estimated ME data, an oat crop cut at the boot stage (first harvest) for silage would support a liveweight gain in young cattle of 732 kg/ha when fed as the sole diet. A crop legume–oat crop harvested for silage when the oat component is at anthesis (second harvest) would support a liveweight gain of 1497 kg/ha.
- The sowing rate of oats used in the mixture will influence the proportion of legume and oats in the harvested forage. Higher rates of oats will increase total forage yield but at the expense of legume content and forage quality. Oat cultivars with a high propensity to tiller should be sown at lower rates if they are not to dominate the legumes. An oat sowing rate of around 15 kg/ha may give a more balanced proportion of legume and oats than the 40 kg/ha used in these studies.
- Sowing time and grazing management prior to harvesting oat–legume mixtures will affect the likelihood of the oats dominating oat–legume mixtures.
- Some legumes, such as Persian and berseem clover, are later maturing and offer the prospect of significant regrowth in late spring following the forage harvesting, providing seasonal conditions allow.
- It is possible to sow several legumes together in mixtures referred to as high density legume (HDL) mixtures. These can be grazed before being closed up for forage harvesting. Typical mixtures include a 3 way mix of berseem clover at 6–8 kg/ha, arrowleaf clover at 2–4 kg/ha and Persian clover at 3–4 kg/ha. Legumes such as balansa clover or sub clover can be substituted for the Persian clover depending on soil type and seed prices. Sub clover is more likely to regenerate in the following year than aerial seeding legumes although legumes capable of significant regrowth after cutting, such as berseem or Persian clover, may produce sufficient seed to regenerate.

FURTHER READING

Condon, K (2000) *Forage legumes–profitable break crops for dryland cropping rotations.* NSW Agriculture, Orange.

Kaiser AG, Piltz JW, Burns HM, Griffiths NW (2004) *Successful Silage.* NSW Department of Primary Industries and Dairy Australia. Orange.

Online silage making guide: www.topfodder.com.au

DISCLAIMER

The information contained in this publication is based on knowledge and understanding at the time of writing, November 2005. However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of New South Wales Department of Primary Industries or the user's independent adviser.

WARNINGS

Pasture improvement may be associated with an increase in the incidence of certain livestock health disorders. Livestock and production losses from some disorders are possible. Management may need to be modified to minimise risk. Consult your veterinarian or adviser when planning pasture improvement.

Legislation covering conservation of native vegetation may regulate some pasture improvement practices where existing pasture contains native species. Inquire through your office of the Department of Natural Resources for further information.

ISSN 1832-6668

Job number 6124