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On-station production of native Speargrass hay in Western Australia

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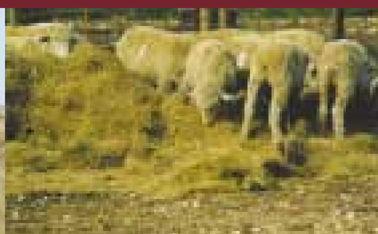
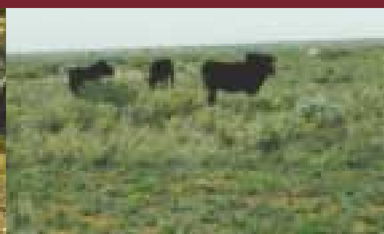
A Producer Initiated Research Project





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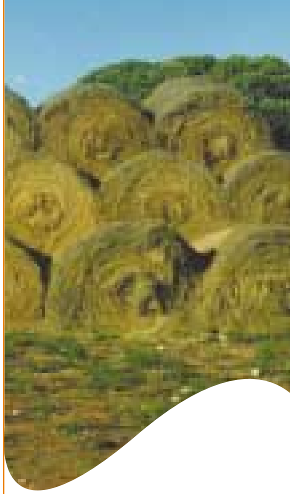

On-station Production of Native Speargrass Hay in Western Australia

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A research partnership between producers of the Nullarbor-Eyre Highway Land Conservation District Committee and the Centre for the Management of Arid Environments

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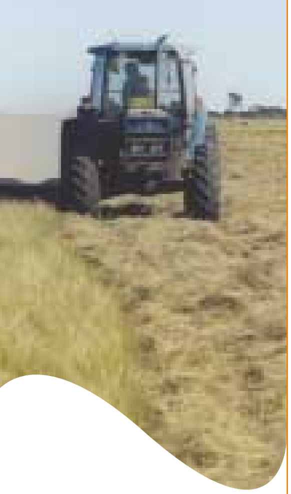
CENTRE FOR THE MANAGEMENT OF ARID ENVIRONMENTS

NULLARBOR-EYRE HIGHWAY
Land Conservation District Committee



PREFACE

It seems strange that such a simple proposition as making hay from the natural grasses of the Nullarbor Plain should have taken such a long time and required the involvement of so many people.

When Mr Rod Campbell of Kybo Station suggested making hay from the natural grasses of the Nullarbor Plain there was considerable scepticism. There seemed so many reasons why such a scheme should fail: the quality of the grasses, the semi-arid environment, the great distances, and shallow soil barely concealing the largest limestone karst on the planet. The practical objections to the scheme seemed obvious, which is why it had never been done before in a methodical manner.

Yet those few who have seen the great plain waving with green grass from horizon to horizon knew the potential.

Pastoralists of the southern rangelands have struggled against much adversity: great distances from markets, decades of low prices for livestock and the worst depression in the wool industry's long history. In such circumstances no one was in a position to risk a considerable sum to obtain the necessary equipment to make a serious attempt at preserving the feed in the good years for use in the more frequent dry years.

The existence of the Nullarbor-Eyre Highway Land Conservation District Committee (LCDC) provided the forum for the idea to be raised, debated and carried forward with the combined weight of all.

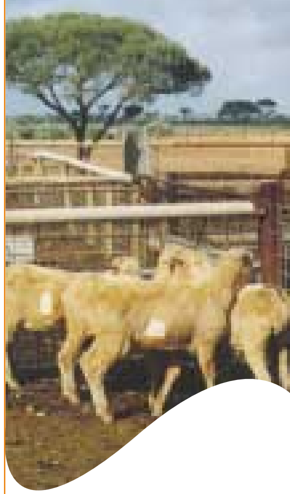
The National Heritage Trust (NHT) provided the means, with a substantial grant to the LCDC, without which the idea may have remained untested for who knows how many more decades.

That human dynamo, Dr Robert Rouda of the Western Australian Department of Agriculture, helped galvanize the project after three years of poor seasons when it seemed that we would never have enough grass. His background in animal nutrition and his enthusiasm for the potential of the rangeland gave us confidence and vital help in designing and executing the trial.

Dr Rouda secured the involvement of Dr Gaye Krebs at the Muresk Institute, Curtin University of Technology. Dr Krebs' approach is as practical as it is learned. Her conduct of the feeding trial adds further credit to the laurels of the Muresk Institute of which Curtin University is rightly proud.

Without the patience and persistence of Ms Samantha Van Wyngaarden, the paper work and details may have frustrated the process, and delayed bringing the exercise to fruition. Sam, funded by the NHT, kept the wheels turning from the Centre for the Management of Arid Environments (CMAE). That organisation is most fortunate in being led by Dr Ben Norton who has brought his first class international experience to bear in applying science to the management of rangelands. This trial helps confirm Dr Norton's hypothesis that increased animal production on the rangeland can be achieved at the same time as conservation is improved under appropriate management.

Special mention must be made of Mark and Karen Forrester of Kanandah Station, who not only volunteered the land on which the hay was made, but carried the burden of overcoming the practical and logistical problems of making hay for the first time on a commercial scale more than 300 kilometres from the nearest farmland. Moreover, Mark and Karen hosted the final field day and publication launch.



The Forresters carried out the cattle feeding trials and Peter, Barbara and Damien Brown of Arubiddy Station carried out the sheep feeding trials. This additional work was diligently executed despite an already very busy schedule. The Browns also hosted two informative and enjoyable field days associated with this trial.

Without the determined application by all the people mentioned, without the structures and decisions of people far removed from the Nullarbor Plain, the trial would never have taken place. The fact that it has been such an outstanding success is proof that profound change is still possible by asking simple questions.

There can be no doubt now that haymaking is not only possible in the rangeland but that it can produce excellent maintenance hay. Great seasonal variability can be ameliorated by making hay when conditions permit. Now the potential exists for livestock to be marketed at the optimum time and condition.

It will take time for the lessons learned to be translated into part of normal pastoral management on the rangeland, but future generations of pastoralists will thank all those who made this trial possible.

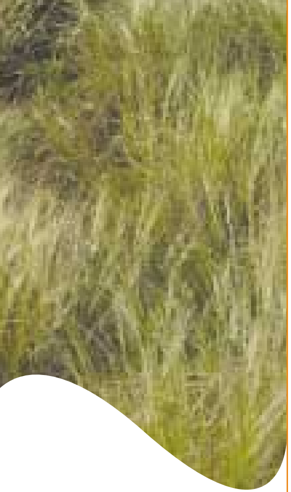
James Ferguson
Chairman
Nullarbor-Eyre Highway
Land Conservation District Committee

ACKNOWLEDGMENTS

- Funding for this research was provided to members of the Nullarbor-Eyre Highway Land Conservation District Committee by the Natural Heritage Trust's National Landcare Program (Project Number 963193)
- The authors wish to thank Mark and Karen Forrester, owner-managers of Kanandah Station, and Peter, Barbara and Damien Brown, owner-managers of Arubiddy Station, for hosting, overseeing and actively participating in the conduct of this work
- The authors also wish to thank Members of the Nullarbor-Eyre Highway Land Conservation District Committee (NEH LCDC) for serving as the steering committee for this project
- Special mention is owed to Mr Warren Potts from Glen Forrest Stock Feeders for manufacturing the customised supplements used in the feeding trials
- Thanks to Peter Timmers from the AussieGRASS project within the Queensland Department of Natural Resources and Mines for modelling the estimates of total standing dry matter
- Finally, the authors extend their gratitude to Mr Adrian Williams, Ms Sandra Van Vreeswyk, Mr Ken Leighton, Mr Andrew Quinn, Mr Damian Shepherd, Mr Mitchell Jones, Mr Greg Brennan, Dr Ian Watson, Associate Professor Brien E. Norton and Professor Murray McGregor for their valued expert technical contributions

Barbara, Peter and Damien Brown

Karen, Mark, Edmund, William, Amy and Nicholas Forrester



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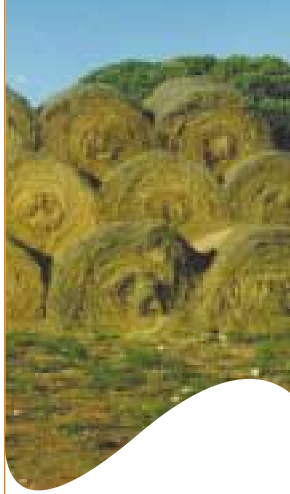


EXECUTIVE SUMMARY

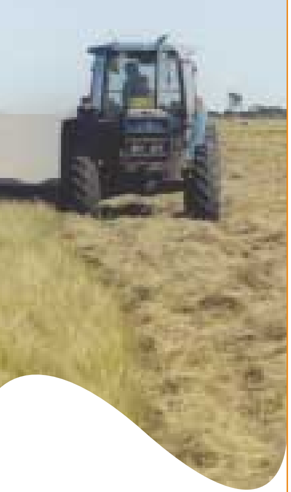
This report documents the practical and economic feasibility of on-station harvesting and production of speargrass hay and haylage and its subsequent feeding to cattle and sheep in the extensive regions of south-eastern Western Australia. Four hundred and ten bales weighing an average 275 kg were produced from a total harvested area of 40.6 ha in the vicinity of Duck Dam on Kanandah Station. In the lead up to harvesting, seasonal conditions were among the best on record. Half of the bales produced were further processed into haylage.

Two feeding trials, involving wethers at Arubiddy and steers at Kanandah, were undertaken to evaluate animal performance when freely fed either speargrass hay or haylage, with or without access to supplements.

The findings indicate speargrass swards on the Nullarbor Plain can be successfully harvested and made into reasonable quality hay, but the harvesting window of opportunity is short and choosing the best harvesting time is essential. Yields of speargrass hay compared favourably with those of other native grass pastures reported by other workers elsewhere. Wrapping the hay to produce haylage did not improve fodder quality.

Speargrass hay supplied sufficient levels of nutrients to maintain livestock, and on-station speargrass hay production on the Nullarbor was a cheaper option than importing hay. Based on our findings, if the highest estimated cost of on-station production is used ($153/t), feeding costs are $1.15/hd/d for cattle and $0.15/hd/d for sheep. Alternatively, if the lowest estimated cost of production is used ($64/t), feeding costs are $0.48/hd/d for cattle and $0.06/hd/d for sheep. Additional supplements can significantly improve livestock performance. The quality of speargrass hay produced has not deteriorated over the duration of this project.

On-station production of speargrass hay presents a lower environmental risk in terms of introduced weed infestation than importing hay from other areas, but the option would only be commercially viable for those producers with diversified enterprises and/or off-station income.



BETTER USE OF EXTENSIVE SPEARGRASS STANDS

Much of the Nullarbor region of Western Australia has been profoundly altered, now consisting of grasslands where it previously supported low saltbush and bluebush shrublands. This change was brought about by increased frequency of fires and the impact of large numbers of rabbits. The change may date back to over a century ago. It is believed that steam trains in the early 1900s caused more frequent fires which encouraged grasses to grow rather than the fire-sensitive saltbush and bluebush shrubs. Rabbit grazing on the already vulnerable shrubs further contributed to their demise. It is unlikely that the shrublands will reassert themselves on extensive areas now dominated by grasses as there are no remaining shrub seed sources and the grasslands bring about increased fire frequency.

The perennial grasslands of the Nullarbor Plain consist mainly of speargrasses *(Austrostipa spp., primarily Austrostipa scabra)* and wallaby grass *(Austrodanthonia caespitosa)*. The total area occupied by speargrass across the Nullarbor Plain has been roughly estimated at 17,400 km^2, or 30 per cent of the pastoral land *(S. Van Vreeswyk, personal communication*[1]*).*

These grasslands respond to winter rainfall and growth is exceptional in years of above-average winter rainfall coinciding with annual rainfall in excess of approximately 200 mm. The grasses are readily grazed during their active growth, but their nutritive value and consumption rapidly decline at the onset of maturity. Speargrass, in particular, produces an elongated, sharp seed-head that can penetrate and debilitate animals. Conserving this species before seed set can effectively extend its usefulness as a fodder for livestock.

During the 1970s in a season when speargrass was abundant across the eastern Nullarbor Plain, Mr Rod Campbell of Kybo Station decided to harvest some speargrass and make it into hay. Without the use of elaborate equipment, he was able to successfully produce hay that he subsequently fed to his sheep. Since that pioneering event, many of the region's pastoralists have repeatedly contemplated harvesting the extensive stands of speargrass in those 'bumper' years to use when animals are held in confinement for extended periods. This led members of the Nullarbor-Eyre Highway (NEH) Land Conservation District Committee (LCDC) to apply for the 1996-1997 round of Natural Heritage Trust (NHT) funding to test the cost effectiveness of on-station harvesting of native speargrass. Funding was granted in 1997 but a series of less-than-optimal seasons delayed the start of the trial until late 2001.

This report documents the practical and economic feasibility of on-station harvesting of speargrass and production of hay and haylage, and its subsequent feeding to cattle and sheep in the extensive regions of south-eastern Western Australia. It is essential that rangeland managers differentiate between **supplemental** and **substitution** feeding. Using fodder to supplement animals actively grazing rangeland paddocks no longer capable of providing nutrients to meet maintenance requirements is a disaster in the making, as it inevitably causes rangeland degradation. When pastures reach this state—a common scenario in recurring droughts—animals must be removed, and if confined for a significant length of time, fed a **substitute fodder**. Supplementing the substituted fodder with nutrients to improve animal performance is an option. Recommendations for producers considering substitute feeding with native grass fodder are provided in this report.

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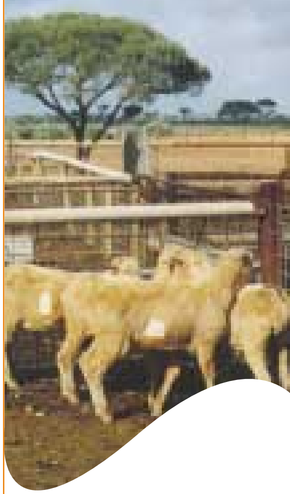
[1]This rough estimate was calculated using 1999 satellite imagery and has yet to be verified. The Rangeland Survey Team (a collaboration between the Department of Agriculture and the Department for Land Information) will begin its resource inventory of the Nullarbor in March 2004 and ground truthing of this estimate is expected by December 2005.



Project objectives

1. To assess the practical and economic feasibility of harvesting, processing and storing speargrass hay and haylage under rangeland conditions.
2. To evaluate the quality of speargrass hay and haylage over time and their effects on the performance of steers and wethers.
3. To determine the need for supplementation to improve the feed value of conserved speargrass fodder.

MAKING HAY WHILE THE SUN SHINES ON THE NULLARBOR

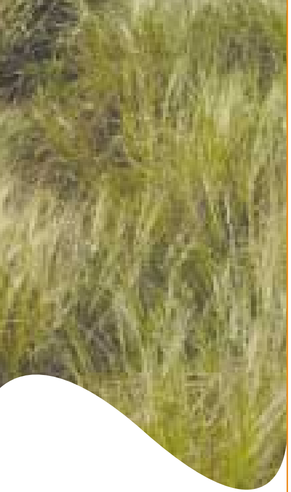
Kanandah Station (30.0° to 32.0° latitude, 124.0° to 124.7° longitude) contains large areas of speargrass pastures in its southern portions around Duck Dam. In early August 2001, Tyrrel Gardiner, a harvesting contractor from Dardanup, and Mark Forrester, owner-manager of Kanandah, conducted a preliminary site visit to determine if harvesting was practical. Four potential sites with a total area of approximately 40 ha were identified and plant samples taken to determine feed value. These samples were found to contain greater than eight per cent crude protein (CP), indicating suitability for livestock forage.

Subsequently, Tyrel Gardiner returned to Kanandah in late August 2001 with the following harvesting equipment mobilised using a Volvo N12 prime mover in road train configuration:

- one New Holland 7840 SLE 100-horsepower tractor equipped with a quick-detach front end loader;
- one Case 5130 100-horsepower tractor;
- one New Holland 654 round baler;
- one Tonutti V14 finger-wheel hay rake;
- one New Holland 462, 2.4 m disc mower;
- one Deutz 2.4 m disc mower;
- one rotary hay-silage wrapper;
- one welder-generator;
- sundry supplies of twine, plastic wrap, fuel, oils and two pallecon containers of molasses.

Mark Forrester inspecting a site for hay making

A stand of speargrass suitable for harvesting



In the lead up to harvesting around Duck Dam, seasonal conditions were among the best on record. Good rain in the summer of 2000 was followed by a light winter season but this was topped up by over 50 millimetres in November 2000. Soil moisture remained high throughout December and January with another 150 mm or so received in February 2001.

These conditions were clearly ideal for the grass growth needed to cut hay. However, for this to be an ongoing management option some assessment is needed of the proportion of years in which similar conditions might also make hay cutting viable. This is not as straight forward as it may at first appear. The best approach may be to consult those with long Nullarbor experience and whose memories (or written diaries) put the 2000-2001 period into historical perspective. Even if good long-term rainfall records were available for the Duck Dam area, the consideration of rainfall alone does not necessarily provide a good indication of total standing dry matter (TSDM). Good summer rainfall will produce more growth than the same amount of winter rain, and long periods in which soil moisture remains adequate will produce more growth than isolated large falls.

Washing down all vehicles and equipment to stop the spread of weeds

Another approach is to model pasture growth and TSDM. The following provides such an assessment. The AussieGRASS project within the Queensland Department of Natural Resources and Mines has provided modelled estimates of TSDM for the Duck Dam area using the Cedar GRASP model. One period where the model may differ from reality is towards the end of each good season. The model suggests high values of TSDM often persist into the first few months of the year following a good winter season but this may over-estimate the length of time that large quantities of dry matter persist.

Rainfall and climate records for the modelling were estimated using the SILO dataset. These estimates are interpolated from data collected by surrounding rainfall and meteorological recording stations and represent the best available estimates for the Duck Dam area. Estimated data may not exactly replicate observed data for particular rainfall events, but over a long period the estimates will accurately represent the climatic environment for Duck Dam. For the purpose of estimating the timing and frequency of periods of high grass growth the model should be adequate. However, please note that the model has not been validated for the Nullarbor so take care when making financial decisions on these modelled estimates. Furthermore, rainfall recording stations were very sparse in this region during the first few decades of the twentieth century and the reliability of modelled data from this early period will be much lower than for the last few decades of the century.

Despite these cautions, it appears that similar periods of high grass growth have occurred about 5-10 times in the last 100 years (Table 1 and Figure 1). This judgement was based on setting thresholds 0.70, 0.80 and 0.90 of the TSDM in the 'best' season ever. While increasing the threshold from 0.70 to 0.80 does not markedly reduce the number of events, the period when high TSDM is available is reduced (Table 1). When the threshold is set to 0.90 the number of potential hay cutting events is reduced to only five since 1900. An important point to consider is that the last 11 years have seen by far the highest number of potential hay cutting events. Four of the eleven events (when the threshold is set at 0.70) have occurred since June 1992. It may be foolish to consider that such a high frequency of potential hay cutting events is typical of the Nullarbor. For example, there were only two such events from 1900 to 1950 and there were no events between February 1918 and August 1955, a period of almost 38 years. Based on this extrapolated historical account, the next period of potential hay cutting may not be until 2039.

The events of 1917–18 and 1968–69 followed quickly after preceding events. That is, germination of speargrass may have been enhanced by the earlier events, providing a high density of grass butts which then provided high grass growth in subsequent events. The period 2000–01 was similar. When considering the opportunity for hay cutting, the unusual nature of these three events should kept in mind. The conclusion might be drawn that the potential for cutting hay occurs at a frequency of about once every 30 years.

Table 1: ***Periods when the index of total standing dry matter has exceeded thresholds of 0.70, 0.80 and 0.90 of the 'best' season***

Total standing dry matter index (as percentage of 'best season' on record)					
at least 70%		at least 80%		at least 90%	
No	**Period**	**No**	**Period**	**No**	**Period**
1	Jul 1915 – Dec 1915	**1**	Jul 1915 – Sep 1915		
2	Jun 1917 – Feb 1918	**2**	Jun 1917 – Nov 1917	**1**	Jun 1917 – Aug 1917
3	Aug 1955 – Jan 1956	**3**	Sep 1955 – Oct 1955		
4	May 1963 – Mar 1964	**4**	May 1963 – Dec 1963	**2**	Jun 1963 – Oct 1963
5	Jul 1967 – Oct 1967				
6	Jul 1968 – Mar 1969	**5**	Jul 1968 – Dec 1968	**3**	Aug 1968 – Sep 1968
7	Jun 1974 – Nov 1974	**6**	Jul 1974		
8	Jun 1992 – Nov 1993	**7**	Jul 1992 – Aug 1993	**4**	Oct 1992 – Dec 1992
9	May 1995 – Nov 1995	**8**	Jul 1995 – Aug 1995		
10	Apr 1996 – Oct 1996	**9**	Apr 1996 – Jul 1996		
11	Mar 2000 – Nov 2001	**10**	Mar 2000 – Sept 2000	**5**	Apr 2000 – Jun 2000
		11	Mar 2001 – Aug 2001		

A description of each of the four harvested sites is presented in Table 2. There was some variability in both the species composition and maturity of the material harvested. In some areas the speargrass had already set seed and begun to dry off. The quality of the hay and haylage made from these more mature stands was likely to be nutritionally inferior to that made from less mature speargrass. Increased maturity is associated with decreased dry matter digestibility and generally lower protein levels. Also, the presence of the hard, elongated seed-heads in mature speargrass could create problems when feeding the hay exclusively to sheep for extensive periods as seed-heads can lodge in the wool and potentially penetrate the skin, causing infection.

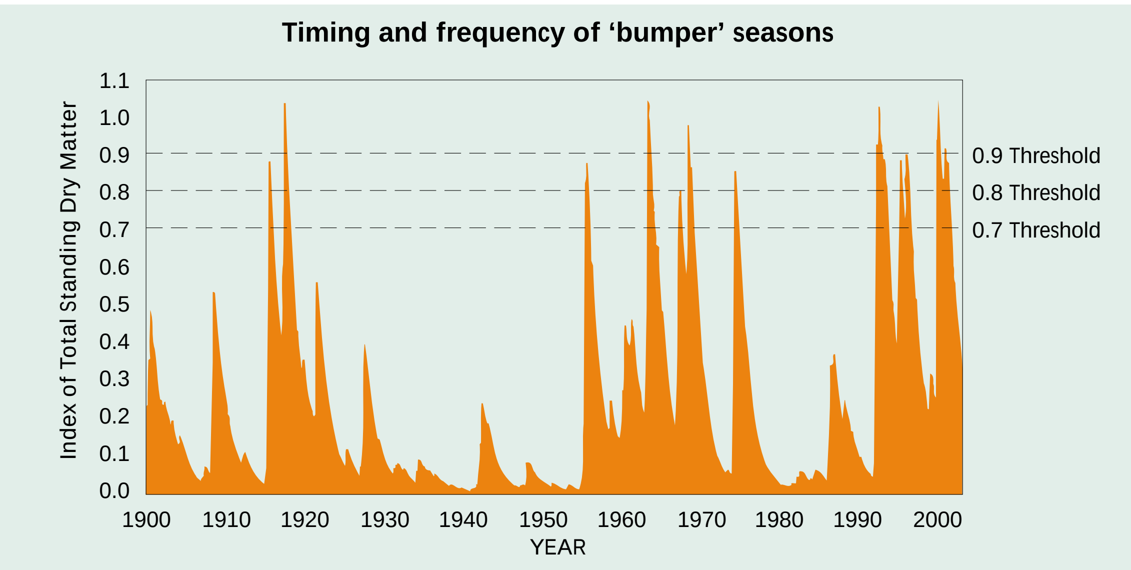


Figure 1: ***Index of total standing dry matter from January 1900 to July 2003 as modelled by Cedar GRASP***

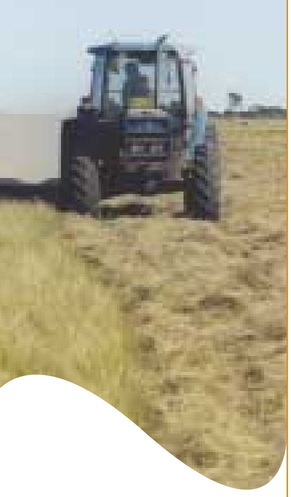


Table 2. Size and general description of the four sites harvested on Kanandah Station between 28 August and 10 September 2001

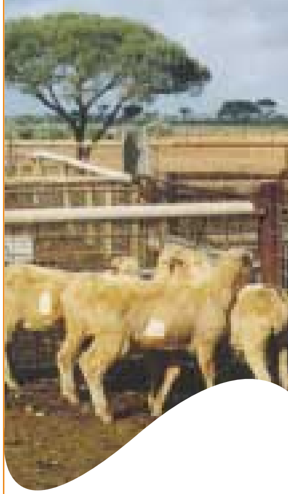
Site number GPS Coordinates (m)*	Area (ha)	General description
1 E:635003 S: 6485348	16.3	Almost pure stand of speargrass with some small, clearly defined, localised scrub patches surrounding rabbit warrens.
2 E: 632571 S: 6487071	1.3	Fresh stand of speargrass with significant amounts of interspersed saltbush, bluebush and other woody shrubs.
3 E: 633590 S: 6478659	16.5	Green fresh speargrass with some bluebush.
4 E: 634796 S: 6476758	6.5	Sparse patches of speargrass with scattered trees interspersed.

*Datum: WGS84 Projection: Universal Transverse Mercator (UTM)

The harvesting operation began on Site 1 with two mowers operating simultaneously and took nine hours to finish. The exercise was interrupted several times to adjust the equipment to paddock conditions. A small quantity of rocks from 5-8 cm in diameter was noted but these were not a problem as the operator was able to adjust mower height. Larger rocks were removed from the mower's path. The mowers were manoeuvred around very large rocks, rocky outcrops and localised scrub patches to reduce habitat disturbance and equipment damage. The harvested forage was left on the ground overnight.

Mowing the speargrass

Removal of larger rocks



The cut grass was not displaced by overnight winds. Early the next morning the forage was raked into 1 m wide windrows then processed into round bales. Small rocks did cause minor problems to the equipment during the raking process but did not severely compromise the operation.

Harvested sward raked into windrows

The first bale produced

Four hundred and ten bales were produced from a total harvested area of 40.6 ha determined using Global Positioning Systems (GPS) mapping technology. Several trips were needed to transfer these bales to the Kanandah homestead where a proportion was wrapped and stored.

The average bale weight was 275 kg making the yield harvested 2.78 t/ha. Yields of native pasture hays commonly vary from 0.8 t/ha (low) to 1.2 t/ha (average) to 2 t/ha (excellent), depending largely on the amount and distribution of rainfall during the growing season *(McLennan 2002)*. The economic feasibility of making native pasture hay would depend on yield and the area available to harvest.

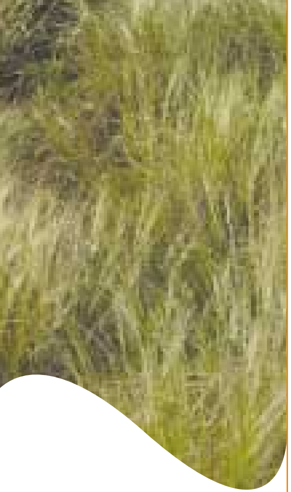
First load of hay heading back to Kanandah

Of the 410 bales made, 216 were wrapped at a rate of approximately one bale per minute. This included the time needed to retrieve a bale off the back of the trailer parked some 200 m from the wrapper. A 20-bale sausage took between 30 and 40 minutes to produce as sealing the ends took about 10 minutes each.

A total of 46 bales from Site 1 were transferred to Arubiddy from Kanandah soon after harvest. On arrival at Arubiddy, half of these were wrapped as haylage, as it was unlikely bales wrapped at Kanandah would have survived the transfer intact. As at Kanandah, the bales of hay and haylage were stored without shelter during the period leading up to the feeding trials.

Analyses of the ensiled material four weeks post-wrapping revealed the moisture content was not vastly different to that of the hay (Table 6 on page 27), making the material more of a 'haylage' than 'silage'.

Wrapping the haylage bales



The total operation took three weeks to complete. We believe that any future harvesting would take considerably less time, as many of the problems experienced in this trial would be addressed before arranging for a contractor.

Some key observations made by the contractor on completion of this trial operation are summarised below.

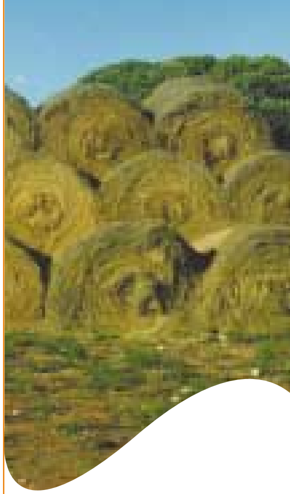
1. Superficial (or vehicle window) inspections during site selection will more than likely result in an inaccurate assessment. The areas being considered should be systematically traversed to determine their suitability.

Sealing the haylage bales

LCDC members inspecting the final haylage product

Speargrass haylage sausage consisting of 20 bales of hay

2. Moisture content and maturity of vegetation processed during the current trial changed significantly over a two-week period with the onset of warmer weather.
3. Harvesting and processing during the cooler periods of the day produced better yields.
4. Large amounts of old (previous year's) growth within an area can adversely influence both the harvesting operation and the quality of the harvested material. Swards do not cut cleanly and a large amount of forage dust is produced during mowing. This dust can cause premature damage to the bearings under the discs on the cutting bar. As well, large quantities of old growth would decrease the nutritive value of any harvested material.
5. The less moisture contained in the harvested forage, the shorter the period between cutting and rolling must be. In this trial, the maximum period between cutting and rolling was 48 h.6. The large rake used in this trial proved effective and efficient. The only problems encountered were the result of small rocks being picked up and sent through to the rolling chamber, causing some scratching of the rubber belts and causing some of the lacing pins on the belts to tear and give way.
7. More workers would have shortened the operation as hay processing and bale transfer could have occurred simultaneously.
8. Several layers of plastic wrap were needed during the ensiling process to overcome punctures caused by woody material (saltbush and bluebush) contained in the bales.



ECONOMICS OF SPEARGRASS FODDER CONSERVATION ON THE NULLARBOR

There are three primary options for speargrass fodder use on Nullarbor stations:

- in an ongoing feedlot situation;
- as a substitute feed when animals are held for husbandry purposes or in preparation for transfer; and/or
- as insurance against anticipated drought.

The economic justification for speargrass fodder use on the Nullarbor relates chiefly to the cost of production. Production for use on-station would likely only be viable during those limited seasons when a plentiful supply of grass results in production coming in at the lower quartile of costs.

During such periods it may be useful for a number of producers to coordinate production to minimise the costs of speargrass fodder.

The cost of speargrass fodder production

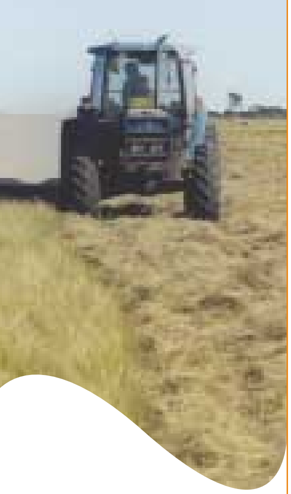
The 112.75 t of hay harvested and processed at Kanandah cost $200/t to produce. This includes GST and all transport costs associated with transfer of the hay from the four harvest sites to the Kanandah homestead. In addition, a proportion of hay bales was transferred to the Arubiddy Station homestead where half of them were wrapped. This transfer expense has been included in the final costing.

Pilot studies are normally far more expensive than subsequent commercial activities, as it is during these initial trials that problems are identified and improvised solutions implemented without the benefit of hindsight. In commercial operations, past experience would play a major role in refining the production process, increasing efficiency and reducing the cost of production.

A number of assumptions have been applied to assess the economic feasibility of native fodder production on Nullarbor stations. These include:

1. contract harvesters are available;
2. distance to harvest sites. For this economic evaluation it is assumed that contractor harvesters would need to travel around 700 km, the approximate distance to Kanandah from Esperance or Merredin;
3. haulage and transport charges of $4.51 per km GST inclusive (*source: Farm Budget Guide 2003*);
4. contract harvester has own haulage equipment, therefore transport costs charged one-way only (return trip is not charged);
5. contract rates for cutting and baling round bales of hay are $15 + GST per bale (*source: Farm Budget Guide 2003*);
6. each bale weighs 275 kg, therefore costing $60/t to cut and bale (GST inclusive)
7. allowance for repairs to machinery set at $1000; and
8. wash-down costs associated with biosecurity (particularly weed control) set at $500.

The economic analyses based on the above assumptions with variations in the area harvested and the potential yield are presented in Table 3. Additional cost associated with on-station haulage of the hay has NOT been included in this budget. Options for transport would include



the contractor's haulage equipment or on-station vehicles. It may be a cheaper option to use on-station vehicles but more time-efficient to use the contractor's haulage vehicle. The decision needs to be made as to whether the hay will be used in place or transferred to a common storage site. Since the quality of the hay produced in the current trial did not deteriorate with time there is no urgency in determining storage options.

On-station production presents a much cheaper option for providing fodder to livestock on the Nullarbor than importing it from surrounding agricultural areas. Oaten hay has been used as a reference in this analysis because it is the most commonly available fodder in Western Australia and its nutritive value in terms of crude protein, metabolisable energy and dry matter digestibility are comparable to speargrass hay (Table 6).

Table 3. ***Cost of hay production on the Nullarbor according to yield***

Hectares	Yield (t/ha)			
harvested	1.0	1.5	2.0	2.5
50	50 t @ $153/t	75 t @ $121/t	100 t @ $107/t	125 t @ $99/t
100	100 t @ $107/t	150 t @ $91/t	200 t @ $85/t	250 t @ $81/t
200	200 t @ $85/t	300 t @ $76/t	400 t @ $71/t	500 t @ $69/t
400	400 t @ $71/t	600 t @ $68/t	800 t @ $65/t	1000 t @ $64/t

The current minimum price of oaten hay is approximately $100/t. Added to this is the cost of transportation, which is $4.51/km (GST inclusive). Hay is a bulky feed and only about 22 t can be transported on a carrier at once. On the basis of distance associated with the Kanandah harvesting (700 km), the haulage costs would be $143.50/t, giving a total landed price of $243.50/t. This estimated importation cost is $90.50/t more expensive than the dearest on-station processing estimate ($153/t; Table 3).

Importing hay is not only more expensive, but it also runs the risk of introducing weeds to the district. The environmental ramifications and subsequent cost to combat introduced weeds would be highly significant and cannot be ignored.

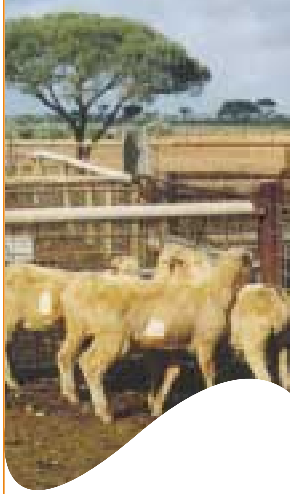
Considerations in regard to adding costs to rangeland production systems

Rangeland feedlots

With the possible exception of high-value differentiated beef feedlot activity, using speargrass fodder combined on a regular basis with imported grain would be unlikely to achieve an economic performance sufficient to compete with beef produced in feedlot situations closer to grain and consumer markets.

While there is a common perception that adding costs and improving quality in the beef or sheep sector will be returned through improved quality and subsequently higher prices, this has not always been evident in the pastoral industry of Western Australia. For many pastoral producers, concentrating on the reduction of fixed and variable costs has resulted in maximising returns over the long term, especially given fluctuating weather conditions and real price trends. Many producers intending to add value through the addition of costs have found that during periods of extreme low prices or drought they were left with insufficient capital to remain viable.

While a full analysis of these circumstances is beyond the scope of this paper, one of the key drivers is the habit of real prices for agricultural products tending to follow a cycle of brief price spikes of three to four years, followed by long periods where prices fluctuate just above and just below the economic cost of production. In an industry so strongly influenced by the forces of weather and commodity prices, economic success has often been the result of driving down cost



to an extent that producers can survive through long periods of marginal returns until a price spike period is again encountered.

The current trial demonstrated that cattle and sheep fed speargrass hay maintained their weight (Table 8) but additional supplements were required to achieve liveweight gain. Because of this, any decision to conserve speargrass on the Nullarbor must take into account that the added cost of fodder production to the enterprise budget will need to be offset by a pure price fluctuation in the future to be economically justifiable. It cannot be assumed that feeding speargrass fodder alone will result in a measurable liveweight gain and therefore a measurable economic return achieved over a defined period.

This report focuses on the benefits of speargrass fodder conservation, not on the benefits of creating a feedlot situation on the Nullarbor, which is unlikely to be justified given that proximity to grain and animal genetics are considered primary drivers of feedlot economics.

The exception to this approach in the case of rangeland production is where a producer or group of producers intends to develop a market for a highly differentiated product, such as bio-dynamic beef for example, and the objective of the feedlot is to even out seasonal feed quality fluctuations. In such cases the additional returns from the product may hold the potential to overcome the added expense of carting feed in addition to the speargrass fodder produced.

Speargrass fodder use in holding situations

The economic justification of speargrass harvesting is heavily influenced by the cost of production. This trial indicated that periods when speargrass could be harvested at low cost levels can be brief and infrequent.

The feeding out of speargrass fodder during animal holding periods would be likely to reduce the total available quantity of fodder available for alternative use such as in a drought situation. However, it will potentially result in reduced opportunity cost for producers as the fodder is used on a more regular basis following harvest.

The decision to feed animals in a holding situation is highly dependent on:

- the value of the animals and their productive capacity;
- the potential for the condition of the animals to deteriorate during the holding period;
- the length of time that it would likely take for the animals to regain weight following release;
- station management and labour capacity and capability;
- the effect of feed deprivation on production;
- animal welfare issues; and
- existing seasonal influences.

Because it is generally not economically justifiable to hold rangeland animals on feed for considerable lengths of time, every effort should be made by the station manager to keep holding periods to a minimum. Because periods such as shearing are brief, management should consider adding labour to reduce the holding period of animals. If this is not practical, limited feeding of speargrass fodder during these periods would be justified where the animals are of reasonable value and the enterprise could benefit from some economic risk-reduction effect such as the avoidance of fibre weakening or severe loss in condition caused by starvation. The latter not only has economic implications, it is also a serious animal welfare issue that is no longer acceptable (legally and ethically) in today's society (*Animal Welfare Act 2002*).

Speargrass fodder as insurance

Speargrass fodder conservation is unlikely to give great economic returns in a Nullarbor feedlot situation, and would in many cases add risks in terms of reduced capital availability for an enterprise. On the other hand, the benefits of fodder conservation as a longer term insurance against drought and de-stocking risk needs to be considered.

It is important to be aware that speargrass fodder conservation does not act as an insurance policy that can offset all drought risk. The reason why this is an important consideration will be discussed below.

A producer deciding whether to conserve speargrass fodder as a drought insurance measure needs to make a number of judgements in regard to:

- current level of financial diversity;
- weather effects;
- price/time effects;
- opportunity cost;
- product availability; and
- risk.

Speargrass, weather, probability and time

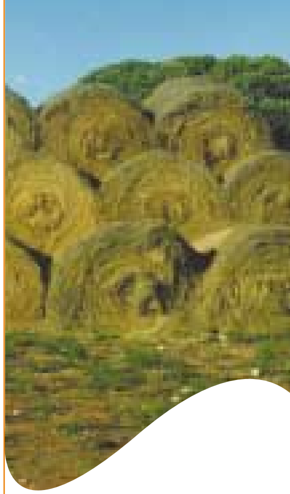
The apparent threat of drought to individual producers and the need to use funds to reduce its risks will vary. A producer with significantly diversified income sources off-station will see drought as less of a risk than a producer with his or her whole economic future dependent on a single station and its economic performance. The economic justification to use speargrass fodder as an insurance option will therefore vary from producer to producer.

The importance of diversity in income sources is clear when basic probability in regard to the weather is considered. To take a simple example, the probability of having a good or a bad season in any one year is 50/50. While this is noted, a producer's real concern should be towards the distribution of good and bad seasons. It is common to fall prey to the gambler's fallacy that assumes after a run of consecutive poor seasons the probability that there will be a good season is increased. This is not the case, because in any one year the probability between good and bad seasons is still only 50/50. The distribution length, or consecutive run of good or bad seasons, can be thought of as infinite. That is, the number of consecutive like seasons will simply increase as more and more seasons are added. The moral of the story is that the longer a producer participates in farming the more likely it is that he or she will experience a prolonged consecutive series of good or bad seasons.

This highlights:

- the importance of income diversity for producers;
- the importance of reducing the risk of ruin to an acceptable level; and
- the inability to cover for all seasonal risk scenarios.

Therefore, the prime consideration in the decision to use speargrass is that in doing so not all of the drought risk is likely to be negated without harvesting and storing speargrass at a level that would be unjustified by the cost of such an activity.



For example, an individual producer with limited off-station resources spends $200,000 harvesting and storing speargrass hay for drought insurance, enough to allow 2000 cattle to be held for an additional 200 days. The producer would benefit if:

- during a subsequent drought and feed-out period the money received for the cattle exceeds that spent on the fodder and the producer sells into this market; or
- the necessity to destock, with its subsequent costs and loss of income is avoided and future prices recover.

On the other hand, if during the feed-out period no such price benefit results, or the drought is longer than anticipated, this producer could find that the investment of $200,000 has only resulted in briefly delaying forced destocking. An investment in speargrass fodder that is not enough to cover the episode of drought could therefore result in a 100 per cent loss of the funds expended.

It could be argued that the producer may have achieved better returns by using the $200,000 to diversify income off-station (opportunity cost) and acting more promptly on the enterprise effects of a drought.

In short, a producer who uses speargrass fodder and gets the timing correct will look very wise after the fact if sufficient product is harvested and stored to avoid destocking or price-reduction risk. But the opposite will be true if the drought continues past the anticipated period, as there is potential for not only stock losses but also a complete loss of the costs sunk into speargrass fodder production.

This study estimates that the highest cost of on-station speargrass fodder production is $153/t, maintenance ration feeding costs are estimated at $1.15/hd/d for cattle and $0.15/hd/d for sheep. The lowest estimated cost of production is estimated at $64/t, feeding costs are $0.48/hd/d for cattle and $0.06/hd/d for sheep.

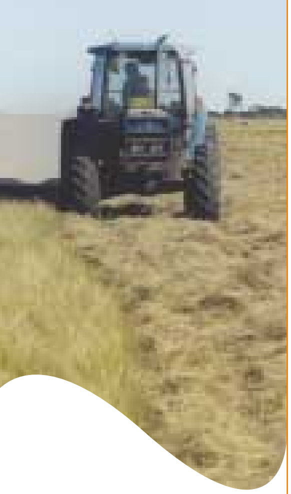
Based on these figures, at highest production costs, 2000 cattle could be held at $1.15/hd/d for 100 days at a cost of $230,000. At the lowest estimated production costs, 2000 cattle could be held at $0.48/hd/d for 100 days at a cost of $96,000.

A producer anticipates that an investment in speargrass fodder will result in either a future price return exceeding the sunk cost, or the avoidance of a forced de-stocking because of drought. If we assume the producer's timing as to drought length is correct and therefore destocking is avoided, then the producer needs to look at the return on investment.

Leaving aside destocking risk and taking the *least*-cost speargrass fodder production option for cattle, the best time for a producer facing a drought is for the drought to occur soon after harvest of the speargrass. Given the low-cost production scenario, during the feed-out period a producer will need to achieve a return that covers $0.48/hd/d. A sale at prices higher than $0.48/hd/d costs results in a return above funds expended. The avoidance of a loss due to a reduction in cattle prices results in the speargrass fodder acting as a put option[2] to reduce enterprise risk. If the opportunity cost of funds expended on speargrass fodder insurance is placed at nine per cent per annum, then to achieve a return above other investment options the producer's returns above speargrass fodder cost will also need to rise by at least nine per cent per annum.

The assumption that cattle prices will rise over time to offset this opportunity cost cannot be made, due to the long-term nature of real commodity prices. Figure 2 shows the opportunity cost

[2] A put option is a real asset or financial instrument that acts to maintain or increase its value when the value of another real asset or financial instrument falls. It acts as a hedge against a fall in the value of another asset. Usually, the put option declines in value through time.



of holding speargrass hay based on an alternative asset compounding at nine per cent per annum. Holding costs and product deterioration are considered to be zero; that is, speargrass fodder quality does not deteriorate with time and the fodder has not been purchased with debt funding. It is assumed that speargrass fodder does not increase in value over time.

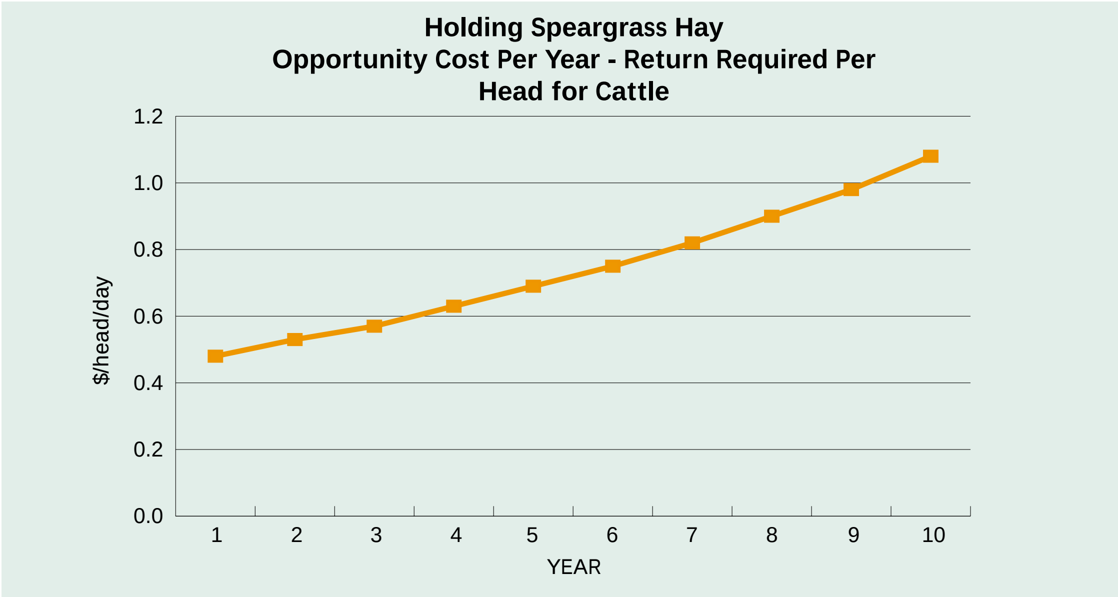


Figure 2. ***Opportunity cost of holding speargrass hay based on an alternative asset compounding at nine per cent per annum***

Clearly, to cover opportunity cost, a drought occurring in approximately year seven following harvest would need to result in a return approaching double that of a drought occurring in year one.

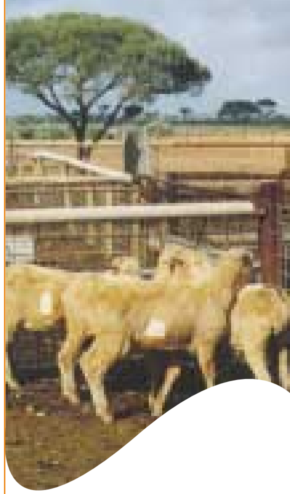
The opportunity cost in this case could be taken as the loss of opportunity to invest in property. The median price of Perth housing is $200,000, and nine per cent is considered to be the long-term compound annual return on Perth property. To continue our example of $200,000 worth of speargrass fodder and nine per cent opportunity cost, the alternative use of these funds invested into the Perth property market would have grown to $490,272 by year 10.

Therefore:

- the timing of drought following speargrass fodder harvesting is critical in determining whether a producer maximises returns over time; and
- correctly estimating the extent of a drought period is vital to avoiding a potential 100 per cent loss of funds invested in speargrass fodder production.

Speargrass fodder as an asset

Once harvested, speargrass fodder could be held on the books as an enterprise's asset. There is the potential for the fodder to be sold to third parties and income earned or costs recouped. From an economic viewpoint, though, the speargrass hay value will vary widely. It is probably more correct to assume that the product has a value at an insurance level, and that full cost plus value would only be achieved in the case where the station holding the product is not experiencing a drought, while those within an economically viable distance are experiencing a drought and therefore creating a demand that could be sold into. The storage of hay as a potentially saleable asset would need to be judged against the above criteria and the opportunity cost of alternative investments.



To self harvest or not to self harvest - capital use

This study indicated that the best period for speargrass hay harvesting could be as short as three weeks. Additionally, prolonged periods between viable harvest years can be expected (Table 1).

This has an impact on the economic feasibility of purchasing your own harvesting equipment. While the variable costs of self harvested hay are lower, the higher fixed costs make it more expensive over the long term than using contractors because of the under-use of capital. It has been calculated that the cost of self harvested hay is $196.00/t. In short, it is likely that capital funds could be put to better use and that despite higher variable costs associated with contract harvesting, over time it is likely to be the most cost-effective option.

Is speargrass fodder viable?

As mentioned earlier, the benefits of speargrass fodder production will vary from producer to producer but the assumption of viability may prove contrary to what one would first think (counter-intuitive).

Poorly diversified producers

It could be assumed that station owners relying on a single station as their primary income source should seek to reduce enterprise risk by investing in drought insurance speargrass fodder. However, the chance of a long delay from harvest to drought fodder use (and large opportunity cost losses), or misjudging the length of the drought (and losing 100 per cent of the costs of harvesting the hay because it runs out before the end of the drought) make the proposition a significantly risky one.

If the primary goals are to reduce risk or avoid financial ruin, then for poorly diversified producers the scenario most likely to achieve these goals is to use excess funds accumulated during the good times to diversify assets and income sources off-station. The reason for this conclusion is that the producer pressured for cash in a bad drought or low stock-price situation may well find matters made worse by having put funds into speargrass hay at the very time when cash flow becomes vital to maintain viability through a prolonged down period. These prolonged down periods, as mentioned, are characteristic of rangeland production systems. As well, because of the inability to accurately predict the timing or the extent of a drought on the Nullarbor, and the additional difficulty in assessing the likely price effects of such an event, speargrass fodder production may not result in a reduction in enterprise risk for some producers; rather, it could result in increased risk.

Well diversified producers

Producers with other off-station assets and income face reduced risk of ruin from a prolonged drought but this does not necessarily mean that they should avoid the reduction of this risk. The decision to harvest speargrass hay is less critical for diversified producers because of their range of income sources and the reduced risk they would face in the event of a misjudgement as to the timing or extent of a drought. In short, they are in a better position to recover and therefore in a better position to gamble on a future outcome. A similar scenario could be the difference between a sophisticated investor of age 35 and an investor close to retirement at age 65. The ability to recover from an error of judgement in many cases warrants the taking on of more risk for the younger, sophisticated investor.

At what level should a well diversified producer invest in speargrass fodder?

In addition to the factors already discussed, to establish an appropriate level of investment into speargrass fodder for insurance or risk-reduction purposes requires an assessment of five key variables:

- is speargrass fodder available in sufficient quantity and quality to be economically harvested?
- what is the estimated time to the next drought?
- what is the estimated length of the drought?
- what is the likelihood that the investment can be recouped through a sale of hay, or via the feeding out of cattle or sheep?
- what is the degree of price risk likely to be faced?

Each of these points is debatable and chaos and probability theory would indicate that an accurate assessment would be little more than good luck. Taking into account the inability to accurately address the above variables, what should a diversified producer do?

As years between exceptional speargrass yields can be many, harvesting should be considered on an opportunistic basis. If an assessment of the speargrass season shows that production costs would come in at the lower quartile, consideration should be given to harvesting enough hay to allow a holding period for a core breeding herd of cattle or flock of sheep. Beyond this level, the risks and opportunity costs of holding speargrass fodder for a prolonged period expand considerably.

Using the data presented in this paper, we estimate that during a particularly good season hay could be produced at the *low* cost of \$64/t with an estimated feed-out maintenance rate set at \$0.48/hd/d for cattle. The following simple example could be considered:

Consideration of feeding cattle speargrass hay

2000 head cattle worth \$500/hd = \$1million.
Drought comes in year one after harvest.
Cattle need to be held on speargrass hay 100 days to avoid destocking.
Maintenance ration: 2000 cattle x \$0.48/hd/d x 100 d = \$96,000.

The cost of insurance in this example is approximately 10 per cent of the cattle's total value. A delay in the drought for approximately seven years would push the opportunity cost of the speargrass investment out to almost 20 per cent of the cattle's value.

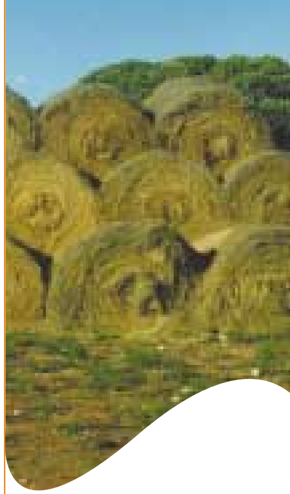
In the above example the period of insurance (100 days) is short and the risk that a drought would exceed this length relatively high, potentially resulting in a 100 per cent loss of costs sunk into speargrass hay. It should also be kept in mind that these calculations are based on the lowest cost estimate for speargrass fodder. As conservation costs increase, for example in seasons where yield is not as favourable or where cost cannot be reduced due to harvest method or option:

- the cost of speargrass insurance will rise as a percentage of herd value; or
- the number of days available for feed-out of maintenance rations will fall.

Loss of income via forced destocking

Speargrass fodder holds several advantages for Nullarbor producers if they get the timing correct, particularly in regard to the length of the drought and the period in which a forced destocking could occur. In such an event the loss of income for several seasons can be considerable. The financial benefits of avoiding a forced destocking via speargrass hay storage could significantly outweigh the cost of hay making during lower cost production periods.

Nevertheless, prolonged drought places extreme pressures on land systems and so some destocking may be forced because of erosion and land care risks.



FEED VALUE OF SPEARGRASS FODDER

Two feeding trials involving wethers at Arubiddy and steers at Kanandah were undertaken to appraise animal performance when freely fed either speargrass hay or haylage, with or without access to supplements.

A key objective of the project was to assess the nutritive value of the conserved fodder over time. This was achieved through two successive feeding trials conducted between 20 April and 1 June 2002 (seven months post-processing) and between 9 May and 4 July 2003 (20 months post-processing).

In the first feeding trial, the performance of wethers and steers fed either speargrass hay or haylage, with or without access to a high protein block, was evaluated. In the second feeding trial, two supplemental feeding regimes were evaluated using steers, and four supplemental feeding regimes were evaluated using the wethers. Only the speargrass hay was assessed during the second round of feeding trails. This was because the results from the first trials indicated no difference in the performance of animals fed either hay or haylage. As hay bale production proved markedly simpler and a cheaper option, the NEH LCDC members resolved haylage was not a viable option for them and any further assessment would have little practical relevance.

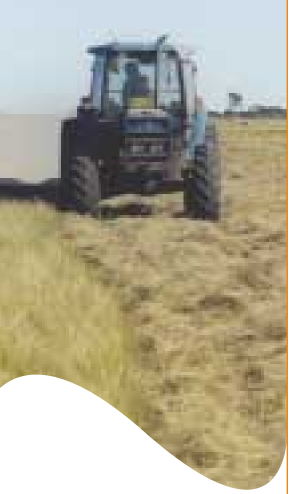
Feeding Trial 1

Twenty four Merino two-year-old wethers with an average weight of 34.4 kg (±2.90 kg) and 24 Murray Grey-Brahman cross steers (aged 12-16 months) with an average weight of 336 kg (±21.4 kg) were each randomly allocated on a stratified weight basis to one of four treatment groups. The four treatment groups were:

i. Hay
ii. Hay + high protein block
iii. Haylage
iv. Haylage + high protein block

The animals were ear tagged then penned together in treatment groups in large yards. All animals were given free access to their respective diets and fresh water was available at all times. Animals were monitored daily by the station owners for general health and behaviour.

The high protein blocks used were (Ridley AgriProducts) Fosforlic™ 30% Protein Dry Feed Supplement. These blocks contain 30 per cent crude protein, 55 per cent salt and three per cent phosphorus (plus other nutrients). At both the Arubiddy and Kanandah sites, the blocks were placed in the yards, away from the water troughs. At Kanandah, the hay and haylage were fed out in hay rings while at Arubiddy the bales of hay or haylage were placed unconfined in the yards.



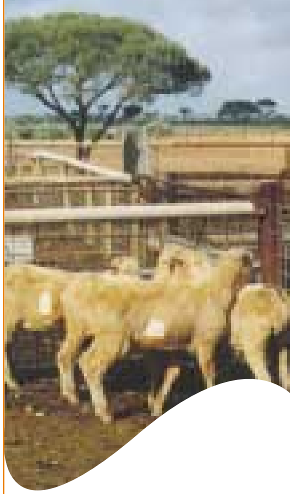
Murray Grey-Brahman cross steers used in the feeding trials at Kanandah

Trial wethers at Arubiddy

When feeding to cattle, the bales of speargrass hay or haylage were confined in hay rings to reduce wastage

High protein blocks used in the first feeding trial were not readily consumed, probably because of their high salt content

When unconfined bales of hay are fed to sheep considerable wastage occurs. Grass seed contamination of the wool on the sheep's head is also greater



The intake of the hay and haylage was determined by subtracting the weight of refusals (recorded whenever the bales were replaced) from the initial weight of the bales. Average intake was calculated by subtracting refusals from the amount fed and dividing by six (the number of animals per pen). The intake of the blocks was determined from the change in weight of the blocks each week. Average intake was calculated by the same procedure used to determine intake of the hay or haylage.

Weighing the hay bales

All feed refusals were weighed throughout the trial

The sheep and cattle were weighed weekly at the same time of the day to minimise variations caused by differences in gut fill.

Weighing the trial wethers

Weighing the trial steers

Feeding Trial 2

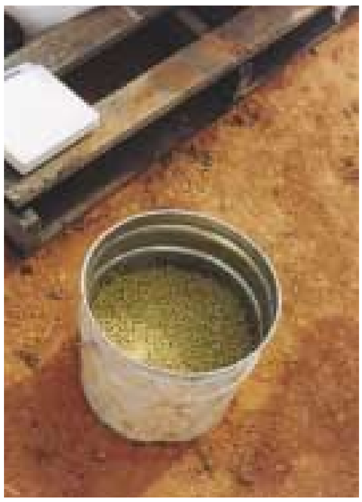
At Kanandah, 12 Murray Grey-Brahman cross steers (aged 12-16 months) with an average weight of 309 kg (±17.8 kg) were randomly allocated on a stratified weight basis to two treatment groups, while at Arubiddy, 24 Merino two-year-old wethers with an average weight of 28.8 kg (±4.42 kg) were randomly allocated on a stratified weight basis to four treatment groups. As in Trial 1, all animals were ear tagged and penned together in treatment groups in large yards and given free access to water and their respective treatment diets. The supplemental diets used in the second feeding trial are shown in Table 4.

Table 4 Dietary supplements used in the second feeding trial

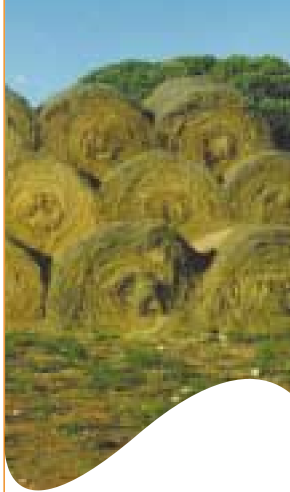
Cattle			
Treatment 1			
Fed at 1 kg/hd/d	Fortified molasses	89% molasses, 1% urea, 9% dicalcium phosphate (DCP), 1% vitamin & mineral premix (Px)	Mixed on-farm
Treatment 2			
Fed at 1 kg/hd/d	Fortified lupins	90.7% lupins, 8.1% DCP, 0.2% magnesium oxide, 1% Px	Commercial pre-mixed
Sheep			
Treatment 1			
Fed at 100 g/hd/d	Fortified molasses	89% molasses, 1% urea, 9% DCP, 1% Px	Mixed on-farm
Treatment 2			
Fed at 100 g/hd/d	Fortified lupins	90.7% lupins, 8.1% DCP, 0.2% magnesium oxide, 1% Px	Commercial pre-mixed
Treatment 3			
Fed at of 200 g/hd/d	Commercial pellets	Commercial-in-confidence	GlenLea™ sheep pellets
Treatment 4			
Fed at 200 g/hd/d	Grains/mineral mix	52.3% barley, 43.6% lupins, 3.6% DCP, 0.5% Px	Commercial pre-mixed

Bulk molasses for on-farm mixing

Amount of fortified molasses needed for six steers for one day



Amount of fortified lupins needed for six steers for one day



Amount of fortified lupins needed for six wethers for one day

Amount of commercial sheep pellets needed for six wethers for one day

Feeding out the grains mineral mix for the wethers

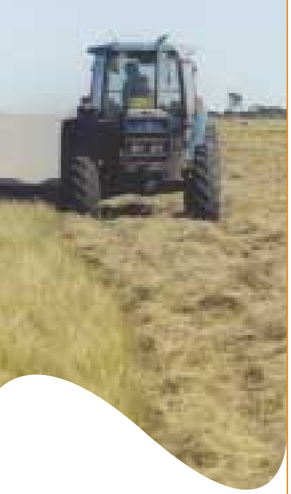
The nutritive value and cost of the supplements used in the second feeding trial are shown in Table 5. The supplements were designed to provide the additional nutrients required to meet **maintenance requirements**, based on the predetermined average nutritive value of the bales of speargrass hay used in this trial (Table 6). The supplements were provided daily in addition to unrestricted access to the speargrass hay. Because of the wastage reported during the first sheep-feeding trial, the bales fed during the second trial were contained to some extent by surrounding them with ringlock.

Table 5. Nutritive value and cost of supplements used in the second feeding trial*

Supplement	Crude protein (%)	Energy (MJ/kg)	Cost* ($/t) incl. GST	Cost ($/hd/d) Cattle	Cost ($/hd/d) Sheep
Fortified molasses	28.6	11.97	447.82	0.45	0.05
Fortified lupins	29.5	12.52	386.10	0.38	0.04
Commercial sheep pellets	17.0	11.70	494.73	-	0.10
Grains/mineral mix	19.9	12.34	344.3	-	0.07

*Cost does not include freight. Costings for the grain supplements based on 20 t bulk loads ex mill in metro Perth.

Costs of the grain-based supplements will fluctuate depending on grain harvest prices. Currently grain prices are high. In years when grain prices are lower it is likely that the cost of these supplements will also be lower.



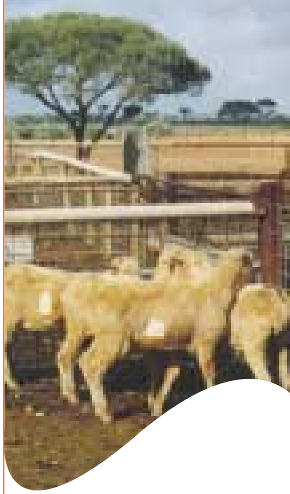
Roughly confining the hay using ringlock reduced wastage by the sheep

Feeding out speargrass hay at Kanandah

Feed intake and liveweight changes in both the sheep and cattle were recorded in the same manner as the first feeding trial. Mid-side patch clips were taken from each wether at both the start and end of the feeding period to determine the effects of the treatments on wool growth. The mid-side patch clips were analysed for clean weight and average fibre diameter.

Removing a 10 x 10 cm patch of wool from the mid-side

Mid-side patches were removed to determine amount and quality of wool grown



Results and discussion

The average nutritive values of each bale of the speargrass hay and haylage used in the feeding trials are shown in Table 6. There was a considerable range in the nutritive value, particularly with respect to dry matter (DM) content, dry matter digestibility (DMD) and crude protein (CP) levels. When the samples were visually assessed before being analysed, there was some green material observed amongst a fair proportion of dry leaf and stem material. The presence of this green material probably explains why the CP was quite respectable for this type of fodder. The DMD and metabolisable energy (ME) values were also quite reasonable and when combined with the CP levels, this fodder should be adequate to maintain both sheep and cattle as stock normally require about 8 MJ ME/kg DM and about seven per cent CP in their diet for maintenance. Given the opportunity, sheep are likely to select the higher nutritive value material and (theoretically) may perform reasonably well on these fodders. The actual performance of the animals in the feeding trials is shown in Table 8.

Table 6. The nutritive value (on a DM basis) of the speargrass hay and haylage used in the feeding trials and the nutritive value of oaten hay used as a reference standard

	DM (%)	DMD (%)	CP (%)	ME (MJ/kg)	Lignin (%)	Ash (%)	P (%)
Trial 1 (7 months post-processing)							
Hay							
Mean	88.6	50.8	6.5	7.1	9.9	4.5	0.04
Range	83.1-95.8	49.9-51.6	5.8-7.8	6.9-7.2	9.2-10.7	4.4-6.8	0.03-0.05
Haylage							
Mean	77.2	54.5	7.1	7.7	8.9	5.8	0.05
Range	50.4-90.6	52.1-56.9	5.7-9.3	7.3-8.1	8.0-10.1	4.4-8.2	0.04-0.06
Trial 2 (20 months post-processing)							
Hay							
Mean	97.8	54	8.5	7.5	-	4.6	0.03
Range	97.3-98.3	53.6-54.4	8.3-8.7	7.5-7.6	-	4.4-5.7	0.03-0.04
Oaten hay (reference standard, *adapted from Butler and Milton, 2001*)							
Mean	90	55-60	7	8	6		

These results suggest that the nutritive value of the hay did not deteriorate significantly over time, despite it being stored in the open. This has important implications in terms of cost savings. One of the arguments against fodder conservation is the associated cost of storage and the deterioration in nutritive quality over time. The prevalent climatic conditions recorded during the storage period covered in this report for both sites are presented in Table 7. At this stage it would appear that the generally dry climate of the region has retarded the rate of deterioration, thus maintaining the feed quality of the speargrass hay.

Table 7. ***Climate parameters for the unprotected hay bales stored at Arubiddy and Kanandah from 1 September 2001 to 31 July 2003 (699 days)****

	Ambient air temperature (°C)		Rainfall (mm)	Evaporation (mm)	Radiation (MJ/m2)
	Max	Min			
Arubiddy					
Max	43.5	22.5	34.2	18	31
Min	13	-1.5	0	1.4	5
Mean	24.9	10.6	0.6	6.6	18.3
Kanandah					
Max	44.5	25	46.8	18	31
Min	13.5	-1	0	2v	6
Mean	27.0	11.5	0.6	7.0	18.8

*The records are taken from the climatic surfaces produced by the Silo project (Jeffrey et al. 2001 <http://www.nrm.qld.gov.au/silo/>) rather than from homestead records directly.

The weathering process on unprotected round bales can affect the palatability or digestibility of hay. This spoilage is usually restricted to the outside crust or thatch section of the weathered bale. Moisture infiltration will spoil round bales and steps need to be taken to minimise this infiltration. Methods to reduce this spoilage may include stacking the bales on a well-drained site or elevating the bales using pallets or tyres. This will not only reduce the incidence of base bales becoming damp but will also serve to keep the storage site weed-free. Stacking bales in rows running north to south will provide even sunlight for drying and leaving gaps between rows will ensure maximum air circulation essential for creating the protective outer crust (Taylor et al. 1995). The nutritive value of the hay remaining from the trial will be monitored periodically for as long as it exists to determine how long it may be stored uncovered and still be a useful feed.

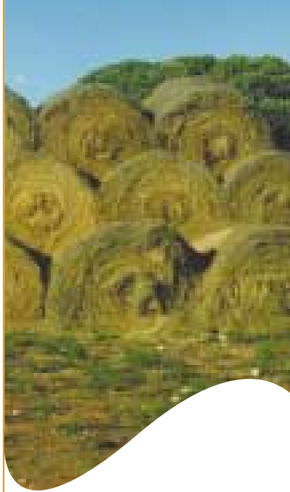
Both the sheep and cattle lost weight when fed only speargrass hay or haylage but this weight loss was less than one per cent of their body weight. In a situation where sheep and cattle are yarded for a couple of days without access to hay or in a paddock with very little feed (which is frequently the case when animals are kept in holding paddocks), weight losses are routinely significantly higher than those presented in Table 8.

Table 8. ***Daily liveweight gain of cattle and sheep fed speargrass hay or haylage, with or without supplementation***

Diet	Daily live weight gain (g/d)	
	Cattle	Sheep
Hay	-281^{a}	-24^{a}
Hay + protein block	-373^{a}	-59^{a}
Haylage	-312^{a}	-10^{a}
Haylage + protein block	-606^{a}	-30^{a}
Hay + fortified molasses	682^{b}	112^{c}
Hay + fortified lupins	884^{b}	111^{c}
Hay + commercial pellets	-	44^{b}
Hay + grains/mineral mix	-	89^{bc}

Values within columns with varying superscripts are significantly ($P<0.05$) different

Supplementing deficient nutrients is a management option available to reduce or reverse such weight loss. Stock blocks are routinely (and successfully) used to improve the performance of livestock grazing dry pastures. Such blocks normally provide additional protein (nitrogen) needed to improve diet use and consequently intake of the dry feed available. The high-protein blocks



provided during the first feeding trial contained 55 per cent salt and did not improve stock performance simply because cattle consumed minimal amounts and the sheep consumed none at all (Table 10). At both Kanandah and Arubiddy, resident animals are accustomed to ingesting high levels of salt, either via their water, pasture, or both. While salt can be a feeding stimulant or attractant for animals consuming low-salt diets, it has an opposite or negative effect on animals already ingesting high salt diets. Better results may have been realised in Trial 1 had the blocks contained minimal (or zero) salt, but these are not readily available commercially.

LCDC members making multi-nutrient blocks that contain no salt

Various moulds can be used in on-farm manufacture of nutrient blocks

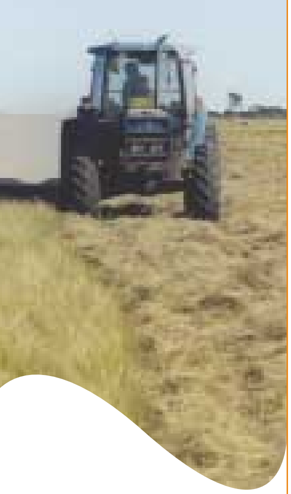
By feeding only a small amount of supplement (1 kg/d for steers and 100-200 g/d for wethers), it was possible to not only curb weight losses but actually promote weight gain in sheep and cattle fed speargrass hay. Furthermore, as shown in Table 9, providing the supplements to the sheep resulted in wool quality being maintained. From a management perspective this has important ramifications in situations where stock are held temporarily in yards or at those times of the year when stock are not quite ready to turn-off and paddock feed is quickly running out or in short supply.

All of the supplements offered were fully consumed each day. It took a couple of days for the trial animals to get used to the supplements but after that they consumed them without hesitation. Cattle readily took to the molasses; however, it took longer for the sheep offered the fortified molasses to recognise the supplement and for the first couple of days they needed a grain trail to induce them to eat the molasses. The molasses also had a tendency to stick to the wool around their faces, but this did not pose a significant problem as it did not 'contaminate' the wool and it would easily wear off.

Table 9. The effect of supplementation on wool growth in sheep fed speargrass hay

Diet	Fibre diameter (µm)	Wool growth (g/100 cm^2/d)
Pre-trial (grazing)*	20.14	0.1512
Hay + fortified molasses	20.81	0.1061
Hay + fortified lupins	21.22	0.1047
Hay + commercial pellets	20.93	0.1592
Hay + grains/mineral mix	20.66	0.1360

* Average value for all sheep in the trial



Once sheep recognise supplements they readily eat them

The average intake of hay and haylage by sheep and cattle in both feeding trials is presented in Table 10. Based on an average intake of 7.5 kg speargrass hay/hd/d for cattle and 1 kg/hd/d for sheep, if the highest estimated cost of on-station hay production is used ($153/t; Table 3) feeding costs are $1.15/hd/d for cattle and $0.15/hd/d for sheep. Alternatively, if the lowest estimated cost of production is used ($64/t), feeding costs are $0.48/hd/d for cattle and $0.06/hd/d for sheep.

Statistically, there were no differences between the intake of hay and haylage by either sheep or cattle during the first feeding trial. Generally, the feed intake of grazing animals is 2.5-3 per cent of their body weight. In both of the current trials, feed intake of sheep was about three per cent of their body weight. During the first trial, cattle intake was about 2 per cent of their body weight. However, the addition of supplements in Trial 2 increased intake by cattle to approximately three per cent of body weight and probably explains the better-than-expected liveweight gains observed from feeding supplements formulated to maintain liveweight.

In both feeding trials, the animals readily and immediately consumed the speargrass hay or haylage, indicating there were no problems with palatability. Anecdotal reports from producers who have previously imported oaten hay suggest animals (or more accurately their rumen microflora) require an adaptation period to acclimatise to the new fodder. During this period it is common for the animals to lose weight. A key advantage of feeding locally produced, native grass hay is that the animals eat it straight away. This provides a critical advantage, especially if the animals to be fed have been deprived of adequate nutrition for an extended period, a common situation during intensive husbandry operations such as shearing or transfer dictated by drought.

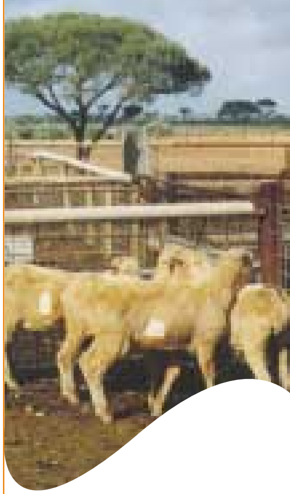


Table 10. Average intake of hay/haylage and supplements in the feeding trials

	Intake	
	Cattle (kg DM/hd/d)	**Sheep (g DM/hd/d)**
Trial 1		
Hay		
- alone	6.8	1115
- with access to block	6.6	1125
Haylage		
- alone	7.5	1060
- with access to block	7.2	1121
High protein block	Minimal	Zero
Trial 2		
Hay		
- fortified molasses group	Approx. 9.5	943
- fortified lupins group	Approx. 9.5	1052
- commercial pellets group	-	1030
- grains/mineral mix group	-	986
Supplements	(fully consumed)	(fully consumed)

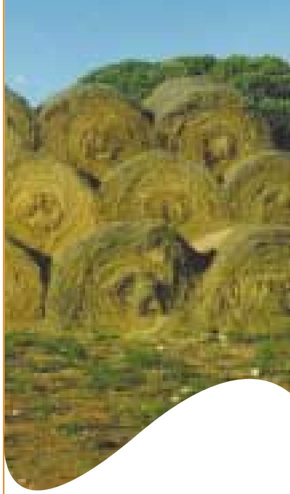
Problems that may arise with long-term feeding of speargrass hay to sheep include the contamination of facial wool and possible ulceration of the gums caused by seeds. Wool contamination was much greater in the first feeding trial but a simple ringlock barrier around the hay bales effectively decreased the incidence of contamination and also served to reduce fodder wastage. Although some sheep developed gum abrasion during the first feeding trial the incidence of ulceration was significantly less in the second trial. Harvesting stands before seed set will greatly reduce the incidence of contamination, ensure a higher plane of nutrition and reduce the incidence of gum problems.

Sheep in Trial 1 where hay was not confined had a higher incidence of seed contamination

Sheep in Trial 2 where hay was confined had a lower incidence of seed contamination

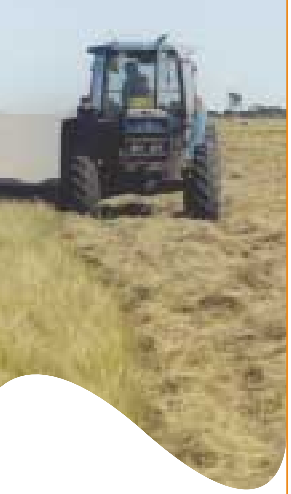
Gum abrasion from speargrass seeds (Trial 1)

Sheep not affected by grass seeds (Trial 2)



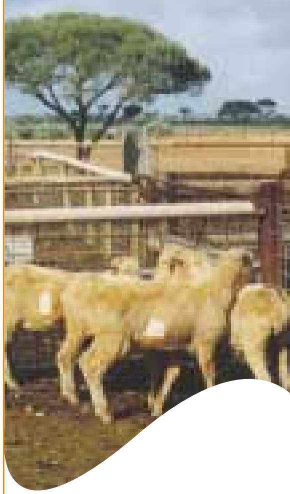
CONCLUSIONS

- Speargrass swards on the Nullarbor Plain can be successfully harvested and made into reasonable quality hay but the harvesting window of opportunity is short and choosing the best harvesting time is critical.
- On-station production of speargrass hay on the Nullarbor is a cheaper option than importing hay to provide fodder to livestock.
- There was no advantage in terms of fodder quality from wrapping the hay to produce haylage.
- Based on the findings of this study, if the highest estimated cost of on-station production is used ($153/t), feeding costs are $1.15/hd/d for cattle and $0.15/hd/d for sheep. Alternatively, if the lowest estimated cost of production is used ($64/t), feeding costs are $0.48/hd/d for cattle and $0.06/hd/d for sheep.
- Yields of speargrass hay compare favourably with those of other native grass pastures reported by other workers elsewhere.
- The quality of speargrass hay has not deteriorated over the duration of this project.
- Speargrass hay supplies sufficient levels of nutrients to support livestock. Providing additional supplements can significantly improve livestock performance.
- On-station production of speargrass hay presents a lower environmental risk in terms of introduced weed infestation than importing hay from other areas.
- On-station harvesting and processing of speargrass fodder would only be a commercially viable option for those producers with diversified enterprises or off-station income. For such enterprises:
  i. as the cost of speargrass fodder increases past the lowest quartile of costs noted in this report, the attractiveness of this option is significantly reduced;
  ii. based on a balanced judgment, opportunistic production of speargrass hay (taking into account seasonal availability influencing yield and therefore production cost) to ensure the maintenance of a core breeding herd or flock through a drought at a level that does not exceed approximately five per cent of a herd or flock's value could be warranted;
  iii. given a similar low-cost scenario in regard to hay yield, the accumulation of speargrass hay at a level that does not exceed 10 per cent in value of a herd or flock in year one could be considered;
  iv. speargrass hay holdings on the Nullarbor at a level in excess of 10 per cent of a herd or flock's value in year one would be considered a significant speculation on the part of the producer;
  v. maximum returns from speargrass hay conservation are likely to result if a drought occurs soon after harvest and is short in duration; and
  vi. it is likely that levels of investment above 10 per cent of a herd or flock's value in year one would not overcome the risk-reduction, diversification and opportunity cost benefits associated with using funds in alternative ventures.



OPERATIONAL RECOMMENDATIONS

- Sites being considered for harvesting in the future should be systematically traversed to locate rabbit warrens and large rocks. Excessive damage to mowing implements can be prevented if such areas are identified and avoided.
- Producers considering on-station fodder production should use GPS mapping technology to record the location of potential harvest sites and the location of obstructions within these sites. This would allow night-time harvesting when temperatures are cooler and also reduce equipment stoppage time. The Rangeland Survey Team will undertake its survey of the Nullarbor between March 2004 and November 2005. A major output of this work will be a comprehensive map of the land systems on the Nullarbor that will be useful to identify potential harvest sites.
- Continued monitoring of harvested sites will be essential to determine post-harvest plant recovery time and operational sustainability.
- The private or cooperative purchase of new processing equipment needed by local producers may not be commercially justifiable.
- Normalised Difference Vegetation Index (NDVI) technology may prove to be a highly effective tool to locate potential harvest sites. This needs further investigation.
- As low-salt content blocks are not commonly available commercially, Nullarbor producers wishing to supplement their animals using nutrient blocks should consider making their own on-station.



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RECOMMENDED READING

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Code of Practice for the Transportation of Sheep in Western Australia, Department of Local Government and Regional Development, Western Australia, March 2003.

Code of Practice for Cattle in Western Australia, Department of Local Government and Regional Development, Western Australia, March 2003.

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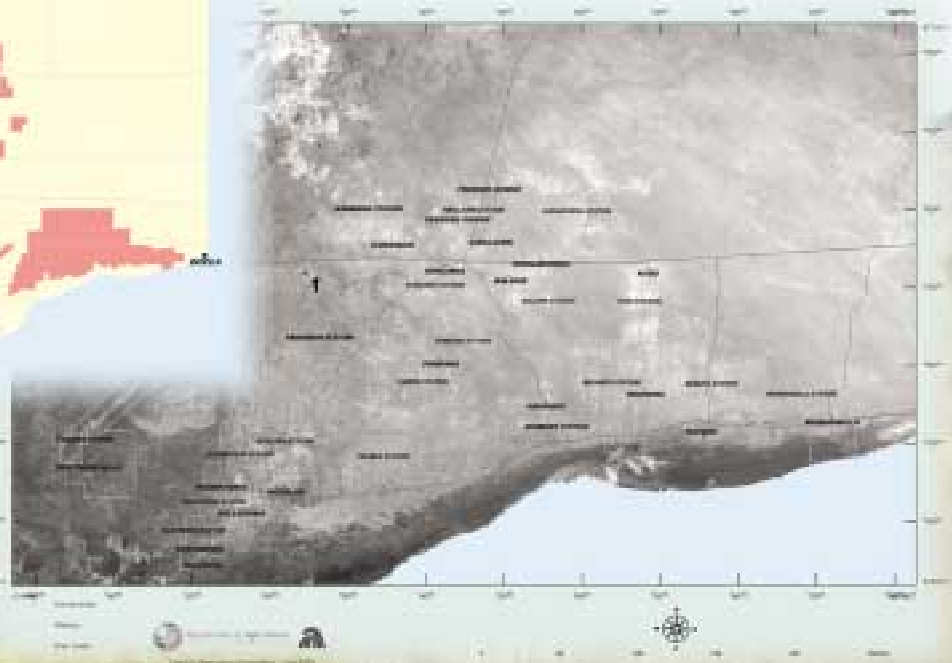

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