9-2001

The Good food guide for sheep : feeding sheep for meat production in the areas of Western Australia

Keith Croker

Peter Watt

Department of Agriculture and Food, Western Australia

Bulletin 4473
ISSN 1326-415X

Department of
AGRICULTURE

The Good Food Guide for SHEEP

Feeding Sheep for Meat Production in the Agricultural Areas of Western Australia

Bulletin 4473
ISSN 1326–415X

Department of AGRICULTURE

The Good Food Guide for SHEEP

Feeding Sheep for Meat Production in the Agricultural Areas of Western Australia

Edited by Dr Keith Croker and Peter Watt, Department of Agriculture, South Perth.

Prepared by the Meat and Dairy Program, Department of Agriculture. September 2001.

 Edited and published by Information Services, Department of Agriculture, Locked Bag No. 4, Bentley Delivery Centre, WA 6983.

CONTENTS

FOREWORD

Since the late 1980s, when wool prices began to decline, Western Australian farmers have steadily reduced their flocks. The Western Australian flock now contains approximately 25 million sheep, down 13 million-head from its highest point in 1990. As sheep numbers have fallen, interest in the production of sheep meat (lamb, hogget and mutton) has grown.

Many farmers have turned to first cross lamb production, joining meat breed rams to Merino ewes. In 2000/2001, approximately 59 per cent of the 5.1 million lambs expected to be turned off in Western Australia will be first cross lambs. Merino lambs will constitute approximately 40 per cent of the turn off and barely one per cent will be second cross lambs.

Most cross bred lambs in Western Australia are sired by British breed rams, such as Suffolks, Poll Dorsets and Border Leicesters, but the choice of breeds has widened in recent years. Some of the 'new' breeds have been developed in Australia, but most have been imported. Dorpers and White Dorpers, Damaras, Karakuls, Africaners, South African Meat Merinos and Dohne Merinos have been imported from South Africa. Texels, Finnsheep and East Friesians have come from Europe (via New Zealand) and American Suffolks have come from the United States.

Farmers with pure Merino flocks are placing more emphasis on the meat value of their sheep. The growing success of the Prime Merino Lamb Alliance, which now has more than 300 producer members, shows both the versatility of Merino sheep and the willingness of woolgrowers to learn new skills in sheep meat production.

Breeding is undoubtedly important in sheep meat production, particularly in combination with a system such as LAMBPLAN®, which uses objective measurements to determine true genetic value. However, even well bred, genetically superior sheep cannot perform satisfactorily unless they are properly fed.

The Good Food Guide for Sheep has been produced to provide Western Australian farmers with a concise compilation of current information on feeding sheep for meat production. Although there are already numerous publications about sheep nutrition, many of them relate to wool production, reproduction or drought feeding, or they concentrate on particular feeds or feeding systems.

This book contains information on a wide range of feeds and feeding methods. Just as there is no single 'best' sheep breed for meat production, there is no ultimate feed regime for sheep for growth.

I hope you will find The Good Food Guide for Sheep an interesting and useful reference.

Graeme Robertson
Chief Executive Officer
Department of Agriculture
September 2001

INTRODUCTION

The major cost associated with the production of sheep meat is that of feeding. Efficient production therefore requires a careful choice of the most appropriate feeding system. The diverse range of climatic conditions and production systems available in Western Australia means that there are many feeding strategies suitable for raising or finishing sheep for meat production. This publication aims to provide farmers with agronomic and production information on these various feeding options.

A substantial proportion of levy and State Government funds is now directed towards producer driven on-farm testing. While these on-farm demonstrations provide an excellent learning experience for the farmers involved, the information does not always reach the wider audience.

At the same time, because there are limited resources available for comprehensive research, these small farm-scale demonstrations are often the only source of information on different production systems available to farmers. One of the reasons this book was produced was to capture some of these case studies and to share the information provided by them.

Farmers, as well as new workers in the sheep meat industry, are probably unaware of much of the information available from past work done in Western Australia on sheep feeding systems. Over many years, staff of Department of Agriculture have been involved in collecting information on the performances of sheep grown using a range of feeds.

This book provides a substantial collation of this information from many publications, and from unpublished records, research results and observations as well as the memories and notes of some producers and agency staff. Until now little of this work, past and present, has been brought together in a readily accessible form that is focused on sheep meat production.

'The Good Food Guide for Sheep' provides farmers with a single, concise, well-referenced and informative publication on all aspects of feeding sheep for meat production. It is hoped this will assist farmers in making well-informed choices of the most efficient production systems for their sheep meat enterprise.

Many people from various sections of Department of Agriculture contributed to the bulletin through criticisms and comments on the articles. There are too many to acknowledge individually, but the assistance freely given by all officers approached improved the quality of the articles. The production of the bulletin was funded by the Meat Program of Department of Agriculture.

Dr Sarah Wiese
Former Project Manager
Sheep Meat Research and Demonstration

Sheep Meat Enterprises in WESTERN AUSTRALIA

Eliza Dowling and Sarah Wiese,
Department of Agriculture, Narrogin

Introduction

Western Australia's small population and closeness to export markets for sheep meat, have a strong influence on the marketing of sheep meat products and on the enterprises required to produce them. Presently one-third of all sheep sold for meat is exported live, one-third is exported as carcase and piece meats and the remaining third is used to supply the domestic market for sheep meat products.

The lamb market

The largest sheep meat enterprise in Western Australia is for lamb, with about two million lambs slaughtered each year. A further one million lambs are exported live. The number of lambs exported both live and as carcases has increased over recent years while the domestic market has been relatively static.

The number of lambs produced by the different enterprises is influenced greatly by changes in the markets. Producers can follow a range of options for marketing their lambs. These are described below.

Paddock sales

Lambs are inspected on the vendor's property by a buyer and are then sold straight out of the paddock. The price is usually based on dollars per head. Twenty-five per cent of lambs slaughtered in Western Australia are traded by paddock sales.

Saleyard auction

A further 25 per cent of lambs slaughtered in Western Australia are sold through the saleyard auction system where multiple buyers bid for pens of sheep on a dollar per head basis.

Over the hook

Lambs are delivered directly to the abattoir and may be sold with or without an agent. Change of ownership takes place at the abattoir. There is a flat rate on a dollars per kilogram basis, or a price schedule depending on the specifications of the individual lambs. Preferred specifications are generally fat score 2 or 3 (6 to 15 millimetres of fat over the ribs) and greater than 18 kilograms carcase weight. Domestic markets tend to also have a preferred upper limit for carcase weight of around 23 kilograms. Forty-five per cent of lambs slaughtered in Western Australia are traded 'over the hook'.

Computer Assisted Livestock Marketing (CALM)

Here the sale is on-farm, with details entered into a computer. Lambs are assessed before sale by an accredited CALM assessor who describes the lambs to the buyers via the descriptions that are entered into the computer. Producers do not need to own or be able to operate a computer to sell when using the CALM system. Only five per cent of lambs slaughtered in Western Australia are traded by CALM. Several of the stock firms have licensed CALM assessors and can provide more information on CALM.

The different costs associated with each marketing method include the agent's commission, yard fees, transport, insurance, transaction levies and assessment fees.

Meeting health requirements

Regardless of the marketing method used, good animal husbandry is required to meet health specifications. Sheep that are affected by arthritis, cheesy gland, dermatitis, hydatids or which have grass seeds, will either incur a heavy penalty at slaughter or will not be accepted. There has been a widely successful campaign in Western Australia to ensure that all sheep for the live export market are vaccinated against scabby mouth. (For further information on animal health matters, please refer to the chapter 'Sheep Health Issues').

Prime lambs

Sucker lambs

Sucker lambs are lambs that have not been weaned from their mothers before sale. Usually they need to maintain a growth rate above 250 grams per head per day to reach their minimum target slaughter weight of 40 kilograms before the green feed dries off (Figure 1). Sucker lambs are a low input enterprise and, with the generally high volume of lambs being sold in spring, tend to return lower prices. Early sucker lambs,

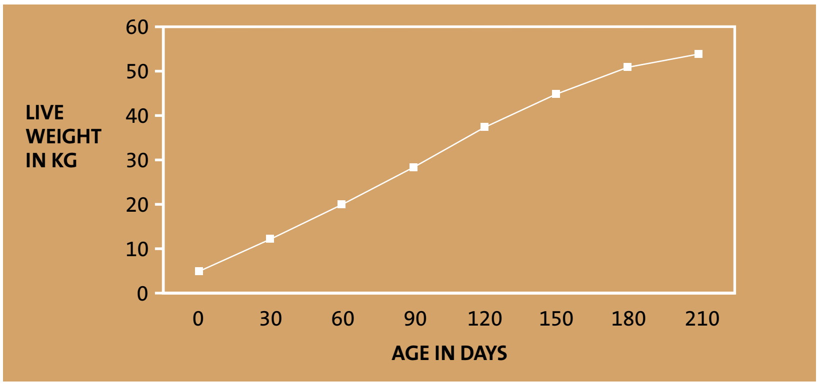


Figure 1. Expected liveweight gain of crossbred sucker lambs born in April/May.

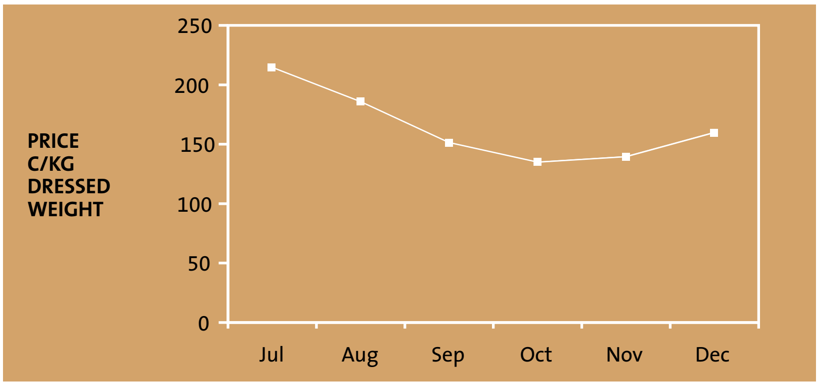
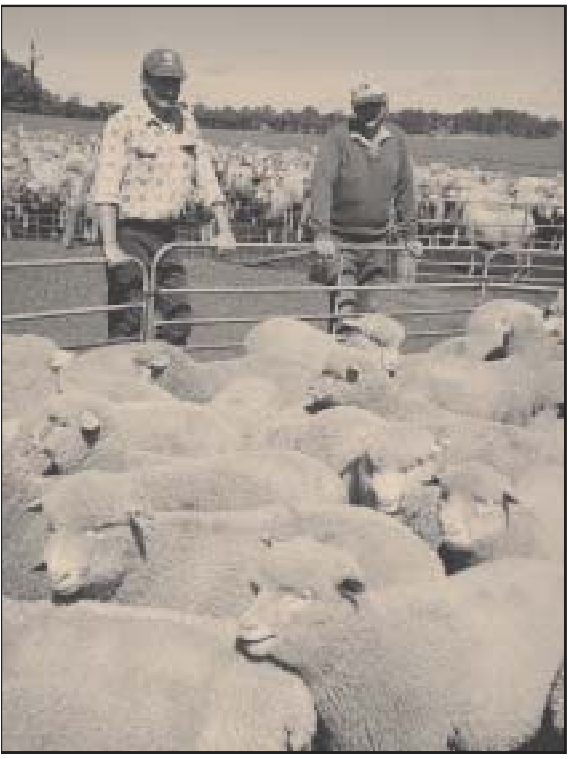


Figure 2. Cents/kilogram for dressed weights of 13 to 16.5 kilogram carcase (Condition score 2). Six-year averages to 1999 for months July to December.



Poll Dorset x Merino sucker lambs finished on annual spring pasture in Pingelly.

(June, July, and August), attract premium prices (see Figure 2 above). However, producers need to plan for a lambing in mid April to achieve a premium in this market. With earlier lambing, ewes will require more feed in autumn.

Carryover lambs (weaned lambs)

Carryover lambs are those that are weaned from their mothers and grown out to meet various market requirements. They are usually sold outside the spring flush of lambs. With carryover lambs, the aim is to produce a finished lamb out of season (from December to August) that will generate a price premium (see Figure 3 for average prices for carryover lambs).

The minimum liveweight at slaughter for these lambs should be 40 kilograms, and the lambs going into summer should be at least 30 kilograms. With a later lambing (July/August) when green feed is available, there is little extra cost for the ewe, but there is for finishing the lambs in summer or autumn when green feed is no longer available. This varies depending on whether a high or low input system is used.

Low input system: With a low input system, lambs are usually finished with grain (lupin, oats, barley or wheat) fed through self-feeders, or trailed out while grazing on stubbles of lupin, cereal or canola. This is a low-cost option but has its disadvantages particularly when summer rain reduces the nutritional value of the dry feed or stubble causing lambs to lose condition. The line of lambs produced is usually of variable condition with some falling outside specifications, and thereby incurring penalties.

Border Leicester x Merino carryover lambs ready for slaughter at Beverley.

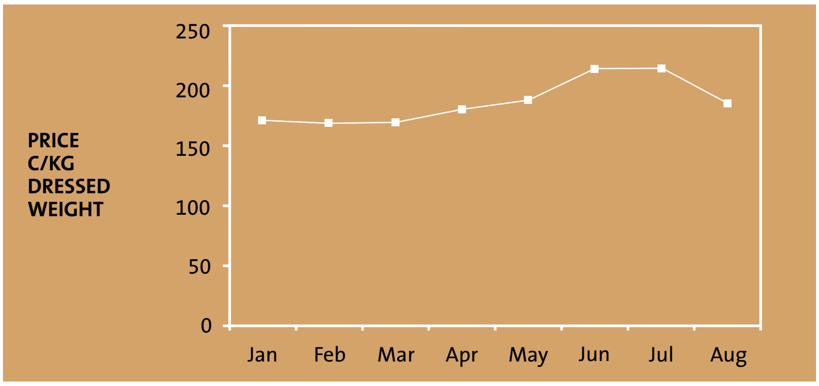


Figure 3. Six-year averages to 1999 for months January to August. Cents/kilogram for dressed weights of 13 to 16.5 kilogram (Condition score 2).

High input system: With a high input system, carryover lambs are intensively fed in feedlots to meet weight and grade specifications. This option is expensive and time consuming but with good management produces a consistent product that should earn a price premium. The extra costs of lot-feeding lambs include shearing, vaccinating and drenching lambs into the feedlot. (For more information see the chapter on lot-feeding of prime lambs).

Merino lambs

Traditionally a by-product of the wool industry, Merino lambs grow up to 100 grams slower per day than crossbred lambs and their skins are of lower value. However, Merinos tend to be leaner and can make heavier weights than crossbreds without becoming over fat. They require more feed to be finished properly and are slower to adapt and perform in a feedlot. The liveweights and growth rates of autumn and spring born Merino lambs in the eastern wheatbelt are provided as an example of the growth performance that can be expected from Merino lambs (see Figures 4 and 5).

Whilst domestic demand for pure Merino lamb meat is extremely low, Merino lambs make up a large part of the export market. There is a strong demand for Merino lamb carcases in the Middle East market. Historically, the Western Australian Meat Marketing Cooperative (WAMMCO) controlled the export market for Merino lambs, but this changed on 1 January 2000 when WAMMCO lost its status as Western Australia's sole exporter of lamb. With limited selling options for Merino lambs it is worthwhile for producers to secure a contract before starting to lot-feed lambs.

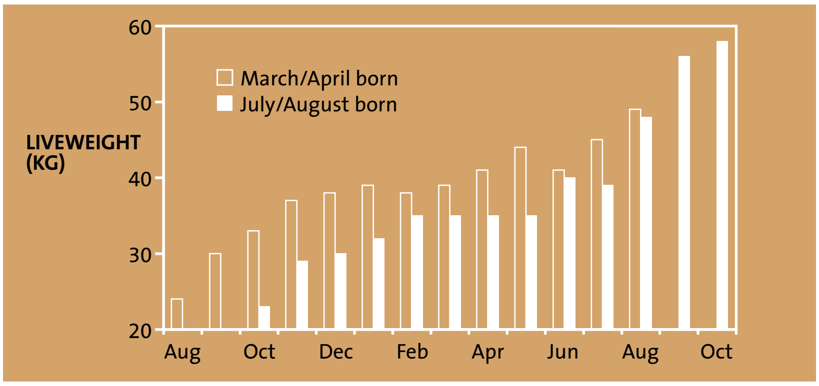


Figure 4. The average weights of spring (July/Aug) and autumn (March/April) born Merino weaners in the eastern wheatbelt.

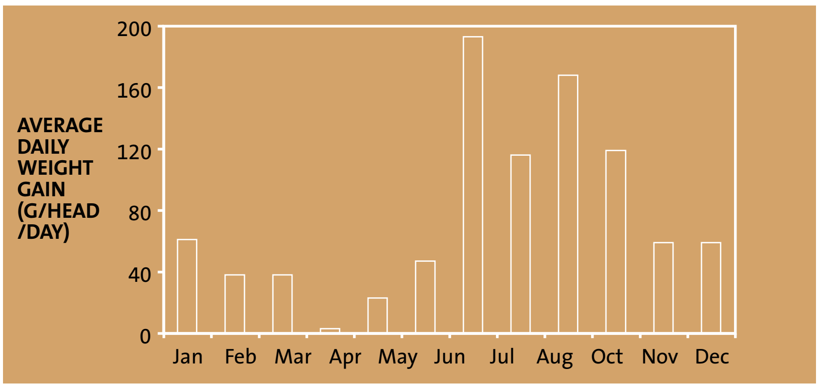


Figure 5. The average rate of weight gain throughout the year for Merino weaners in the eastern wheatbelt.

Damara x Merino fat tail lambs for live export at Narembeen.

The Live Export Market

The value of live sheep exported from Western Australia for the financial year 1999/2000 was 150 million dollars (ABS figures). This represents an export in that year of 3.85 million sheep. The preferred live sheep for Middle Eastern Muslims is a young unblemished (entire) ram, with no physical deformities or disease. Previously Western Australia has exported older Merino wethers, but the percentage of younger sheep has steadily increased in the past eight years (see Figure 6).

Live export of lambs

The minimum requirement is a healthy lamb at 35 kilograms liveweight. Buyers usually take a large line of lambs that are less uniform than would be acceptable to the domestic market. The preference is for unblemished ram lambs over wethers. There are very few opportunities for export of ewe lambs.

Lambs vaccinated for scabby mouth and shorn before shipping are preferred. Some supplementary feeding may be required to bring lambs up to a suitable weight and condition for shipping. There are few other costs in producing lambs for live export. Good opportunities exist for contract production of fat tailed breeds.

Ram lambs for live export

Both Merino and crossbred lambs are acceptable for the ram lamb market. However, because of faster growth rates, crossbreds can reach weight specifications more easily. Ram lambs need fewer procedures at marking since mulesing, castrating and often ear tagging are not required. Lambs should be weaned and separated from females at 12 to 14 weeks of age as they become sexually active at about this age. Ram lambs have the potential to grow 20 per cent faster than wethers but they also have a higher energy requirement. They can also be difficult to finish if the feed supply becomes low.

Fat tailed breeds for live export

Fat tail breeds command a premium price in the Middle East as buyers in these markets prefer breeds with fat tails. Contracts are available at mating, giving a guaranteed price per head for lambs that meet the required specifications for liveweight and condition score. Fat tail ewe lambs are also becoming acceptable to the live export market. Fat tail breeds are acceptable in the export carcase market should they not make the contract specifications for live shipping, or in some cases can be sold as store lambs to be finished in a feedlot.

Fat tail crossbred lambs exhibit the same hybrid vigour as other crossbred lambs.

Live export wethers

Adult wethers vaccinated for scabby mouth and shorn before shipping are preferred. Preference is for a big-framed sheep in condition score 2 to 3. Older wethers were supplied in earlier years, but more recent demand has been met with younger mature wethers (two to three years old). The demand for mature wethers predominates, but export of hoggets and lambs

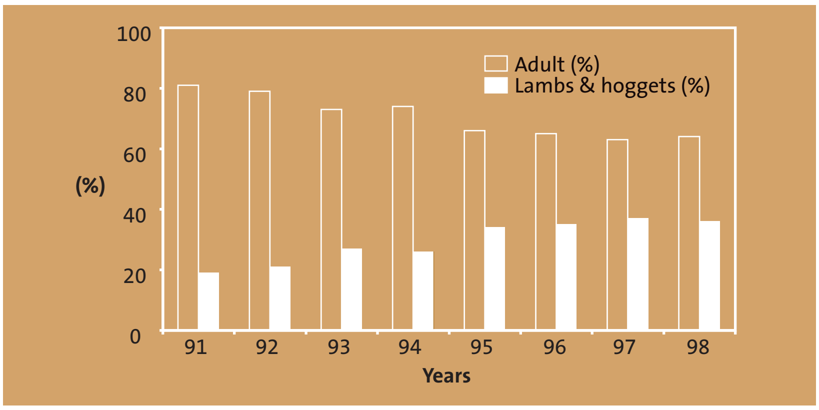


Figure 6. The proportion of adult versus young live sheep exported from 1991 to 1998.

is increasing, with occasional opportunities for ewes. Low wool prices have resulted in fewer wethers available for export, as producers turn more to cropping enterprises.

Mutton

There is a market for old ewes and rams that are culled for age, are of poor fertility, or are surplus to requirements. Mutton produced should be 85 per cent lean. Merinos of condition score 2 readily meet this requirement. Boned carcases are cored to test for fat content. As most of the Western Australian sheep that are culled for age are Merinos, meeting the criterion for 85 per cent lean meat is not usually a problem.

As with all other sheep enterprises, penalties are incurred at slaughter for diseases and other health issues. Cheesy gland is more of a problem in older animals. This is because the disease is spread at shearing by sheep carrying the disease coughing onto sheep with open cuts, and so the prevalence of the disease in a flock gradually increases with the age of the flock.

Mutton prices often show seasonal fluctuation and have been very low in recent times, despite the fall in sheep numbers in Western Australian flocks (see Figure 7). Sheep for the mutton market can be sold through saleyard auctions, direct paddock sales and recently through WAMMCO.

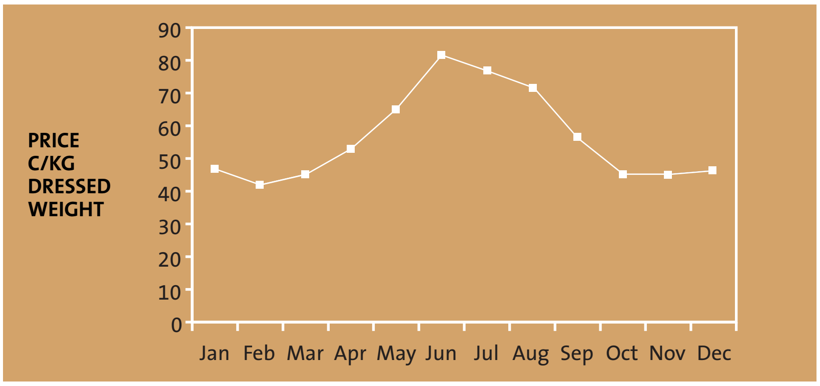


Figure 7. Cents/kilogram for dressed weights of 19 to 26 kilogram (Condition score 3). Six-year averages to 1999 for months January to December.

Further Reading

AMLC. Production and Marketing of Large Lean Lambs.

Bulletin No. 4645. Controlling sheep meat disorders.

Farmnote 72/2000. Sheep health in a feedlot.

Farmnote 74/2000. Achieving production targets for prime lambs.

Farmnote 76/2000. Lot-feeding prime lambs.

Farmnote 25/99. Preparation and assessment of sheep and lambs for slaughter.

Farmnote 68/94. The Awassi fat-tail sheep

Farmnote 96/94. Pre-road transport handling and care of live sheep for export

Principles of Ruminant NUTRITION

John Milton, Department of Agriculture, based at
The University of Western Australia, Nedlands;
Janet Paterson, Sci Scribe Scientific Copywriting, Brookton
and Daniel Roberts, Department of Agriculture, Katanning.

KEY MESSAGES

- Energy and protein are the key nutrients that limit sheep production.
- Deficiencies of vitamins and minerals can be of particular importance in lambs.
- To feed sheep successfully, we must aim to meet the nutrient needs of the microbial population in the rumen of the sheep.

Definition of animal production

Animal production is concerned with the conversion of chemical components in forages and grains into meat, wool and milk. The nitrogen, carbon, and minerals in pasture and other feeds are converted to muscle, milk and wool through the processes of digestion, absorption and assimilation within the body of an animal. How efficiently this occurs depends on the quality and quantity of the feed available as well as the type of animal eating the feed.

Uniqueness of ruminant animals

Sheep are ruminants and as such are characterised by having a specialised stomach with a number of compartments, one of which is known as the rumen or paunch. The rumen is basically a 4 to 10-litre vat in which millions of microbes ferment incoming feed into products that the sheep then uses to grow.

Without these microbes sheep could not exist because the microbes possess the special ability to break down the otherwise indigestible cellulose component of plant material. Cellulose forms a large part of the fibrous feed of ruminants. No animal has the enzymes capable of breaking apart the cellulose bonds to release the energy they contain. Thus, without the microbes, the sheep could not access the energy contained within fibrous plant feeds.

Another special feature of ruminants is their ability to 'chew the cud' or ruminate. As a normal part of eating, food is regurgitated from the rumen into the mouth and re-chewed. This makes the feed particles smaller and increases their surface area so that when they re-enter the rumen it is easier for the microbes to access the feed and continue their fermentation. Without this process of rumination, the feed particles would remain too large for the microbes to access the carbohydrates and protein contained within them.

The microbes in the rumen ferment feed carbohydrates to produce volatile fatty acids. These volatile fatty acids are the major source of energy for the sheep.

Carbohydrates such as soluble sugars and starch are easily broken down by the microbes. Others, such as the celluloses contained within the cell walls of plant material are more complicated in structure and take longer to break down. Another complex material known as lignin can not be broken down at all by the rumen microbes and its presence in mature plant material considerably limits the efficiency of fibre digestion by the rumen microbes.

Plant protein is broken down into its component amino acids by the rumen microbes. These are either incorporated into microbial protein or degraded further to produce ammonia that is then used to synthesise microbial protein or is absorbed into the blood stream to be recycled or excreted as urea in the sheep's urine. When the microbes themselves pass from the rumen, through the acid stomach and into the small intestine, they are then digested into amino acids and these are absorbed into the sheep's blood stream. Microbial protein can be of high quality in that it generally contains the right balance of the amino acids needed by the sheep to synthesise muscle, wool and milk protein.

Nutritional requirements of the ruminant

When we consider the nutritional requirements of the ruminant we must also consider the nutritional needs of the microbial population in the rumen. In essence we aim to 'feed the rumen microbes to feed the sheep.' If we are able to maintain a healthy, productive microbial population then we can be confident that the sheep will receive adequate energy (in the form of volatile fatty acids) and protein (in the form of microbial protein).

Energy

Energy provides the power needed to drive all the metabolic processes of an animal. Without it, chemical reactions would not occur and muscle, milk and wool could not be synthesised. Provided there is adequate protein in the diet, the amount of energy available to an animal determines how productive the animal can be in terms of meat, wool and milk production.

The key factor in supplying energy for sheep production is how easily the energy can be extracted from a feed. In other words how quickly the sheep's digestive processes can access and use this energy to produce meat, wool or milk.

The speed with which the energy becomes available depends on how digestible the feed is. Feeds such as green pasture, good hay or grains are easily digested because they contain large amounts of soluble sugars and starches and only a small proportion of the less digestible structural carbohydrates such as cellulose and lignin found in cell walls.

As plants age, more and more of these structural carbohydrates are laid down in the stems and the soluble, more simple sugars stored in the stems are moved to form the seed heads or grain. This means that feeds such as dry pasture or straw take longer to digest because they contain less soluble sugars and the chemical bonds that bind the cell walls together are very strong and require more time and energy to break than the bonds that hold simple sugars together.

> When pastures begin to 'hay off' or sheep are put onto stubbles, their food intake generally drops off. This is because it takes longer for the microbes to break down the structural carbohydrates contained in these feeds and, in consequence, the feed remains in the rumen for longer. The sheep can not eat more feed until the rumen empties.

The total energy content of a feed is known as its 'gross energy' and is a measure of the amount of heat generated when the feed is completely combusted to ash in the presence of oxygen. However not all the energy in a feed is available to an animal since some remains trapped in the plant cells and is unable to be extracted by the animal's digestive processes. Additional energy is lost in the gaseous products of digestion such as CO_2 and methane and a small amount of energy is also lost in the urine of the animal. Once these losses of energy are taken into account, the remaining feed energy is known as the 'metabolisable energy' which is the energy available to the animal for the metabolic processes of maintenance and growth.

It is the metabolisable energy content of a feed that determines how much production can be achieved by an animal, that is, whether an animal's weight will be maintained, increased or decreased. It is essential to know the metabolisable energy content of feeds when formulating diets and developing feed budgets for ruminants.

Since metabolisable energy is difficult to measure, it is usually calculated from the digestible dry matter of the feed using an appropriate equation. The greatest loss of energy when forage is digested is that lost in the animal's faeces. Put simply, digestible dry matter is the proportion of the dry matter consumed that is not excreted in the faeces. Digestible dry matter is expressed as a percentage, that is, the proportion of dry matter in the feed that can be digested by the animal.

A young ryegrass/clover pasture can have a digestible dry matter value as high as 80 per cent and a calculated metabolisable energy of 11.8 megajoules per kilogram of dry matter. This is similar to a reasonable quality barley grain. This means that the animal can digest 80 per cent of the dry matter in the diet and that for every kilogram of feed eaten, 11.8 megajoules of metabolisable energy will be released to the animal.

A mature grass-dominant tropical pasture that has recently finished flowering and is starting to become lignified, may have a digestible dry matter value of about 60 per cent with an metabolisable energy of 8.6 megajoules per kilogram of dry matter. On the other hand, a wheat stubble that has little leaf material present, is heavily lignified and contains a significant amount of indigestible silica, may have a digestible dry matter value of only 40 per cent with a metabolisable energy of 5.6 megajoules per kilogram of dry matter.

Short seasons such as that experienced in 2000 produce pastures and stubbles of a relatively high digestible dry matter. When the season stops abruptly, the plants do not have time to lay down structural carbohydrates and there is less movement of soluble sugars out of the stem and into the seed heads. The nutritive value of this dry feed will remain high throughout the summer as long as there is no summer rain to leach out the soluble sugars in the stems. Long seasons give stubbles of poorer quality because of the high proportion of structural carbohydrates and low amounts of soluble sugars remaining in the dry forage.

Animals require energy to maintain their basic metabolic processes such as kidney, liver, brain and heart function as well as to lay down muscle, fat, protein and wool. The energy required to maintain processes such as heart function is termed the 'maintenance energy requirement' of the animal. The amount of energy needed to maintain an animal depends on what the animal is doing and what environment it is living in. For instance, sheep produced in hilly country will need extra energy for maintenance to walk up hills in search of food. Similarly, sheep grazing a sparse pasture will have to walk further and therefore require more maintenance energy than a sheep grazing a relatively dense, green pasture or one that is housed and lot fed.

A 50 kilogram sheep walking three kilometres to water and back again each day will increase its maintenance requirement by 0.78 megajoules or 14 per cent. If it climbed a total of 600 metres on the way its maintenance requirement will increase by an additional 0.42 megajoules making a total increase of 1.2 megajoules or 21 per cent. In other words, to maintain its liveweight, the sheep will require 20 per cent more energy each day than a sheep with water close by and grazing flat land.

The need for extra maintenance energy under certain production conditions such as those described above become particularly important when we want to get sheep to specific target weights for milk and meat production. Part of the reason why weaners grown for prime lamb production grow faster in a feedlot is because they expend less energy searching for food and more energy growing than lambs produced on pasture alone. Another reason is that lot-fed lambs also tend to be given a feed ration capable of supporting high rates of growth.

Once the energy requirements for maintenance have been met, the sheep can use the additional metabolisable energy from the diet for productive processes such as meat, milk and wool production. Thus, the metabolisable energy intake required for production is principally determined by the desired growth rate or level of milk production. For example, lactating ewes require at least double their normal energy intake to produce enough milk to sustain the growth of their lamb/s.

Protein

Non-ruminant animals rely solely on the protein in their diet to produce proteins such as muscle and enzymes within their bodies. Consequently, if protein is deficient in the diet, the animal will have insufficient protein for these processes.

Ruminants have an advantage over non-ruminants because the microbes in the rumen are able to produce protein from non-protein nitrogen as well as from the protein in their diet. This means that the microbes can use nitrogen in the form of urea or sulphate of ammonia to make microbial protein. When these microbes are eventually digested in the small intestine of the sheep, this non-protein nitrogen ultimately provides the sheep with protein. This is particularly useful when sheep are grazing diets low in protein such as straw stubbles.

However, when the crude protein content falls below seven per cent, the microbes in the rumen are not able to reproduce themselves and the population begins to decline. As the microbial population falls, fewer microbes are available to break down the carbohydrates entering the rumen and in consequence the feed intake and growth rate of the sheep starts to drop off.

Growing sheep need between 12 and 15 per cent crude protein in their diet while sheep fed for maintenance only need about 8 per cent. Lupins can contain 30 to 40 per cent crude protein and it would therefore be wasteful to feed lupins alone since up to 65 per cent of this lupin protein could be wasted in the urine of the sheep. The aim with protein supplementation is to feed enough protein to raise the protein content of the base feed and thereby stimulate the feed intake (and therefore energy intake) of the sheep.

One of the disadvantages associated with the rumen microbes is that they fully degrade much of the protein entering the rumen into ammonia. This ammonia can be resynthesised back into microbial protein but any excess ammonia is absorbed into the sheep's blood stream with much eventually being wasted when it is excreted in the urine as urea.

When the feed is low in protein the amount of nitrogen excreted in the urine is relatively low. However, diets high in protein cause more ammonia to build up in the rumen and, in consequence, much of the incoming protein is wasted in the urine of the sheep.

Microbial protein produced in the rumen travels to the sheep's small intestine where it is broken down yet again into amino acids that are absorbed into the blood stream of the sheep for subsequent protein synthesis. All these processes are energetically inefficient and some of the protein entering the rumen is consequently wasted because of this inefficiency.

Some heat and chemical treatments will protect proteins from attack by the rumen microbes. These protected proteins 'by pass' the rumen and are fully available for digestion in the small intestine. Canola meal is a good example of a protein source that is partially protected during the canola oil extraction process. Trials have shown that including some of the protein source as canola meal leads to small increases in the efficiency with which feed is converted to liveweight. Some commercial pellet formulations include a proportion of the protein as canola meal. It is only likely to be economic to use a source of protected protein if the difference in price between the protected and unprotected protein source is small.

Minerals

While protein and energy are the major nutrients that limit animal growth, certain minerals can also reduce production if they become deficient, particularly in fast-growing production animals. Macro-minerals are those needed in relatively large amounts (grams per kilogram) and include calcium, chlorine, magnesium, phosphorus, potassium, sulphur and sodium. Trace minerals such as cobalt, copper, iodine, iron, manganese, molybdenum, selenium and zinc are needed in much smaller amounts (milligrams per kilogram).

The intake of minerals by sheep varies throughout the year. Adult sheep tend to have enough reserves of minerals to provide for their own needs and those of the foetus during temporary seasonal deficiencies. However, animal reserves of minerals will be depleted when they are fed only a grain-based diet for more than one month. Periodic feeding of a multi-mineral and vitamin mix will be needed for any long-term feeding in feedlots.

All grains are low in calcium and have relatively high levels of phosphorus leading to a calcium to phosphorus ratio well below the ideal of 2:1. An imbalance of calcium and phosphorus while feeding grain can lead to reduced appetite and growth, soft bones and fractures, and the formation of urinary stones that may obstruct the urinary tract, especially in wethers and young rams. If urinary stones do block the urinary tract this can lead to rupture of the urinary bladder, leakage of urine into the abdomen, and the fatal condition called "water belly".

To avoid all these problems it is recommended that 1.5 per cent of finely ground limestone be added when feeding cereal grains to sheep.

Trace element deficiencies are more severe in foetuses and young animals. Newborn lambs, pre-ruminant lambs, and weaned lambs may not get enough trace elements for optimum health and growth during seasonal deficiencies.

The trace elements most likely to be deficient in Western Australia are selenium, cobalt and copper. Selenium deficiency is most often encountered in winter and spring (in lambs and calves) and summer and autumn (in weaner sheep). Cobalt and copper deficiencies usually occur in spring, particularly in years with rapid pasture growth after good winter rains. Oral drenches and injectable products are available for the prevention and treatment of deficiencies of each of these elements, and intra-ruminal pellets are available for the prevention and treatment of selenium and cobalt deficiencies.

Adding selenium and copper to fertilisers used to top-dress pastures will prevent deficiencies of these elements in grazing stock. Selenium, cobalt and copper are all included in most mineral supplements. Selenium deficiency may cause nutritional myopathy ("white muscle disease") in young sheep, but the same condition can also result from a vitamin E deficiency. The actual cause needs to be determined to ensure the correct treatment is provided.

Copper deficiency in livestock may also result when copper in the diet appears to be adequate, but there are high levels of molybdenum and/or sulphur. The molybdenum and sulphur interact with the copper and make it less available for absorption from the digestive tract.

Vitamins

Vitamins of importance in ruminant nutrition are either fat or water-soluble. The fat-soluble vitamins include vitamins A, D, E and K and the water-soluble vitamins are those in the B group and vitamin C. Green pastures generally contain adequate levels of vitamins A, E and K for sheep and vitamin D is synthesised in the skin provided animals are exposed to enough sunlight.

Sheep usually synthesise enough vitamin C to meet their requirements and the microbes in the digestive tract are usually able to synthesise adequate amounts of the B-group vitamins. Cobalt is required for the synthesis of vitamin B_{12} by the rumen microbes and cobalt deficiency shows as a deficiency of vitamin B_{12} with the main effect being a disturbance in energy metabolism leading to reduced growth in young animals.

Vitamin A deficiency can occur after prolonged dry periods. Sheep need to eat green feed, such as weeds, for at least a day to get enough vitamin A to last for three months. Some feeds, such as subclover and lucerne, have higher vitamin A levels.

Thiamine (vitamin B_1) deficiency is usually caused by the presence of the enzyme "thiaminase", which is ingested in certain plants or is produced by microbes in the rumen. Thiaminase destroys the thiamine entering and produced in the rumen, and deficiency of this vitamin leads to the development of a neurological disease. A change to a high-grain diet may precipitate thiamine deficiency, and the condition has also been reported in sheep fed diets that have insufficient fibre to encourage good rumen motility.

Vitamin E, like selenium, has a major role as an anti-oxidant and the metabolic roles of vitamin E and selenium are interchangeable to some extent.

Sheep that have experienced reasonable lengthy periods on green feed and are only fed concentrated diets for short periods are unlikely to experience mineral and vitamin deficiencies. However, if young animals have only had a short period of access to green feed, or have been off green feed for more than three months, their body reserves are likely to be low.

Periods of rapid growth, pregnancy and lactation, generate high demands for minerals and vitamins and animals with low body stores may become deficient if they are not able to obtain all the vitamins and minerals they need from their feed source. Feed produced in high rainfall environments tend to have lower levels of vitamins and minerals because their concentrations are diluted in the fast growing plants.

PASTURE

Grazing Annual Pastures

Keith Devenish, Department of Agriculture, Northam and
Mike Hyder, Department of Agriculture, Albany

KEY MESSAGES

- Animal production is directly related to the quality and quantity of the pasture the animals graze.
- The estimation of 'feed on offer' (FOO) can be used as a guide to manage both pasture and animal production.
- For pasture, near-maximum seed production occurs when spring FOO exceeds 4000 kilograms dry matter per hectare. However, FOO of 1300 kilograms dry matter per hectare can provide enough seed to establish a good sub-clover pasture the following year.
- Near-maximum liveweight gain for sheep will occur when FOO is greater than 2000 kilograms dry matter per hectare. However, a FOO of more than 1100 kilo grams dry matter per hectare will still provide some liveweight gain.
- Sheep growth is directly correlated to the digestibility of pasture feed.
- Digestibility decreases considerably as a pasture matures.

Introduction

Annual pastures are the most important source of feed in the Mediterranean environment of the agricultural region of Western Australia. They consist mainly of grasses, broadleaf weeds and legumes. These pastures play an important part in the farming system as a feed source for the sheep meat enterprise. Annual pastures can be divided into high value green feed and lower value dry feed.

Digestibility

Digestibility is the most important characteristic of annual pasture because this influences the amount that a sheep can eat as well as how fast it will grow. Digestibility, expressed as a percentage, provides a prediction of the proportion of the pasture consumed that is actually used by the animal. In winter and spring, the digestibility of green feed is high (70 to 80 per cent) but this value declines rapidly as pastures mature and dry off. Once digestibility falls below 50 per cent, even adult sheep will not be able to maintain their weight.

Green feed

The growth rates of young or adult sheep during winter and spring should be in the vicinity of 1.5 to 2.0 kilograms per head per week once there is ample green feed available (or until they reach their peak weight according to their age). The supply of green feed is often limited at the start of the growing season and consequently the growth rate for sheep is low. The slow growth of pastures during June and July can be attributed to low levels of light, a low leaf area index, waterlogging and frosts.

Sheep feed is usually in abundance towards the end of the growing season and during the traditional spring flush. At this time, growth rates of sheep are as close to the maximum as possible.

Merino ewes rearing sucker lambs on subterranean clover based annual pasture at Pingelly.

Dry barley grass has a very low digestibility and feed value over summer.

Both the quantity and timing of rainfall events are major factors affecting pasture production. However, soil type, fertiliser application, grazing management and pasture species can also have a big influence on pasture growth. A rule of thumb is that 20 kilograms of pasture (weighed dry) per hectare should be grown per millimetre of growing season rainfall. The length of the growing season, and hence the period of green feed, can also be influenced by the position in the landscape, the soil type and locality within each respective rainfall zone.

The major production of sucker lambs is usually matched to the winter and spring period by selling lambs straight off the ewes during the green feed season. These sales are usually between June and October, with southern areas producing suckers into November. Those animals not sold as suckers are then weaned and are often shorn. During this period they will require additional management as they begin to graze on dry pasture feed.

Dry feed

For young sheep, a dry annual pasture with about 50 per cent legume content can only provide growth rates of one to two kilograms per head per month for one to two months, because it is only slightly above a maintenance ration. The rate of growth for weaners can vary considerably from December to April with the digestibility of dry feed being the main influence on animal growth.

The dry residues of annual pastures like sub-clover, medic, and serradella, along with weeds such as ryegrass and capeweed, usually have a digestibility of about 55 per cent at the start of summer. This level can vary considerably and will decline over time, especially after rainfall. Dry feed with a digestibility below 55 per cent will at best only maintain liveweight and supplementary feeding with grain will be required to finish animals being produced for meat. The period of high quality pasture can be extended by spray topping pasture with a knockdown herbicide in spring.

Case example

The results from a summer grazing trial conducted at Perenjori in 1996/97 provide a good example of the limitation of dry feed for young sheep. In this trial (see section "Increasing lamb growth on medic pasture cover cropped with lupins") crossbred weaner lambs in the control treatment grew at less than half a kilogram per head per week on a dry legume pasture (more than 80 per cent medic) from December to January. In this trial the quality of feed was good and had not been spoilt by summer rain. This result highlights the need to supplementary feed at this time to improve animal growth.

Supplementary feeding in summer

If growth rates of lambs or weaners are to be maintained during summer on annual legume pastures, then supplementary feeding will be required. A high quality grain, such as lupins fed at 100 to 400 grams per head per day, will help produce a reasonable growth rate for meat sheep (one kilogram per head per week). Another strategy may be to feed less grain and maintain liveweight during this period until crop stubbles, such as those from lupins, become available.

Weaning lambs

For prime lamb production (after the sucker stage), the first major setback can occur if the lambs are weaned as pastures dry off. During this critical time, grain should be fed to at least maintain the weight of the weaners and eliminate the setback. Weaners should be pre-trained while still on their mothers to recognise whatever grain is fed as a supplement. This usually means trail feeding the ewes and lambs two or three times before weaning so that the lambs recognise the grain as a feed source.

Feed On Offer (FOO) - an indicator for management

Grazing research has shown that estimating the amount of FOO is a useful indicator for the management of both pasture and sheep. It is expressed in kilograms of pasture dry matter per hectare. The technique of estimating FOO is a practical skill that can be readily learnt from a Woolpro or Prograze adviser (or livestock consultant) and can be used as a guide to predict sheep growth rates. Most of the work on FOO and sheep performance has been done with sub-clover based pastures.

The critical factor determining the production level of livestock grazed on pasture is the amount of pasture that animals are able to eat, otherwise known as intake. There is a *range* of FOO that can result in the desired intake and subsequent production for sheep. If FOO drops below a certain level, sheep are unable to consume sufficient pasture to maintain liveweight.

The Prograze manual suggests that once FOO is less than 1100 kilograms dry matter per hectare the rate of feed intake is reduced and sheep can only be expected to maintain weight or at best, make very slow weight gains (Table 1). Near-maximum feed intake for sheep occurs at around 2000 kilograms dry matter per hectare and there is no significant advantage allowing more than this amount of FOO for sheep.

Hence, as a general rule, the message is "*2 tonnes of feed is all they need*".

Table 1. Prograze feed on offer (FOO) benchmarks for sheep (kg DM/ha)

	Hoggets (35–40 kg)	Dry sheep (50–55 kg)	Pregnant ewes (50–55 kg)	Lactating ewes (50–55 kg)
Slow increase in liveweight	1000–1200	800–900	1000–1200	1200–1400
Near maximum increase in liveweight	1800–2000	1800–2000	2000–2500	2000–2500

Grazing management

Overgrazing of annual pastures in autumn can lead to a significant reduction in pasture seedling density, especially within the first 12 days after the break of season. As a result, the productivity of pastures during winter will be lower because there are fewer plants.

For sub-clover pastures, grazing to a FOO of at least 1100 kilograms dry matter per hectare during spring will ensure enough seed is set for the next pasture season. Near maximum seed-set occurs when FOO exceeds 4000 kilograms dry matter per hectare.

To maximise the seed set of sub-clover, the options are to:

- defer grazing pasture at the break-of-season until FOO is at least 500 to 800 kilograms dry matter per hectare;
- maintain winter pastures between 1500 to 2500 kilograms dry matter per hectare FOO;
- de-stock pastures when dry FOO has decreased to 1000 kilograms dry matter per hectare in summer/autumn

For aerial seeded species such as medic, serradella, biserrula and other clovers (eg balansa, Persian, rose), similar management will assist in long term persistence. The most important issue is to reduce grazing pressure at the start of flowering until seed maturity. Reduced grazing pressure is mainly required when FOO levels are less than 2000 kilograms dry matter per hectare.

Seasonal variability in annual pasture growth

The pattern of feed supply in different rainfall zones is shown schematically in Figure 1. The timing of the break-of-season has a large effect on the supply and the total dry matter production in each season. The reduction in growth during June and July occurs largely as a result of a lower amount of light energy being available for photosynthesis as well as low soil temperatures. Pasture growth tends to increase during August with the availability of more light energy.

Under conservative stocking regimes, large amounts of high-quality FOO accumulate during spring. Up to 75 per cent is lost after 'haying-off' (senescence) due mostly to natural decay. In other words, very little is eaten by grazing animals and turned into wool or meat products. Using more of this spring "hump" by combining grazing management and conservation techniques is one way to improve the productivity of pasture systems in a Mediterranean environment.

The variation in the timing of the break-of-season results in different amounts of FOO during winter (compare the amount of FOO in Figure 2 after the break in 1993 with that in 1994). The FOOs peak at different amounts in spring and then sharply decline over the following summer and autumn periods. Often only a small percentage of the accumulated FOO at the end of spring is converted into meat or wool.

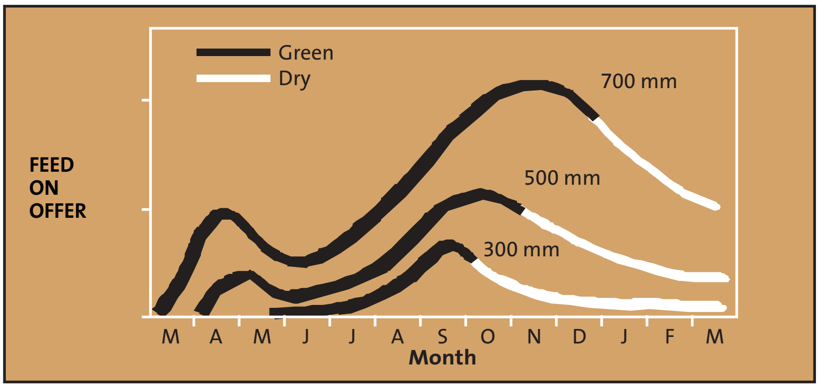


Figure 1. Schematic representation of green feed on offer or FOO, in low (300 mm), medium (500 mm) and high (700 mm) rainfall zones.

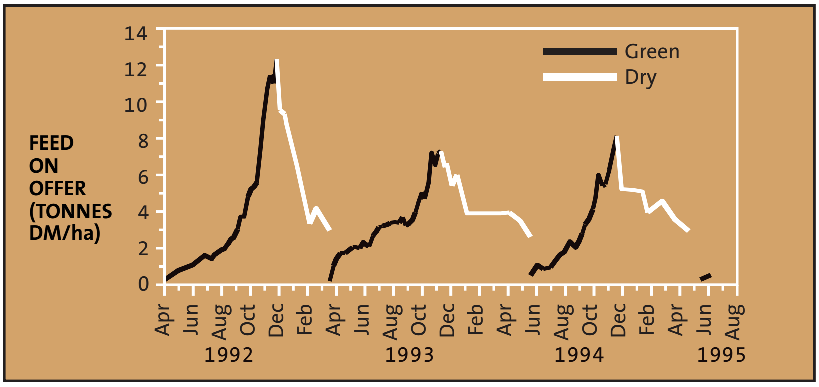


Figure 2. Feed on offer profiles (insects controlled) under district average set-stocking rate of 8 wethers per hectare at Mt Barker Research Station between 1992 and 1994.

Grazing management to control insects

Redlegged earthmite (RLEM) and other pasture pests (blue-green and cowpea aphid, lucerne flea, blue oat mite) can cause losses of up to 80 per cent of legume pasture seed if they are not controlled. This loss occurs when seedlings are killed early in the season and when flowers are damaged during spring.

Research has shown that grazing pastures to a FOO level of 1400 kilograms dry matter per hectare during spring reduces RLEM numbers considerably. The benefits from pest control in spring, whether by grazing management or correctly timed applications of insecticide (TIMERITE®, the Kondinin Group can provide information on this package), usually carry over to the following year.

Cropping

The adverse effects of cropping on pasture legume seed reserves are well documented. Seed loss after one year of cropping with relatively softer-seeded species such as sub-clover can be as high as 70 per cent while hard-seeded species such as medic and yellow serradella lose about 30 per cent of their seed reserves after one crop.

Sub-clovers are better adapted to longer pasture phases than medics. Medics and yellow serradella will persist better in intensive pasture-crop systems like the year-in year-out rotation.

Tactics for pasture management

There are a number of tactics that can be used during the season to manage the variation in the supply of pasture. These are described in the Woolpro or Prograze manuals, or alternatively you can contact your local Woolpro or Prograze adviser for more details.

Further reading

Hyder, M.W.; Thompson, A.N.; Doyle, P.T. and Tanaka, K. (1994). The effect of feed on offer during spring on liveweight change in Merino wethers of different ages. *Proceedings of the Australian Society of Animal Production* **20**:255-8.

PROGRAZE Sustainable Grazing Manual.

WOOLPRO Reference Manual.

Pastures in the Agricultural Area

Trevor Lacey, Keith Devenish and Clinton Revell,
Department of Agriculture, Northam

KEY MESSAGES

- The environment and the farming system determine how suited a pasture species is to a particular area.
- Pasture species vary widely in their seasonal pattern of feed production

There are environmental and management factors that determine where particular pastures will perform best, including length of growing season, soil pH, cropping intensity and water availability.

Self-regenerating annual pastures like sub-clover, medic and yellow serradella, are best adapted to intensive cropping systems.

Pasture systems are now evolving to include short periods of 'phase' pastures in between periods of continuous cropping. Phase pastures may also include self-regenerating annual species but the use of longer periods between crops also allows the use of perennial species such as lucerne.

Work through Table 1 to identify the pasture options that are best suited to your specific environment. For detailed variety recommendations see the Farm Budget Guide.

Table 1. Pasture options for different environments

Additional moisture availability	Soil types	Permanent pasture and phase pasture systems	Intensive cropping rotations
Yes	Light	Perennial grass, lucerne, tagasaste, blue lupins, serradella, biserrula, sub-clover, arrowleaf clover, warm season fodder crops	Serradella, sub-clover, biserrula, warm season fodder crops
	Medium	Lucerne, perennial grass, saltbush, sub-clover, serradella, biserrula, crimson clover, balansa clover, persian clover, warm season fodder crops	Serradella, sub-clover, biserrula, balansa clover, persian clover, warm season fodder crops
	Heavy	Lucerne, perennial grass, saltbush, medic, balansa clover, persian clover, warm season fodder crops	Medic, balansa clover, persian clover, warm season fodder crops
No	Light	Tagasaste, blue lupins, serradella, biserrula, sub-clover, arrowleaf clover	Serradella, sub-clover, biserrula
	Medium	Lucerne, perennial grass, saltbush, serradella, sub-clover, biserrula, crimson clover, balansa clover, persian clover	Serradella, sub-clover, biserrula, balansa clover, persian clover
	Heavy	Lucerne, perennial grass, saltbush, medic, balansa clover, persian clover	Medic, balansa clover, persian clover

Seasonal feed availability

In working out management strategies for sheep meat production it is important to consider the availability of feed during the year. As is shown in Table 2, there is considerable variation in the availability of feed for optimum production.

The suitability of the particular feed will vary with farm location and rainfall. The increased availability of moisture (ie summer rainfall, ground water discharge,) will increase the feed availability from perennials and warm season crops, but will adversely affect the quality of pasture residues.

Further reading

Maximum meat: the complete guide to producing quality sheep meat. Department of Agriculture. 1998.

Pasture legume recommendations. Farm Budget Guide, Farm Weekly.

Table 2. The seasonality of the availability of pastures as a source of feed for sheep

Pastures	Availability of feeds											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Annual pasture	**	**	*	*	*	***	***	****	****	****	***	***
Long season annual pasture (e.g. serradella)	***	**	*	*	*	***	***	***	****	****	****	***
Lucerne	***	***	***	***	***	***	***	****	****	****	****	***
Perennial grasses (summer-active)	***	***	*	*	*	*	*	*	***	***	****	****
Saltland pastures mix (halophytes, perennial grasses and balansa)	**	**	**	**	**	***	***	****	****	****	***	***

* *Low quality, low quantity - unlikely to provide maintenance.*
** *Low quality, high quantity - likely to provide maintenance for dry sheep only.*
*** *High quality, low quantity - likely to provide maintenance and a low growth rate (short period)*
**** *High quality, high quantity - most likely to produce maximum growth rate.*

Sandplain Lupins; a Good Feed for Lambs

Keith Croker, Stewart Gittins, Grant Doncon and Jeremy Allen, Department of Agriculture, South Perth

KEY MESSAGES

- Sandplain lupins are a cheap, nutritious source of feed for the summer/autumn period.
- Sandplain lupins can be grazed for three to four months at a stocking rate of 10 to 15 sheep per hectare, to achieve weight gains of up to 100 grams per head per day.
- Weaners need to be monitored closely for signs of lupinosis and if it develops they need to be taken off the lupins, grazed on other pastures and not be given lupin seed.

Sandplain lupins (also known as WA blue lupins) were accidentally introduced into Western Australia in the late nineteenth century. Since then they have become naturalised and grow on poor sandy soils in the West Midlands where it is difficult to get other productive pasture species to grow. These lupins are hard seeded, self-regenerating plants.

Available feed

Stands of sandplain lupins are very variable in mass and composition from site to site, and between years, but usually have high amounts of dry matter (more than five tonnes per hectare) at the start of summer. This material consists of lupin pods and stems, an understorey consisting of lupin leaf material, grasses, clover and weeds, and lupin seed. The seed has a high content of crude protein (about 32 per cent) and a high *in vitro* digestibility (about 80 per cent) but contains variable quantities of quinolizidine alkaloids that may give it a bitter taste.

Grazing potential

Grazing experiments over four consecutive summer/autumn periods (1994/95 to 1997/98) at Badgingarra demonstrated that sandplain lupins can be successfully used as a valuable feed for Merino weaners (see Figure 1).

Over the four-year period, the composition and density of the lupin stands varied considerably, but no significant rains were encountered during any of the grazing periods. In all years the weaners grazed the lupins for three to four months from early December. During three of the years, the weaners grazing at the lowest stocking rate (five per hectare) gained about 75 grams per head per day while on the lupins.

In December 1998, the performance of Border Leicester x Merino weaners grazed on sandplain lupins on a farm at Eneabba was monitored.

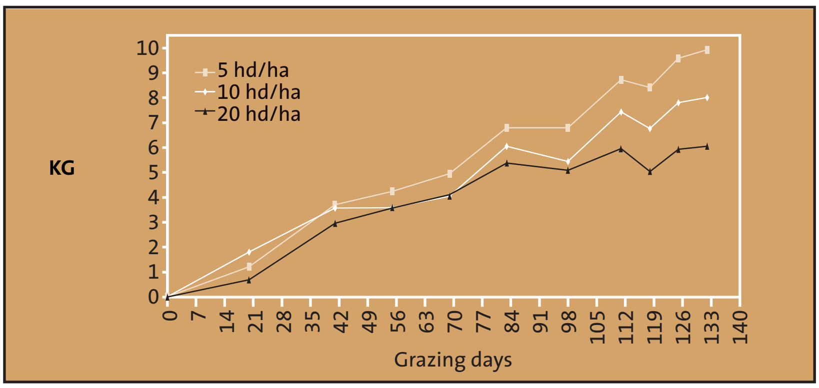


Figure 1. Liveweight gain of Merino weaners grazed on sandplain lupins at Badgingarra from early December 1997.

The paddock and sheep had been subject to the farmer's usual management practices during winter/spring. The weaners were put into the paddock at the beginning of December. The size of the flocks was adjusted to produce a stocking rate of 10 per hectare, which, based on previous results, was expected to enable reasonable growth over an extended period in summer/autumn.

The July-born weaners had been vaccinated at weaning against cheesy gland, pulpy kidney and tetanus. The vaccine contained selenium and the weaners were also given an injection of vitamin B_{12}. They were drenched with Ivomec® when put into the lupin paddock. The weaners started the grazing period with an average liveweight of 34 kilograms, and gained about 10.5 kilograms over the subsequent 105 days. This was a growth rate of about 100 grams per head per day (see Figure 2).

Ninety per cent of the weaners were sent to the Midland Saleyards at the end of grazing of the sandplain lupins (10 per cent were considered to have not reached a saleable weight). The sheep averaged 25.5 dollars per head.

This work has demonstrated that, in the absence of significant summer rain, crossbred weaners can make substantial gains in weight over three months while grazed on stands of sandplain lupins, during a period when normal paddock pastures cannot maintain significant rates of growth. This growth was obtained at a minimal cost using a feed resource that is often under-used or neglected.

Problems to avoid

It is important that sheep grazed on sandplain lupins be checked regularly, especially late in summer and autumn, to minimise the risk of the development of lupinosis, and to avoid overgrazing with the consequent exposure of the soil to wind erosion. If lupinosis develops in weaners, growth rates are greatly reduced. Regular checks enable the early detection of lupinosis, and the sheep can be taken off the lupins before losses occur.

The amount of material on the ground needs to be monitored so that the paddocks don't become a potential erosion risk.

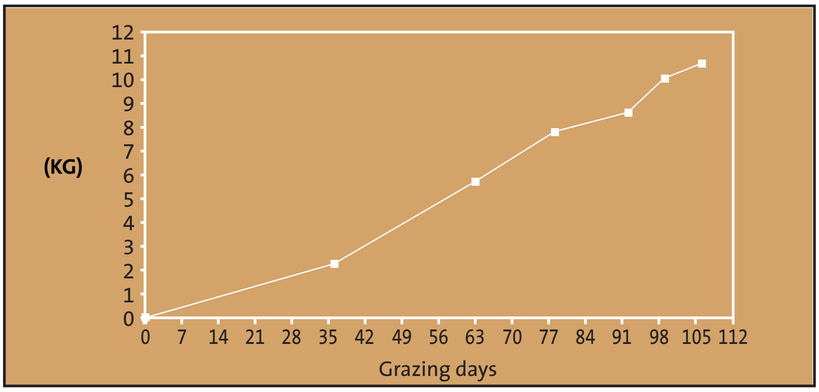


Figure 2. Weight gain of crossbred weaners grazed at 10 head per hectare on sandplain lupins at Eneabba from early December 1998.

Merino weaners grazing dry sandplain lupins at Badgingarra.

Moving the water point before the surrounding area is too bare will give better use of the feed while reducing the erosion potential.

Note: Sandplain lupins are very susceptible to the disease Anthracnose that has been evident in Western Australia lupin crops since 1996/97. Increasing prevalence of this disease in Western Australia is likely to reduce production from sandplain lupins. The expansion of the area of sandplain lupins and associated increased source of Anthracnose inoculum is not encouraged because this would increase the risk of disease in the white lupin industry.

Further reading

Blake, J. and Nelson, P. (1989). Sandplain lupins. *Western Australian Department of Agriculture Farmnote* 47/89.

Gittins, S.; Doncon, G.; Croker, K. and Allen, J. (1999). Blue lupins: a better use for an old feed. *Ovine Observer*, No. 8, Sep 1999.

Morcombe, P. (1989). The sandplain lupin: its nutritional value and grazing management. *Journal of Agriculture, Western Australia* ***30***, 108-110.

Grazing Saltland Pastures

Trevor Lacey, Department of Agriculture, Northam

KEY MESSAGES

- Animal production is directly related to the quality and quantity of the pasture the animals graze.
- Young sheep will gain weight on good, mixed saltland pastures containing annual pasture species but will usually lose weight on saltbush alone.
- Weaners will grow at up to 100 grams per day (0.7 kilograms per head per week) during summer without supplementary feeding on saltland pastures growing in areas with low salt levels and consisting of a good mix of halophytes and balansa and persian clovers.
- A good quality water supply with low salt content is required when grazing sheep on diets with high levels of salt as sheep will drink up to 7 litres per day.

Introduction

There is little information about the production of sheep meat from saltland pastures in Western Australia.

Saltland pastures are best referred to as a combination of:

- Perennial salt tolerant shrubs known as halophytes (eg. saltbush and bluebush) that have the ability to accumulate salt in their leaves; lower the water table; and alter the micro-environment to allow the establishment of other plant species, and;
- Perennial grasses and annual pasture legumes such as puccinellia, tall wheat grass, balansa and persian clovers. These perennial grasses and annual legumes provide the bulk of feed in saltland pastures and when green are preferentially grazed. For more information on annual pastures and perennial grasses refer to the sections in this book.

Costs of establishing saltland pastures

The costs associated with developing saltland pastures can be highly variable and largely depend on the amount of capital infrastructure required, such as fencing, water supplies and surface drainage, as well as the establishment costs of the new pasture species. The capital costs should be spread over the life of the saltland pasture when determining the total cost of establishing the pasture.

The capital cost of establishment is often high. However, there is little cost in the form of lost productivity, as most of this land is currently unproductive. Michael Lloyd, a farmer at Lake Grace, has estimated the costs for direct seeding saltland pasture to be 170 dollars per hectare (contract) or 55 dollars per hectare (sown by the farmer). The costs of fencing and providing water are additional.

Where to grow saltland pastures.

Saltland pastures are generally grown on land where salinity and waterlogging affect the production and profitability of salt-sensitive grain crops and pastures. The selection of species is dependent on rainfall, degree of waterlogging and level of soil salinity at each specific site. Areas of high salinity and waterlogging favour the

Old man saltbush growing in a saline and waterlogged area in Cuballing.

poorer quality and more salt tolerant species such as the saltbushes. These areas are not well suited to high-quality stock feed such as balansa and Persian clovers and the grasses; tall wheat grass and puccinellia. However, often the establishment of the more salt tolerant species will lower the water table sufficiently to allow leaching of salts and the subsequent establishment or colonisation by less salt tolerant species with higher grazing value.

Grazing management

Saltland pastures need to be managed to protect the range of species in the stand. Where there is a mix of both perennial and annual species the requirements of each need to be considered. The balansa component of the pasture will be dependent on the availability of seed and fertiliser and may require the control of insects. Therefore, saltbush plantings will need to have row spacing wide enough to allow access for vehicles to apply fertiliser and insecticides.

Rotational grazing is recommended for the long-term persistence of perennial plants. This should be combined with reduced grazing during flowering periods of balansa and persian clover, along with a period of heavy grazing during summer and autumn to remove the bulk of dry matter and help increase the seed softening process. All this is required whilst leaving leaf on the halophytes to increase water use.

Quantity of feed and its availability

The saltbush component of saltland pastures produces relatively low levels of digestible material. A three-year trial at Katanning with four varieties of saltbush showed that saltbush had an average annual yield of leaf and fine stem material of less than 500 kilograms of dry matter per hectare. In this trial, the bulk of the feed came from the poor-quality annuals such as barley grass, and other salt-tolerant natural species present, in addition to the planted perennial grasses.

The bulk of feed available from saltland pastures will usually be from late autumn through to early summer. Additional feed from the perennial grasses and perennial salt-tolerant shrubs (for example, saltbush and bluebush) may be available during the summer and autumn, but this depends on the availability of moisture.

The value of this perennial feed during summer and autumn is very high compared to that available at other times of the year. These pastures may offset the need to supplementary feed stock through the autumn, and thus enable grazing to be deferred on newly germinated annual pastures. In this way, higher stocking rates can be used across the whole farm.

Quality (energy, protein and digestibility)

Grazing trials at Katanning have shown that saltbush alone is of limited value because high salt concentrations reduce the dry matter intake and digestibility of the material. The quality of this material may vary depending on the salinity of the site and the occurrence of rainfall that allows salt to be washed from the leaves.

Mixed sward of Balansa and Persian clover growing on a winter waterlogged but not excessively saline area.

The quality of the pastures can be improved by planting other grass and clover species in the inter-row. For example, puccinellia and tall wheat grass have higher digestibility, lower salt levels and higher animal intake than saltbush, but they are not high quality feeds. Balansa and Persian clovers have a higher quality even when dry. However, the salt content of balansa can be high and this will reduce sheep intake when it is grown on severely salt affected land.

Sheep meat production from unimproved saltland pastures (for example, halophytes and barley grass) is rarely high. At best these pastures will provide maintenance diets, certainly for young sheep, but usually these sheep lose weight on saltbush pastures. Improved saltland pastures with good balansa and Persian clover as a significant proportion of the mix will grow weaners at up to 100 grams per day (0.7 kilograms per head per week) over summer without supplementation. However, to do this the clovers need to be grown on areas with low salt levels in the soil, although these areas may be prone to winter waterlogging.

Economic returns

The returns from meat production on saltland pastures have not been well established and will vary from case to case. The best returns are likely to be obtained where substantial increases in stocking capacity are achieved through the conversion of very low performing land to land with a much higher production level and in the reduction of some supplementary feeding costs. Capital costs such as fencing and the provision of additional water points associated with the use of saltland pastures can often determine the profitability of these pastures. Where high quality annual pasture and perennial grasses are a significant part of the pasture, returns from meat production are similar to that obtained on normal annual pastures.

Michael Lloyd, a farmer at Lake Grace, estimated the gross margin for a wool enterprise based on a saltland pasture at about 75 dollars per hectare.

It has been noted that there is a positive effect on the flavour of meat produced from sheep grazing saltland pastures. As a result of this effect, there have been attempts to market meat produced on saltland pastures as a high-value premium product. However, a significant and reliable market for this type of meat has yet to be developed.

Provision of good quality water

High levels of salt in saltbush pastures cause sheep to drink up to seven litres of water per day, twice the water consumption by sheep on low salt diets. This means that there needs to be a plentiful supply of good quality water when sheep are grazed on any saltland pastures.

Further reading

Barrett-Lennard, E.G. (1998). “Halophytes or plants for saltland”. Soil Guide. Department of Agriculture, Bulletin No 4646.

Barrett-Lennard, E.G. and Malcolm C.V. (1995). “Saltland Pastures in Australia – A Practical Guide”. Department of Agriculture, Bulletin No 4612.

Warren, B.E.; Casson, P.A. and Barrett-Lennard, E.G. (1995). “Value of saltbush questioned”. *Journal of Agriculture, Western Australia* ***36***: 24-27.

Dryland Lucerne Grazing Systems

Trevor Lacey and Keith Devenish,
Department of Agriculture, Northam

KEY MESSAGES

- Lucerne grows in a wide range of environmental conditions and soil types throughout Western Australia.
- Lucerne can produce feed with a quality and quantity equal to or better than sub-clover, and will provide green feed for a longer period.
- Green feed is generally available from April to December and at various periods throughout summer and autumn depending on moisture availability.
- Lucerne has produced growth rates for one-year-old sheep of 1.3 to 1.75 kilograms per head per week.
- The use of lucerne offers an opportunity to finish meat sheep out of season for premium markets.

Costs of establishment

Establishing lucerne in the Western Australian wheatbelt has been commonly quoted at costing between 80 to 100 dollars per hectare. This cost can be spread over the life of the lucerne stand, or the length of the lucerne phase in a lucerne-crop rotation. It is often accepted that the costs of lucerne establishment can be spread over the period for which benefits are derived within the cropping phase. Therefore, in a four-year lucerne phase, the cost of establishment can be calculated to be 20 to 25 dollars per year of the rotation. The cost of establishing lucerne is comparable to that of establishing a good legume-based annual pasture.

Where to grow lucerne

Lucerne requires at least 250 millimetres annual rainfall to persist. Data from Pingrup (320 millimetres rainfall) found that lucerne produced 4 to 6 tonnes per hectare of dry matter per year, which was equal to or greater than that for a sub-clover pasture. The level of production achieved with an annual rainfall less than 320 millimetres has not been well defined. Lucerne grows on a range of soil types and pH (see the bold in Figure 1), but is best suited to well-drained soils with a pH between 4.8 and 8.0 ($CaCl_2$).

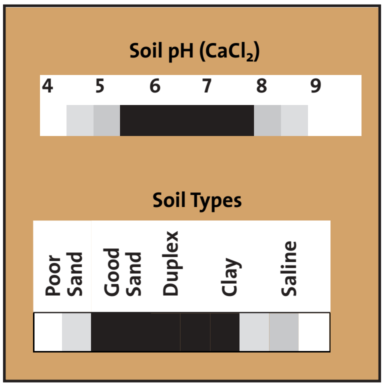


Figure 1. Soil suitability for lucerne.

Lime should be applied at one to two tonnes per hectare where soil pH is between 4.8 to 5.2.

It should be noted that Figure 1 is only a guide to where lucerne performs best and there are cases where lucerne is growing outside these recommendations for soil type and pH.

Winter active varieties of lucerne are preferred for dryland sowing in Western Australia. They have good fodder qualities and the persistence of the stand is adequate for a four to five year lucerne pasture phase.

Lucerne will grow on moderately saline soils. However, production is affected at relatively low levels of soil salinity, especially when it is compared to a crop such as barley (see Table 1). Barley has more salt tolerance than wheat and is often grown by farmers on soils that are marginal for grain crops due to salinity levels. This knowledge will help when deciding where to grow lucerne. As a comparison, lucerne can have a loss in production of more than 50 per cent at a soil conductivity of 90 milliSiemens per metre compared to a loss in barley production of five to ten per cent.

Grazing management strategies for lucerne.

For best results, lucerne should be rotationally grazed if it is to persist in a grazing system. For sheep, the grazing rotation can vary from a three paddock system (lucerne grazed for three weeks and rested for six weeks), to a six paddock system (lucerne grazed for one week and rested for five weeks). Stocking rates are adjusted so that the dry matter is reduced to similar levels by the end of each grazing period (grazed to a height of one to two centimetres or about 400 kilograms dry matter per hectare). The resting or ungrazed period enables lucerne to replenish its root reserves, helping to maximise production and allowing the pasture to survive over the dry summer months.

Extending the grazing periods and reducing the resting periods are possible under some favourable growing conditions and at lower stocking rates, or where there is additional feed available in the paddocks from other pasture species (although this may be at the expense of total production). However, adopting this practice in less favorable conditions may severely affect the lucerne production by reducing plant numbers or weakening plants (with subsequent plant growth reduced for the following six to 12 months).

Table 1. Production losses (per cent) in lucerne and barley with increased levels of salinity

	Soil conductivity (EC 1:5 (w/v)mS/m) 20	40	90	150
Lucerne	0%	15 –20%	> 50%	100%
Barley	0%	0%	5 –10%	35 – 45%

Adapted from Stanley and Christinat (1994)

Crossbred lambs grazing lucerne at Buntine in April.

Availability and quantity of feed produced in a season

For an average rainfall season, lucerne will provide green feed earlier in winter and extend the availability of green feed at the end of the growing season compared to annual pasture. In the medium rainfall regions of the central wheatbelt, it is common to graze lucerne into December during a season with average rainfall.

The amount of summer (January to April) feed production depends on moisture availability from either summer rain or from stored soil moisture. Lucerne can rapidly convert summer/autumn rainfall into high-quality green feed whereas summer rain will reduce the quality of dry feed and can cause a “false break” of annual pastures.

The quality of feed available from lucerne remains relatively constant throughout the year.

A typical pattern of lucerne availability in the 350 millimetres rainfall zone is shown in Figure 2. This depicts the rotational grazing pattern suggested for a paddock of lucerne. The solid lines show the cumulative amount of pasture dry matter available in kilograms per hectare of feed (on offer) for an average season. During the months between January and April the level of feed on offer is extremely variable with significantly more feed in a year with a wet summer, or when soil moisture is not limiting.

The broken line in Figure 2 represents a two-week period of grazing where the total feed available in the paddock is reduced to about 400 kilograms dry matter per hectare. A consequence of this rotational grazing pattern is the requirement for a number of lucerne paddocks or alternative sources of good quality feed, to maintain production levels.

Lucerne pastures are capable of producing levels of total biomass comparable to or better than good annual pasture (eg. sub-clover) over a 12-month period. But the lucerne plant material is considered to be of much higher feed value due to its summer/autumn production.

Farmer experience in the wheatbelt suggests that the total carrying capacity on lucerne pastures is equal to, if not better than, good clover-based annual pastures. The difference is that the longer period of green lucerne feed during the late autumn/early winter and late spring/early summer periods, can achieve growth rates for sheep as high as those obtained during the winter green feed period. In addition, the summer/autumn production greatly increases in response to summer rainfall. The significance of these attributes to sheep meat production is the flexibility to turn stock off into high priced markets either early or late in the normal growing season.

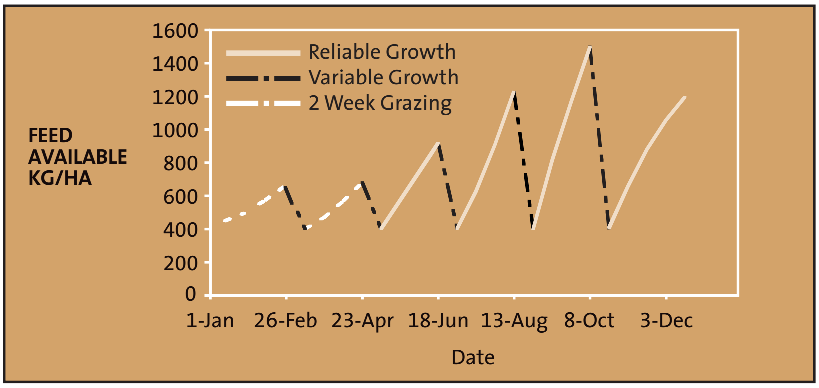


Figure 2. Predicted feed availability profile for an established stand of lucerne in the 350 to 400 mm annual rainfall zone.

Lucerne feed quality

Lucerne provides high quality feed for grazing animals. It is highly digestible (about 65 per cent) and is a reliable and economic source of crude protein (12 to 24 per cent) with good levels of metabolisable energy (8 to 11 megajoules per kilogram dry matter).

Stocking rates

Trials in the wheatbelt have demonstrated that lucerne can support average district stocking rates while providing additional green feed after annual pastures have matured. Farmer experience shows that lucerne is a high quality source of green feed as long as it is grazed for short periods of two to six weeks. Set stocking is not advisable for dryland lucerne because sheep will constantly select and graze the lucerne plants, thus reducing their vigour.

Sheep have been successfully grazed on farms at Morawa and Mingenew on a three-paddock system for three-weeks-on and six-weeks-off (see Morawa case study at the end of this section). Other farmers with only one paddock of lucerne have used two to four times the normal stocking rates for one to three weeks at a time. The main issue is to rest the lucerne from the intensive grazing because sheep will selectively graze the lucerne plants due to their high digestibility and palatability.

Table 2. Sheep growth rates on dryland lucerne at three sites in the wheatbelt using a three-paddock system

Location	Grazing period	Stocking rate *(hd/ha)*	Initial weight *(kg)*	Final weight *(kg)*	Grazing days	Weight gain *(kg/hd)*	Weekly growth *(kg)*
Morawa	Sep-Nov'99	6	45.5	59.0	84	13.5	1.13
Mingenew	Jul-Sep'00	10	45.0	58.5	66	13.5	1.43
Dandaragan	Feb'00	12	–	–	18	4.5	1.75

Sheep growth rates

Growth rates of more than one kilogram per week can be expected from sheep grazing on dryland lucerne. Growth rates of 1.13 to 1.75 kilograms per head per week have been measured at three wheatbelt sites in Western Australia (Table 2). The sites all had a three-paddock system. Stocking rates have been averaged over the three paddocks.

Thirty-four 12-month-old Merino wethers were used at the Morawa Lucerne Research Site (see the following case study) where they were grazed on a rotational basis in a three-paddock system (three weeks on, six weeks off). They were grazing from 2 June 1999 until 15 January 2000 at an average stocking rate of almost six head per hectare over the entire site (17 per hectare for three weeks at a time). However, their weight was only measured from 7 September (after they were shorn) to 30 November. A growth rate of 161 grams per head per day (1.13 kilograms per week) was measured for the period.

On a farm near Mingenew, the same rotation produced a growth rate for one-year-old mixed sex Merinos of 204 grams per head per day (1.43 kilograms per week) measured from July to September 2000. At a third site near Dandaragan, 12-month-old Awassi ram lambs were grazed on lucerne from 11 to 29 February 2000, and a growth rate of 250 grams per head per day (1.75 kilograms per week) was measured for this period.

Economic value of lucerne

A high value animal feed such as lucerne should be matched to a high value grazing enterprise such as prime lamb production. The green feed from lucerne can be saved, by de-stocking for extended periods while the lucerne dry matter increases, until the early summer period (October/December), late autumn (April/May) or whenever considerable summer rain is received.

Landcare considerations

Lucerne is a herbaceous perennial plant that develops a deep root system and has a greater ability to dry out the soil profile than an annual crop or pasture species. For this reason lucerne is being evaluated as an option for farmers as a part of a "low recharge farming system" that will help to reduce recharge to water tables and the subsequent development of secondary salinity.

It is expected that the area of lucerne currently being grown in Western Australia will increase over the next five to ten years. AGWEST lucerne researchers Roy Latta and Keith Devenish have estimated that almost 400 farmers seeded lucerne in 2000, many for the first time. The indication is that the area established to dryland lucerne in Western Australia is at least 50, 000 hectares and could be as high as 75, 000 hectares. The increase in the area of lucerne has grown at about 50 per cent each year since 1995, when there were only 5000 hectares established to lucerne.

Other special considerations

- Bloat in sheep grazing dryland lucerne stands in Western Australia has not been commonly reported (see section on animal health); it is mostly associated with cattle.
- Enterotoxaemia (Pulpy Kidney) may cause animal losses on dryland lucerne as is the case on many other high quality feeds or grain supplements. Cattle and sheep should be vaccinated against enterotoxaemia.
- Red gut and nitrate poisoning are minor problems that may occur on lucerne, but they have not caused significant problems on dryland lucerne in Western Australia.

Further reading

Devenish, K.L.; Rogers E.S. and Rogers, D.A. (2000). Agriculture WA, "Trial and Demo Reports 2000", Northern Agricultural Region", pp 195 – 196.

Farmnote No.4/98. Dryland lucerne – establishment and management.

Stanley, M. and Christinat, R. (1994). "Success with dryland lucerne", 1.2-6. Printed by Open Book Publishers, Adelaide.

Merino wether hoggets grazing lucerne at the Morawa Agricultural College in March.

CASE STUDY - MORAWA DRYLAND LUCERNE TRIAL

Keith Devenish, Department of Agriculture, Northam

- Lucerne provided an extra three months of green sheep feed after the end of spring.
- Sheep gained weight at 1.13 kilograms per week between September and November.
- An opportunity exists to finish prime lambs on lucerne for the December/January market.

Site details

A lucerne trial was established at the Morawa Agricultural College in 1998 to evaluate the potential of lucerne in the low rainfall region of the northern wheatbelt. Pioneer L69 lucerne was sown on 2 June at five kilograms per hectare. During the first 12 months the lucerne was crash grazed for short periods in October, December, March and April. The six-hectare area was then fenced into three, two-hectare plots.

Grazing details

Thirty-four Merino wether hoggets (12 months old) were grazed on the site during the second year from 2 June 1999 to 15 January 2000 on a rotational system of three-weeks-on and six-weeks-off. The stocking rate during the grazing period was 17 sheep per hectare, producing an average stocking rate over the entire site of almost six sheep per hectare.

The sheep were shorn in September and then weighed every three weeks until 30 November. However, the site was grazed until 15 January. A significant fall of rain (37 millimetres) was received at the end of January 2000 so the sheep were grazed on the lucerne again for four weeks in February. More rain was received in March (79 millimetres) and the plots were ready for grazing by the beginning of April. The summer of 1999/2000 was abnormally wet and so in a more normal summer the availability of feed would be lower.

Results

The average liveweight after shearing was 43 kilograms, condition score 2.9. By 30 November the average weight had increased to 59 kilograms and the condition score to 4.6 (this is an exceptionally high condition score and suggests that the stocking rate was too low). The growth rate during this period was 161 grams per day (1.13 kilograms per week). The annual species component of the pasture had senesced by early September.

Conclusions

This was one of the first trials of sheep grazing lucerne to be conducted in Western Australia. The results indicate that lucerne can provide green feed for several weeks longer than annual pastures in late spring/early summer. They also indicate that farmers can expect sheep to grow at a minimum of one kilogram per head per week while grazing lucerne.

Tagasaste (Fodder Shrub)

Tim Wiley, Department of Agriculture, Jurien Bay

KEY MESSAGES

- Tagasaste grows well on deep poor sands where annual crops and pastures struggle.
- Tagasaste is only of moderate quality in autumn and animals need lupin supplements during this time to grow.
- Tagasaste can be set stocked with cattle, but only grazed for up to six weeks at a time with sheep.

Soil types for tagasaste

Tagasaste grows best on freely drained, deep soils such as sands and deep gravels. Tagasaste is well suited to the poor deep sands of Western Australia. It will not do well on shallow soils or where there is waterlogging.

Soil acidity

Tagasaste grows best on soils with a pH between 4 and 7.

Salt and waterlogging tolerance

Tagasaste has a nil tolerance of salt or waterlogged conditions.

Rainfall zones

Tagasaste grows successfully in areas of 300 to 1000 millimetres of annual rainfall.

Cost of establishment

It costs about 100 dollars per hectare to establish tagasaste. This cost varies depending on plant and row spacing, and the insect and vermin control required. There are often additional costs for re-fencing paddocks and providing new water points.

Grazing management

- Tagasaste should be only lightly grazed during the first two years. Once mature, tagasaste performs best with well managed, hard grazing.
- Tagasaste can be completely stripped of all leaves by intensive grazing with sheep as long as it is then allowed to recover.
- While tagasaste can be heavily grazed by sheep for up to six weeks without causing damage, it should not be set stocked by sheep for extended periods as they damage the new shoot buds and can kill plants.
- Cattle can continuously graze tagasaste because unlike sheep, they do not remove the new shoot buds.
- Tagasaste must be hard grazed and/or cut at least once in the first six months of each year. This prevents the plant flowering during the following spring. Flowering results in the leaves being dropped, a slowing of plant growth and a decline in palatability over the following summer.
- Tagasaste requires mechanical cutting if it is allowed to get beyond the reach of the animals grazing it (sheep can only graze up to about 1.2 metres). Cutting will cost about 40 dollars per hectare provided it is cut soon after reaching its permissible height.
- Tagasaste can be grazed at any time of the year. However, the feed quality is best in winter and poorest in autumn.

Feed availability

In the West Midlands, tagasaste can produce between three and five tonnes of dry matter per hectare per year. Highest production will be achieved with good rates of superphosphate (200 to 300 kilograms per hectare per year) and on sites with perched watertables.

Mature flowering tagasaste on deep sands near Goomalling.

Very good production can be achieved in low rainfall areas when tagasaste is situated above sandplain seeps.

While tagasaste is a true perennial and grows year round, there is a distinct seasonal pattern of growth and feed quality. Tagasaste growth peaks in spring and is lowest at the end of autumn. Tagasaste responds quickly to summer and autumn rain. Cold weather and frost slow tagasaste growth in winter.

Feed quality

Fertiliser trials have consistently shown that high rates of phosphorus fertiliser are required for maximum animal growth rates. At the Dunmar Research Station, Badgingarra, an extra kilogram of liveweight per hectare was gained from cattle with every extra kilogram of superphosphate per hectare applied (up to 300 kilograms per hectare). At this site the tagasaste feed production peaked with less than 200 kilograms per hectare per year of superphosphate. Animal production improved with even higher rates of fertiliser (Figure 1).

This occurs because phosphorus fertiliser improves the feed quality of the tagasaste resulting in an increased feed intake by the animals. Similar results were seen at this site when sheep grazed the trial. While growth rates of both sheep and cattle were minimal in autumn, the higher rates of superphosphate meant that animals were still gaining weight slowly rather than losing weight.

In tagasaste, protein, digestibility and most minerals are highest in winter and spring and then gradually decline over summer. During winter and spring, tagasaste is of very good quality and animal growth rates are as good as on any other green feed. No supplements are required at this time of year.

Over summer and autumn the feed quality gradually declines. By late autumn animals on tagasaste will only be maintaining condition. At this time of year protein is the limiting factor for animals despite it never dropping below 14 per cent in the tagasaste leaf. Phenolic compounds are thought to inhibit animal intake and growth rates in autumn.

Trials and farmer demonstrations have shown that supplements with a good protein source (such as lupins) will boost animal growth rates in autumn.

Supplementation of stock grazing tagasaste with lupins produces a very efficient feed conversion ratio of 4 to 1. That is, one kilogram of liveweight gain is achieved for each four kilograms of lupins fed.

In autumn, mineral concentration in the edible fraction of tagasaste can drop below levels considered necessary for grazing animals. If animals are required to make growth in autumn, supply a well-balanced salt-based mineral lick.

Occasionally tagasaste will not be palatable to sheep in autumn. Reasons for the variability between paddocks and seasons are not clear. However, it has been found that palatability is improved if tagasaste is cut mechanically and left to dry for several days.

Out of season prime lambs

In a 1997 experiment at Dunmar Research Station, Merino ewes that lambed in March (Merino x Polled Dorset lambs) were grazed on tagasaste in the short 'broccoli' form until late July without supplementary feeding. The lambs grew at 228 grams per head per day during that period

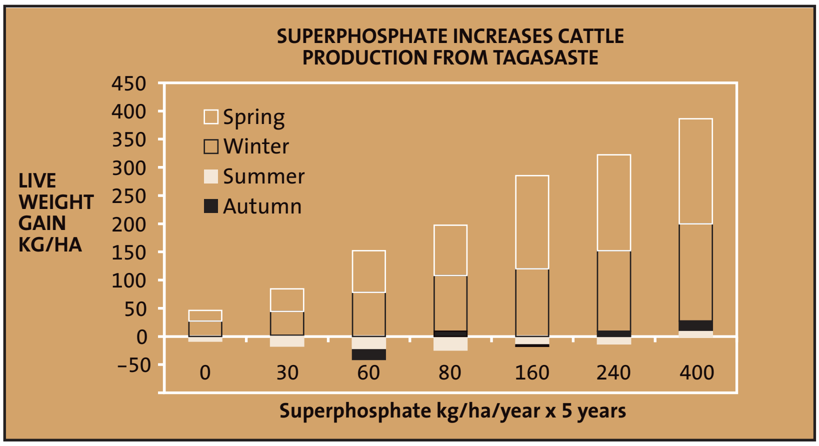


Figure 1: Liveweight gains of cattle grazing tagasaste grown with increasing rates of superphosphate on new land at Dunmar.

while still on their mothers. (This rate of liveweight gain is similar to those on annual pasture). In a similar experiment where the lambs were dropped in December they gained only 100 grams per head per day to July.

Tagasaste cutter.

Returns from tagasaste

Trials conducted for the Martindale Research Project, found that 100 sheep could be fed for 30 to 40 days on tagasaste that had been locked up for 11 months. This was equivalent to a year round average of eight to ten DSE per hectare per year. This is a considerable improvement for these poor sandy soils that previously carried only one to two DSE per hectare per year with annual pastures.

However, in the trials detailed above, the sheep grazing tagasaste usually only maintained weight in autumn. Lupins are required to enable sheep to grow out at this time of year. One kilogram of lupins should result in 0.25 kilograms of liveweight gain. Therefore, if lupins are costed at 200 dollars per tonne, then an extra kilogram of liveweight gain can be achieved at a cost of 80 cents.

If tagasaste is grazed in winter or spring, no supplements are required to grow animals out. Growth rates of animals on tagasaste in winter and spring are similar to those on good annual pasture. This was seen in trials at the Badgingarra Research Station even when all the inter-row pasture was sprayed out and the animals only had tagasaste.

A whole farm analysis based on performances on the Dunmar Research Station has shown that tagasaste is profitable when it is used to replace supplementary feeding of sheep with grain in autumn. The analysis was done on a self-replacing Merino flock. In the analysis, the whole farm profitability was very sensitive to wool price. However, at any wool price it was profitable to have ten per cent of the farm sown to tagasaste to replace the need for supplementary feeding (see Figure 2).

Species

Tagasaste is a cross-pollinating species and the seed is therefore a genetic mix. There are no true commercial 'varieties' of tagasaste.

Landcare benefits

On deep soils (ten metres) tagasaste can use all the season's rainfall, thereby lowering water tables. Where tagasaste can tap into a perched, fresh watertable it can use twice the average rainfall.

Further reading

Angell, K. and Glencross, R. (1993). Tagasaste and *Acacia saligna* establishment using bare-rooted seedlings. Department of Agriculture, Bulletin No. 4262.

Lefroy, E. C.; Oldham, C.M. and Costa, N.J. (1997). Tagasaste *Chamaecytisus proliferus*. Proceedings of a workshop to review tagasaste research in Western Australia. Centre for Legumes in Mediterranean Agriculture (CLIMA). Occasional Publication No. 19, CLIMA, Western Australia.

Wiley, T.; Oldham, C.; Allen, G. and Wiese, T. (1994). Tagasaste. Department of Agriculture, Bulletin No. 4291.

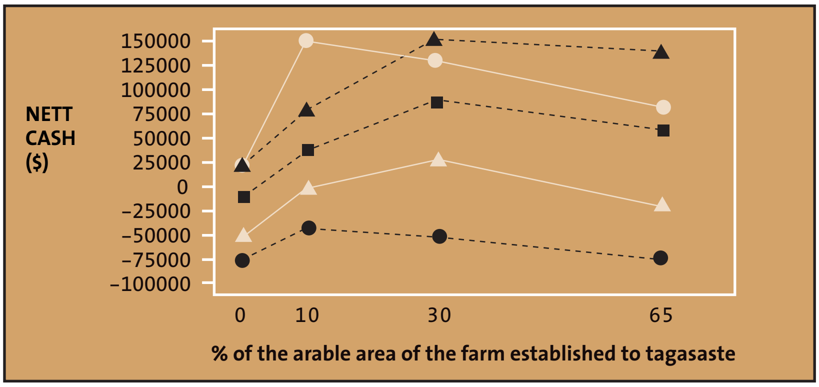


Figure 2: A comparison of the analysis of the MIDAS model output comparing the net cash returns from farms with zero, 10%, 30% or 65% of their arable area as tagasaste in 1989 ● and 1991 ▲ at a wool price of 935 cents per clean kg. The analysis in 1991 also included the influence of a range in the price of wool, 406 cents ●, 582 cents ▲, 759 cents ■ and 935 cents ▲ per clean kg. The major assumptions in the 1991 analysis were, tagasaste ration grazed = 6000 sgd/ha in autumn, tagasaste grazed 7 days per week in all other situations = 3000 sgd/ha, no cropping and net cash ($) does not include interest on the investment in tagasaste

Native Perennial Grasses in Permanent Pastures

Roy Butler, Department of Agriculture, Merredin

KEY MESSAGES

- In the south west of Western Australia, there are over 100 native grass species, most of which are perennial.
- Little is known about the agricultural suitability and performance of most of these grasses.
- The summer-active native species in particular could be useful components of permanent or long rotation pastures.
- From limited information, it seems that moderate growth rates, of 100 to 200 grams per head per day, could be expected of crossbred sucker lambs on native-grass dominant pastures.

*Curly windmill grass (*Enteropogan acicularis*) at Merredin in April.*

There has been a resurgence of interest in perennial plants suitable for permanent or long-rotation pastures. The perennials that are particularly desirable are those that will grow in summer, reducing recharge and possibly lowering water tables. For sheep, summer-active perennials supply green, nutritious feed when most annual pasture plants are dead and of low nutritional value. Summer-active perennials can fill or part-fill the summer-autumn feed gap, thus reducing supplementary feed costs. If there is sufficient summer rain or suitable ground water, stock might be finished for sale solely on pastures containing summer-active perennials.

To date, the perennial plants attracting most interest for use in pastures are introduced species. These are comprehensively covered in the publication "Perennial grasses for animal production in the high rainfall areas of Western Australia" (see 'further reading' section for details) and so are not covered by this reference. However, some native perennial grasses are also worthy of consideration and so provide the focus of this chapter. They are adapted to our climate and our generally poor soils, and some appear to be both palatable to and safe for stock. However, these are early days in the study of our native grasses, and in particular their possible agricultural benefits.

Feed quality

The following table shows the analyses for feed quality of three species of native perennial grasses that are summer-active and growing on farms in the eastern wheatbelt. These particular grasses can be quite palatable and nutritious, depending on plant maturity and soil conditions. The samples were collected in summer when the plants were probably nutritionally at their best, that is, leafy, green, and growing vigorously.

How well will lambs grow on pastures containing native grass species? This depends on the plant species, density and stage of growth, and soil conditions, as well as animal and pasture management. The following case study suggests that lambs will probably grow at moderate rates (100 to 200 grams per head per day), especially if there is above average summer rain. Supplementation will be necessary in dry summers, and if higher growth rates are required.

Case study - Crossbred lamb production on native perennial grass based pasture.

Roy and Judith Butler run a small crossbred flock on a farm near Merredin. The permanent pasture is dominated in summer by native perennial grass species, especially windmill grass *(Chloris truncata)* and curly windmill grass *(Enteropogon acicularis)*, with some leafy nine-awn *(Enneapogon polyphyllus)*. The sheep are run as one mob, with a ram, throughout the year.

As with other perennial pasture species, careful management of native grasses is essential, especially in summer and autumn. Rotational grazing is practised with rest periods to allow seed set and recovery from defoliation.

The summer of 1999/2000 was one of the wettest ever experienced in the district. The growth of windmill grass, in particular, was exceptional. The stocking rate over the summer was approximately 2.8 DSE per hectare. In early February, the total food on offer (FOO) was 2300 kilograms dry matter per hectare and the green FOO was 1300 kilograms dry matter per hectare. Over summer, the sheep received a small lupin supplement of approximately 30 grams per head per day.

The autumn and winter of 2000 were also unusual, with a late break and a poor germination and subsequent growth of annual grasses and legumes. Windmill grass and curly windmill grass continued to grow through the winter, although they are regarded as summer-active species. Two winter-active native perennial species – a spear grass *(Austrostipa* species*)* and a wire grass *(Aristida* species*)* – became prominent in the pasture during the winter. The sheep were supplemented with an average of 64 grams per head per day of lupins from April to the end of July, when supplementary feeding ended. The stocking rate climbed steadily through the winter to a peak, in early September at approximately 4.3 DSE per hectare.

Figure 1 shows the moderate, average monthly growth rates of sucker lambs born in 1999 and 2000.

A mixed sward of native perennial pastures at Merredin in April.

Table 1. Feed quality of some summer-active native perennial grasses, sampled in January/February 2000

	Curly windmill grass	Windmill grass[1]	Windmill grass[2]	Leafy nine-awn
Moisture (%)	29.8	73.8	60.2	74.5
Dry Matter as received (%)	70.2	26.2	39.8	25.5
Acid Detergent Fibre (%)	32.9	33.6	33.1	35.3
Dig. Dry Matter (%)	66.0	63.4	61.2	62.1
Est. Metabolisable Energy (MJ/kg DM)	9.6	9.1	8.8	8.9
Crude Protein (%)	19.6	14.2	10.4	15.0

1 *From ungrazed, continuously cropped, fertilised, no-till paddock.*
2 *From intermittently grazed, unfertilised paddock, in continuous pasture since 1994.*

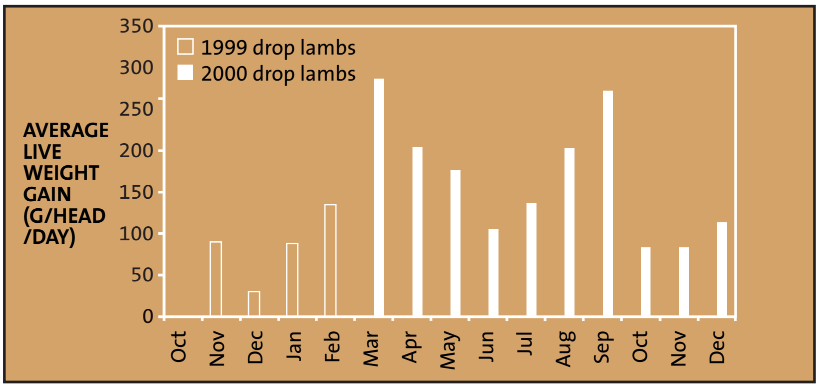


Figure 1. Average monthly growth rates of crossbred sucker lambs on predominantly native grass pasture, Merredin (1999/2000).

Further Reading

Miscellaneous Publication 2/98. Greathead K.; Sanford P. and Cransberg L. (1998). Perennial grasses for animal production in high rainfall areas of Western Australia. Department of Agriculture.

Miscellaneous Publication 8/99. The use of native perennial grasses on farms in the wheat-belt of Western Australia. Department of Agriculture.

Native Grasses Information Kit. Produced by Avril Baxter for the Revegetation on Farms Project (May 2000). Sustainable Rural Development Program, Department of Agriculture.

Western Australian Native Grass Society Newsletter. Editor Dallas Lynch, Greening Australia (WA) Northam.

Farmnote 43/2001 Native perennial grass-based pastures for livestock.

Subtropical Perennial Grasses

Tim Wiley, Department of Agriculture, Jurien Bay

KEY MESSAGES

- There is a range of subtropical perennial grasses available for most soil types.
- Excellent production can be achieved where there is a shallow water table.
- With good management, animals can grow on perennial grass pastures over summer.

Soil types

Subtropical perennial grasses will grow on almost all soil types. Differences within species are due mostly to their response to soil moisture. It is recommended to sow a mixture of species to cover any variations in soil type (see Table 1 for the broad growing environments of different species).

In general, subtropical perennial grasses should not be sown on areas that are to be used for winter cropping as they may be difficult to drill seed through and are expensive to remove. However, satisfactory results have been reported on the south coast with canola sown into perennial grass. On two farms where kikuyu grass was sprayed before cropping, a good regeneration of the grass followed the canola crop, with the slow-growing kikuyu grass having little effect on the canola crop over the winter or on its subsequent yield.

Acidity

There are no quantitative data on the effects of soil pH on subtropical perennial grasses in Western Australia. Experience suggests that problems for subtropical perennials would only be encountered at the extremes of acidity or alkalinity. Soil pH is likely to be more of an issue for the companion legumes.

Salt tolerance

Species such as puccinellia, tall wheat grass, Rhodes grass and para grass have good salt tolerance, but establishment is difficult on salt-affected areas. Exposing potentially saline areas in late spring by spraying and grazing the areas in readiness for seeding with tropical grasses, can accelerate the surface accumulation of salt, adding to the difficulties of establishment.

Climate

Subtropical perennial grasses are summer active and winter dormant. All these grasses will be burnt by frost, but will survive.

The grasses will grow and survive in all regions of Western Australia. Their production is more dependent on their position in the landscape and the pattern of rainfall, than on the average annual rainfall. These pastures respond well to summer rainfall events.

The seed of these grasses will not germinate if it is too cold. The temperatures required for germination will not be achieved until late September in the northern section of the agricultural region and by early to mid October in the south of the agricultural region.

Cost of establishment

Subtropical perennial grasses are difficult to establish and require total weed control before sowing. They should be sown in spring when temperatures are rising. The seed must be placed on the surface and then pressed or rolled in.

Experienced farmers estimate that these grasses can be established for about 100 dollars per hectare. They also suggest that it is worth considering withholding grazing during the establishment phase. The grasses are safe to graze once the roots are well established and the plants cannot easily be pulled from the ground. Failure to establish the grasses at the first attempt will increase overall costs considerably.

Grazing management

Rotational grazing is probably the best way to manage the perennial grasses over summer. However, most species will persist under set stocking. Whatever the grazing method, grazing pressure needs to be maintained on these grasses over summer and through autumn because if they are under-grazed at this time they will deteriorate in quality and palatability.

On the highly productive wet areas, farmers are using temporary electric fences to cell-graze these pastures. They may graze the grasses at up to 1000 DSE per hectare in a cell for up to a week. Generally the rotation is set up so that there is a four to six-week rest between grazings. However, on the south coast, continuous grazing of kikuyu grass over summer at high stocking rates has proved to be successful.

Valley planting of tall wheat grass near Williams.

Table 1. Subtropical perennial grass species and their use in the landscape

Soil moisture	Dry	Winter wet	Winter flooded	Salt tolerance
Species				
Rhodes grass	#	#		#
Green panic	#			
Setaria	#	##	#	
Blue panic		##	#	
Elephant grass	#	##		
Kikuyu	# *(in southern areas only)*	##	##	
Para grass			###	#
Paspalum		##	##	
Tall wheatgrass		##	#	#
Puccinellia		##	#	##

Key # satisfactory to ### very satisfactory

Table 2. Perennial grass production and quality on a winter flooded white sand at Cataby (13 February 1996)

Species	Dry Matter (10 Nov-13 Feb 96) *(t/ha)*	DM digestibility *(%)*	Crude protein *(%)*	Metabolisable energy *(MJ/kg)*	Pasture growth rate *(kg/ha/day)*
'Nandi' Setaria	5.0	71	9.1	10.2	53
'Kazungula' Setaria	12.1	64	8.0	9.0	127
Green Panic	11.1	64	6.1	9.0	117
Kikuyu	5.7	–	–	–	60
Hymenachne	8.4	71	8.3	10.0	88
'Gatton' panic	8.8	63	8.4	8.9	93
'Puna' chicory*	4.3	85	12.1	12.3	45
'Callide' Rhodes grass	7.0	68	11.1	9.7	74

**Broad leaf biennial herb of high feed value*

Subtropical perennial grasses should be grazed down hard to ground level by the end of autumn. This allows the annual legumes in the pasture to make good growth at the break of season. With a well-managed pasture mix, it should be difficult to see perennial grasses below the clovers in winter and spring. Winter grazing should aim to optimise the annual legume component of the pasture.

Feed availability

The amounts of feed produced by subtropical perennial grasses depends on the supply of nitrogen and soil moisture (see Tables 2 and 3).

These grasses are very drought tolerant and can survive without summer rain. On sites with shallow perched watertables (less than 2.5 metres) they do not require summer rain to be very productive.

Perennial grasses have a high requirement for nitrogen for optimum production. Where there is adequate soil moisture they will respond to up to 400 kilograms per hectare of nitrogen. If bagged nitrogen fertiliser is applied it should be through split applications while soil moisture persists. However, the most efficient system for meeting nitrogen requirements is to have a productive companion legume.

Table 3. Perennial grass production and quality on a valley loam at Moora (13 February 1996)

Species	Dry Matter (26 Oct-13 Feb 96) *(t/ha)*	DM digestibility *(%)*	Crude protein *(%)*	Metabolisable energy *(MJ/kg)*	Pasture growth rate *(kg/ha/day)*
'Katambora' Rhodes grass	3.8	69	8.2	9.9	35
'Pioneer' Rhodes grass	3.2	70	9.2	9.9	29
'Callide' Rhodes grass	3.1	73	10.7	10.5	28
'Nandi' Setaria	3.4	80	15.3	11.5	31
'Kazungula' Setaria	4.8	79	13.2	11.4	44
Guinea grass	4.0	76	13.4	10.9	36
'Green' panic	5.3	77	13.4	11.1	48
'Gatton' panic	3.4	79	13.7	11.3	31
Kikuyu	2.5	78	16.7	10.2	23

Feed quality

The quality of feed provided by subtropical perennial grasses depends on the availability of moisture, the time of year (Figure 1), the amount of nitrogen available, stage of regrowth (Figure 2) and the grazing pressure on the grasses.

There is a general trend for the quality of feed provided by perennial grasses to decline gradually over summer. Rotational grazing will provide a pasture with a large proportion of young leaves with high nutritional value. At Badgingarra, the sheep gained weight even though the analysis of the whole plant showed that it was of very low feed quality. In this case, the sheep selectively grazed the young grass shoots and these were of higher quality than the rank parts of the grasses.

Both protein and energy can become limiting. Animals should be monitored and a supplement such as lupins fed as required. Companion legumes will also boost the quality of the total feed supply when they are green. On wet areas balansa or persian clover, Cadiz serradella, and strawberry or white clover are likely to be suitable for growing with the perennial grasses. On drier areas, serradellas, subclover, arrowleaf clover, biserrula or blue lupins may suit depending on the location.

Grazing performances from subtropical perennial grasses

Stocking rates for subtropical perennial grasses vary from site to site depending on the availability of subsoil moisture and summer rain.

The following examples outline the sheep carrying capacities of some of these grasses. However, presently there is little documentation of animal performance on these subtropical grasses in the agricultural areas of Western Australia.

David Monks at Badgingarra runs 1800 weaners on 30 hectares of kikuyu grass and strawberry clover on a low lying wet sand throughout each

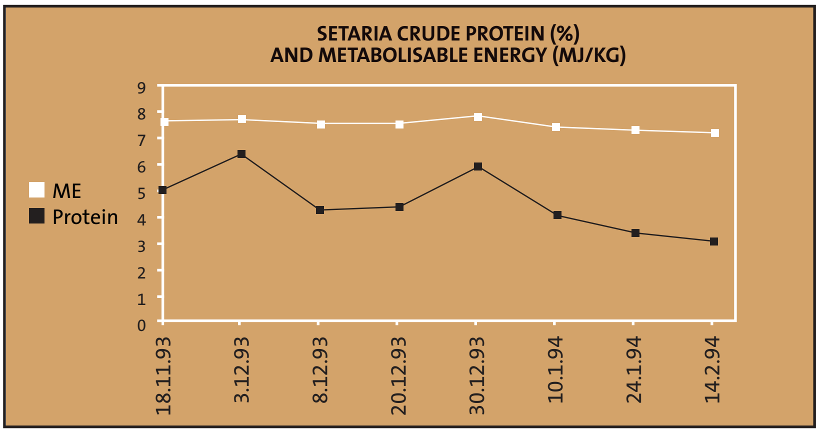


Figure 1: Decline in crude protein content of Setaria over summer on a poor sand (Badgingarra 1993/4).

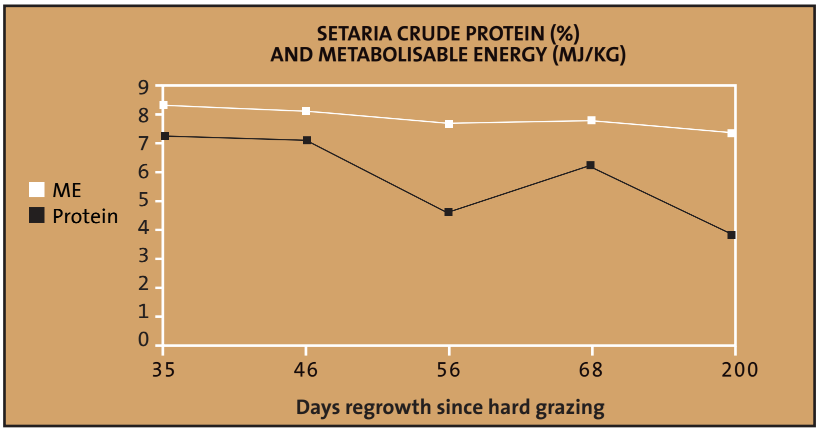


Figure 2: The quality of Setaria declines as the plants regrow from hard grazing (Badgingarra 1993/4).

Rhodes grass on waterlogged flats near Badgingarra in March.

summer. He uses a cell grazing system to rotate sheep and avoid Barbers Pole worm problems. These sheep do not see dry feed until they are one year old. In other words, it is not until they are in their second summer that they go on to dry annual pastures for the first time.

On a neighbouring farm, Dale Park ran seven weaners per hectare for 114 days over summer on Setaria grass. He compared liveweights on Setaria with a district practice of grazing Blue lupins and oat stubbles (Figure 3). This was a deep, poor white sand and there was no summer rain. Weaners on the Setaria gained 30 grams per head per day without supplementary feeding.

At Peter Nixon's, West Gillingarra, weaners were run at 265 per hectare for 30 days on a strawberry and balansa pasture on wet sand over summer. These weaners put on 150 grams per head per day or 1100 kilograms of liveweight per hectare.

An experiment at Manypeaks on the south coast showed the benefits of grazing kikuyu grass-based pastures compared with annual pastures. The main benefits were in carrying capacity (that is, increased stocking rate and/or less supplements fed) and in wool quality, with stronger cleaner wool grown on the kikuyu grass.

Other considerations

Barbers pole worm can be a serious problem on wet areas with perennial pastures, and other worm species may be a problem in the milder climates. To help reduce this problem, the pastures should have a long spell before summer grazing.

Sheep should be adequately drenched before grazing these grasses. Long spells (for example, six weeks) between grazings in summer, will, through heat and desiccation, help reduce viable worm eggs available on the pasture. Where there is concern, regular sampling and assessment of the worm status of sheep should be undertaken and further advice sought from a veterinarian.

In some areas there have been some problems with selenium and cobalt deficiencies on the wet sands over summer. Farmers should apply these trace elements with fertiliser or directly to the animals (see Farmnote 110/94, 'Trace element deficiencies in sheep and cattle').

Horses should not be grazed on pure Setaria pastures as they can develop the 'Big Head' syndrome caused by a calcium imbalance due to high levels of oxalates in Setaria.

Problems with oxalates in other species of animals have been reported in the eastern states but not in Western Australia. These types of problems are usually avoided where there is a mixture of pasture species.

Landcare benefits

The subtropical perennial grasses will increase water use and prevent both wind and water erosion.

Further reading

Miscellaneous Publication 2/98. Greathead K.; Sanford P. and Cransberg L. (1998). Perennial grasses for animal production in high rainfall areas of Western Australia. Department of Agriculture.

Farmnote 20/99. Perennial grasses : their role in the Ellen Brook Catchment

Farmnote 11/95. Kikuyu, the forgotten pasture

Farmnote 110/94. Trace element deficiencies in sheep and cattle

Farmnote 8/92. Chemical manipulation for irrigated kikuyu grasses.

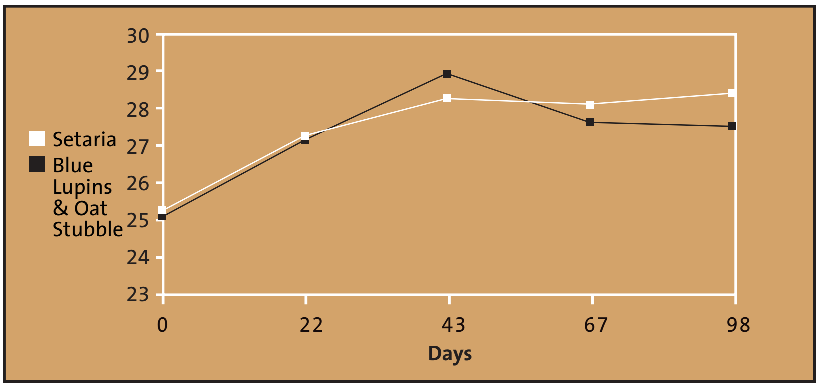


Figure 3: Liveweight (kg) of weaner rams grazing Setaria or Blue lupins and oat stubble from 8 December 1993 to 31 March 1994 (Badgingarra).

Summer Fodder Crops

Tim Wiley, Department of Agriculture, Jurien Bay

KEY MESSAGES

- Summer fodder crops are a viable feed source on wet areas and in wet summers.
- Soil temperatures must reach 14 to 19°C for germination, depending on species.
- There are some possible health problems with sheep grazing sorghum.

Soil types/niches

Summer fodder crops will grow:

- On most soils provided there is a reasonable level of nutrients and soil moisture.
- In areas where winter crops have failed from waterlogging.
- In permanently wet areas.
- After good summer rains.

Soil pH

The suitable range for pH of the soil is between 4.5 and 7.

Salt tolerance

The tolerance to salt in the soil is moderate to poor depending on the species of the crop.

Cost of establishment

It costs about 80 to 150 dollars per hectare to grow fodder crops.

Types of summer fodder crops

Sorghum

Sorghums are summer growing grasses with a reasonable drought tolerance. There are forage and grain varieties of sorghum. There is also a range of hybrids derived from crossing sorghum with sudan grass. However, only the forage types of sorghum and their hybrids should be used for grazing, as they are more productive and of better quality.

Sorghums usually produce a greater bulk of summer feed than other summer fodder crops.

Sorghums contain prussic acid that can be toxic to stock. Therefore, newer varieties have been bred with lower levels of prussic acid.

Sorghums are usually biennial. This means that they become dormant over winter and regrow in the second summer, after which they usually die out. Varieties that show promise in Western Australia include 'Jumbo' and 'Superdan'.

Sorghums will not germinate well until soil temperatures reach 18°C at 9.00 a.m. Some germination occurs at lower temperatures, but the resulting seedlings are weak and do not perform well.

Pivot irrigated hybrid sorghum (Speed Feed™) at Pingaring in February.

Sweet sorghums

Sweet sorghums have higher sugar levels than the other sorghums and this makes them more suitable for silage. They also have coarser stems than the other sorghums and are, therefore, less suitable for grazing by sheep.

Temperate millet

As a fodder crop, millets are suited to one summer season. In some cases millet has regenerated from self-sown seed. The seed is much less temperature sensitive than sorghums and will germinate at a 9.00 a.m. soil temperature of only 14°C. (See further discussion about soil temperatures and germination under the heading 'Other issues' in this section). Millets do not contain prussic acid but are usually not as productive as sorghums or pennisetums. Varieties showing promise in Western Australia include 'Shirohie' and 'Japanese'.

Forage pennisetums

Forage pennisetums were previously known as pearl millets. Forage pennisetums generally have higher protein and digestibility than sorghums. The pennisetums do not contain prussic acid. They also have finer stems and are the preferred summer forage for sheep.

Pennisetums are frost sensitive and can be killed if sown too early. Pennisetums require some rain after seedlings emerge to promote the development of the secondary root system. They will germinate at 16°C. A variety showing promise in Western Australia is 'Nutrifeed'.

Maize

Maize is extremely productive, but is probably only viable in Western Australia with irrigation.

Production potential

Dry matter production of summer fodder crops is dependent on the moisture supply. Yields of two to 10 tonnes dry matter per hectare could be expected depending on moisture supply and nitrogen application. Because they usually rely on some summer rain, their production in Western Australia tends to be unreliable except on wet areas.

When considering the benefits of summer fodder crops it should be remembered that they need to be fitted in with other management components for the whole farm. Where crops have failed from waterlogging, summer crops are a useful option as they dry the site out and also control weeds. Perennial pastures are a better option on permanently wet sites as there is a once only cost of establishment.

Table 1. Average growth rates and condition scores of Merino and crossbred lambs on forage sorghum

	Initial liveweight *(kg)*	Final liveweight *(kg)*	Growth rates *(g/h/d)*	Condition score
Crossbred	33.2	35.3	138	1.6
Merino	29.6	31.8	153	1.3
Overall growth rates	31.8	34.0	146	1.5

Table 2. The nutritional value of sorghum before and after grazing

Stage of grazing *(days)*	Dry matter *(%)*	Metabolisable energy *(MJ/kg DM)*	Crude protein *(%)*
1	80.7	10.2	22.1
15	54.9	9.8	18.6

'Jumbo' sorghum growing on waterlogged flats at Dandargan in April.

Case study - Sorghum over summer

Fiona Jones, Department of Agriculture, Katanning

The performance of crossbred and Merino lambs on Betta Graze forage sorghum was monitored at Beaufort River. A good stand of sorghum was established which provided a valuable source of feed over the summer period, particularly with the high summer rainfall causing a rapid decline in dry feed quality.

The sorghum was seeded in October in 75 centimetre rows and urea was spread at 100 kilograms per hectare before the January rainfall. Application of urea can increase the risk of prussic acid poisoning on sorghum and needs to be monitored closely. The lambs were stocked at 43 DSE per hectare for 15 days with sulphur blocks to reduce the risk of prussic acid poisoning.

The average liveweight gain for the Merino and crossbred lambs was 146 grams per head per day with no supplementary feed provided during this period. (See Table 1.)

The crude protein of the sorghum was high at the start of grazing (Table 2), when the plant had plenty of fresh leaf material. By the end of the grazing period, the crude protein of the sorghum was still more than adequate but the metabolisable energy was lower due to a higher proportion of fibrous stem and less leaf material.

The sorghum was spelled for three and half weeks between the first and second grazings. The plan was to graze the sorghum three or four times during the summer. Used in this way, sorghum provides a way to get lambs to a reasonable weight over summer before finishing them in a feedlot.

Feed quality

The quality of summer fodder crops will vary with soil moisture, soil fertility and grazing management. Protein can vary from less than 10 to 25 per cent. Digestibility is normally in the range of 55 to 70 per cent. Protein and digestibility both decline with increasing age of a stand over the summer and increasing height of regrowth. Nitrogen fertiliser will improve the protein level but not the digestibility of summer fodder crops.

While summer fodder crops can provide feed of reasonable quality over summer, supplements with lupins may be required for maximum growth rates of animals. Generally, more lupins will be required as the stand ages.

Summer fodder crops are generally low in both sodium (salt) and sulphur. Balanced mineral licks containing these nutrients should be made available to stock.

Grazing management

Grazing of fodder crops should be delayed until the plants are well established. For sorghums, do not put stock in until the crop is about one metre high. Sweet sorghum can be grazed when the crop is 1.5 metres high and millet and pennisetums when the crop is 0.5 metre. After this, the best results will be with rotational grazing, although set stocking is still possible.

Do not graze the stand too low. The sheep should be removed once the height of the forage is down to 15 centimetres. Regular grazing helps delay flowering and this maintains the quality and growth rate of the fodder for a longer period. If the fodder is left ungrazed, it is more likely to suffer moisture stress. If sorghum plants are allowed to mature their protein level and digestibility will decline rapidly.

Grazing problems

Prussic acid poisoning

Animals can be affected by prussic acid poisoning when grazing sorghums. Prussic acid is converted to hydrogen cyanide in the gut of the animal. The cyanide reduces the uptake of oxygen into the blood and symptoms of the poisoning include muscle tremors, staggers, deep and rapid breathing, frothing at the mouth and gasping for breath. Death can occur in extreme cases. In sheep, the poisoning can be treated by drenching animals with 14 grams of sodium thiosulphate in 500 millilitres of water.

Factors that increase prussic acid levels are excess nitrogen, inadequate phosphorus and moisture stress. The risk of prussic acid poisoning can be reduced by ensuring that:

- sheep are not hungry when first put on to sorghum;
- there is other feed in the paddock;
- the sorghum is at least 0.8 metre tall;
- the plants are not grazed when they are (moisture) stressed and;
- a mineral lick containing sulphur is available.

Nitrate poisoning

Nitrate poisoning can occur in sheep grazed on a wide range of grass fodders. Fortunately it is not a common problem. However it will occur when there are very high levels of soil or fertiliser nitrogen. The poisoning causes severe gasping, convulsions and death. It can be treated by drenching with vinegar.

Other issues

Summer fodder crops will not germinate at low soil temperatures. Ideal germination is achieved when the 9.00 a.m. soil temperature at seeding depth is 18°C. The millets will germinate at soil temperatures of only 16°C. Sowing too early will result in weak seedlings or the seed may rot. This is different to the summer active perennial pastures that can be sown up to a month before the soils are warm enough without any adverse effect. The 9.00 a.m. soil temperature can be estimated as half way between the daily minimum and maximum temperatures.

Sow at two to five centimetres depth where there has been good weed control. Sow about five kilograms per hectare of seed at wide row spacings of 0.5 to one metre. Close row spacing can lead to very poor results.

Use rates of fertiliser similar to those used for wheat grown on the same soil type. However, be careful where nitrogen and potash are sown with the seed as these fertilisers can kill emerging seedlings. It is safest to drill the fertiliser before seeding or with alternate runs of the seeder. Use sulphate of ammonia if top dressing as urea is rapidly lost to the atmosphere when spread in summer.

Landcare and rotational benefits

The degree to which summer crops help to dry out wet areas for the following season is not yet clear. Spraying out weeds in spring will reduce their seed bank for the following year. This may well provide a means of preparing for a winter crop, especially where weeds have become resistant to chemicals. However this will also reduce the legume seed bank that is important for subsequent pasture regeneration.

Further reading

Fry, J. (Compiled by) (1997).
A reference manual for farmers involved in Woolpro productivity evaluations.
Segment 5 – Tactics for different summers, pp 15-18.
Department of Agriculture.

Stuart, P.N. (1993).
The forage book. Pacific Seeds, Toowoomba, Queensland.

CROPS

Sheep performances on cereal and canola stubbles

Grazing sheep on grain legume stubbles

Grazing sheep on matured grain legume crops

Increasing lamb growth on medic pasture cover cropped with sweet lupins

Sheep Performance on Cereal and Canola Stubbles

Daniel Roberts, Department of Agriculture, Katanning and
Janet Paterson, Sci Scribe Scientific Copywriting, Brookton.

KEY MESSAGES

- Sheep can only consume a small proportion of the dry matter available in stubbles.
- Spilt grain is the most nutritious component of the diet of sheep grazing cereal stubbles.
- Adult dry sheep can only maintain liveweight for a short period of time when grazing dry stubbles alone.
- Young sheep will only maintain liveweight when spilt grain and green material are also available.
- To minimise weight loss of adult sheep and maintain liveweight of young sheep, supplementation of stubbles with cereal grain or lupin seed will be necessary.

Introduction

Stubbles are a major feed source for sheep during the summer-autumn period in Western Australia.

While there is often up to three tonnes of dry plant material per hectare available, sheep grazing stubbles eat only about six per cent of it. Leaf material (59 per cent digestible) makes up about a quarter of the stubble material, while the stem material (29 per cent digestible) accounts for just under half. The large amount of indigestible stem material reduces the overall value of stubbles.

When grazing cereal stubbles, the aim is to maintain the liveweight of young sheep, to minimise the weight loss of adults and to maximise utilisation of nutrients available from stubbles. There are large losses of edible material caused by shattering during harvest and trampling as sheep selectively graze the stubble paddocks. Microbial breakdown and wind also contribute to the loss of the high quality components of stubbles.

The energy content of the dry plant material determines how much the stock can eat. About a quarter of fresh wheat stubble has a digestibility of more than 55 per cent, one third has a digestibility between 50 to 55 per cent and the rest is indigestible stem material.

Young sheep (25 to 30 kilograms) will start to lose weight once they are eating stubble material below 55 per cent digestibility which is the threshold for maintenance of liveweight.

Table 1. The dry matter, energy, protein and fibre content (dry matter basis) of straws and stubbles fed to sheep. The average across the range of values is shown in brackets.

Straws/ stubble	Dry matter (%)	Metabolisable energy (MJ/kg)	Crude protein (%)	Acid detergent fibre (%)
Oat	89	6.0 – 7.7 (6.8)	4.0 – 6.5 (5.0)	38.0 – 45.0 (43.0)
Barley	89	6.0 – 7.5 (6.7)	4.0 – 6.5 (5.0)	38.0 – 47.0 (44.0)
Wheat	91	5.8 – 7.0 (6.5)	2.5 – 6.5 (3.5)	43.0 – 52.0 (47.0)
Triticale	89	5.5 – 7.0 (6.3)	2.5 – 6.0 (3.5)	44.0 – 52.0 (48.0)
Lupin	92	5.5 – 9.5 (8.0)	6.0 – 10.0 (8.0)	36.0 – 44.0 (42.0)
Pea	90	6.5 – 7.8 (7.2)	6.0 – 8.5 (7.5)	38.0 – 44.0 (42.5)
Canola	92	5.5 – 7.5 (6.5)	4.0 – 7.5 (6.0)	42.0 – 50.0 (47.0)
Sorghum	88	5.5 – 7.0 (6.5)	3.5 – 6.0 (4.5)	45.0 – 54.0 (48.0)

These values were extracted from data collected by Independent Lab Services, Perth.

Composition of stubbles

Leaf material and spilt grain provide the most nutritious components of the diet of sheep grazing cereal and legume stubbles. The average nutritive values of stubbles sampled in Western Australia are recorded in Table 1.

Merino lambs grazing a barley stubble. Lambs grazing a barley stubble will require additional protein supplements for optimum growth.

The availability of small amounts of green material (weeds or crop regrowth) following summer rains will also increase the productivity of animals that graze stubbles. The sheep's diet will consist of more than 80 per cent green material when there is as little as 40 kilograms per hectare of green material in the stubble.

Mature sheep grazed on stubbles may initially increase in liveweight because of intensive selection for these more digestible parts of fresh stubbles (grain, weeds and leaf material). However, lighter or younger sheep are unlikely to maintain liveweight for as long, unless considerable grain and/or 'green pick' are available because they simply cannot eat enough of the nutrients they need for growth.

Adult dry sheep (55 kilograms) grazed on crop residues will only maintain their liveweight for 60 to 100 sheep grazing days per hectare. Young sheep (25 to 30 kilograms) will not maintain liveweight on dry plant material alone and will require supplementation within 7 to 14 days to avoid weight loss.

> Supplementation is needed to maintain the weight of young sheep on stubbles as well as to improve the efficiency with which nutrients within the stubble material are converted to liveweight. The aim of supplementation is to stimulate the sheep to eat more of the stubble by providing a protein-rich feed such as lupins. The protein and soluble carbohydrate in the lupins stimulate the microbial population in the rumen which can then process the incoming stubble more quickly. It is important to use the dry feed available in stubbles before it is lost through summer rain and trampling.

Young sheep (25 to 30 kilograms) should be fed 50 to 75 grams of lupins per day from the first or second week on stubbles. This should help to increase their intake of higher quality stubble components such as spilt grain and leaf material. However, the intake of lupins needs to be monitored to ensure that the sheep are not substituting them for stubble. After week two, the lupin supplement will need to be increased to 150 grams per head per day because the more digestible stubble components will usually have been eaten by this time.

Cereal stubbles

The spilt grain in cereal stubbles contains starch that can cause acidosis if rapidly consumed. Acidosis is caused by the lowering of the pH in the rumen of sheep, leading to part of the microbial population being killed off and a lessened ability by the rumen to process fibrous feed. To minimise the chances of developing acidosis, sheep should be acclimatised to the grain before being put onto ungrazed cereal stubbles.

Spilt cereal grain will not provide enough protein for growing lambs and it is important to feed out some lupin grain as well. This will also help the sheep to better utilise crop residues. If possible, lambs should be moved regularly to new stubbles so that they can have maximum access to spilt grain and leaf material. An appropriate mineral mix should be fed to overcome any possible deficiencies of sodium, calcium, and sulphur.

After the removal of weaners, the stubbles can usually be grazed for a while by older sheep.

Canola stubbles

Observations on the performances of sheep indicate that canola stubbles do have some value as a stock feed but information collected so far is limited. Any green pick arising after swathing or from late maturing plants will increase the value of the stubble, particularly for young sheep. Liveweights of young sheep on canola stubble increased by up to two kilograms over 12 days (the shortest period of weight gain) to 42 days (longest period of weight gain) on several farms located in the wheatbelt. Grazing time was extended with an increase in the proportion of green or part-green canola stems in the stubble. Also of importance was the availability of small green branches at the start of grazing.

Where there has been good weed control, most canola stubbles only have dry, hard and brittle stems. Sheep eat some of the residual canola seed in the swathed rows but its influence on their performance is not known. Supplementation with grain is usually required to maintain the liveweights of young sheep grazed on canola stubbles.

Merino lambs grazing a wheat stubble. Initially introducing lambs to the stubble for short periods over several days is important for wheat stubble.

Chaff Cart Heaps

Recent developments in cart collection systems have improved the availability of the higher quality components of cereal crop residues by separating harvested material into leaf-rich and stem-rich components. The average nutritive values of the material in chaff-cart residues in Western Australia are shown in Table 2.

The heaps from the chaff cart collection system provide an accessible source of feed for sheep at discrete locations within a paddock. The average energy content of the collected material is generally enough to maintain the liveweight of adult dry sheep.

When cereal paddocks are harvested about half a tonne per hectare of chaff cart residues is available for stock to graze while on the stubbles. Swathing the crop increases both the amount of material collected by chaff carts and the capture of weed seeds.

Table 2. The dry matter, energy, protein and fibre content (dry matter basis) of chaff-cart residues. The average across the range of various values is shown in brackets.

Chaff-cart residues	Dry matter (%)	Metabolisable energy (MJ/kg)	Crude protein (%)	Acid detergent fibre (%)
Oat	90	6.5 – 8.0 (7.2)	5.0 – 7.0 (6.0)	36.0 – 44.0 (41.0)
Barley	90	6.5 – 8.2 (7.5)	5.0 – 7.5 (6.5)	37.0 – 45.0 (42.0)
Wheat	90	6.2 – 8.5 (7.5)	4.5 – 8.0 (6.5)	39.0 – 50.0 (45.0)
Canola	92	6.0 – 8.5 (7.5)	5.0 – 9.5 (7.5)	42.0 – 50.0 (45.0)
Lupin	92	7.5 – 9.5 (8.5)	7.5 – 11.5 (9.5)	35.0 – 43.0 (41.0)

These values were extracted from data collected by Independent Lab Services, Perth

There has been some monitoring of sheep given access to the harvested crop residue during summer on a limited number of farms throughout the wheatbelt. The number of grazing days in paddocks with cart heaps was extended by up to 31 per cent compared with those stubble paddocks without chaff cart residues.

In large stubble paddocks, providing strategically located chaff heaps improves the utilisation of the material available over the whole stubble paddock. Sheep are attracted to graze these chaff heaps particularly when they are located beyond the over-grazed areas surrounding a watering point.

Monitoring sheep performance on stubbles

There is a wide variation in the voluntary intake, ingestion of nutrients and performance of sheep when grazed on dry cereal and lupin stubbles.

It is essential to weigh, or at least condition-score, a sample of 50 animals in a flock on a monthly basis to determine when the value of the stubble has decreased and supplementation is necessary for the maintenance of liveweight.

Further Reading

Aitchinson, E. (1988). Cereal straw and stubble as sheep feed. *Journal of Agriculture, Western Australia*. **29**: 96-101.

Croker, K.P. and Suiter, R.J. (1977). Stocking rates for weaner sheep on standing crops. *Journal of Agriculture, Western Australia*. **18**: 21-23.

Jacob, R. (1984). Utilisation of cereal stubble for sheep feed. *In* 'How much wheat do sheep grow' (Western Australian Department of Agriculture and North Midland Branch of the Australian Society of Animal Production: Northam. WA).

Purser, D.B. (1983). The nutritional value of stubbles. In 'Stubble Utilisation' (Rural and Allied Industries: Perth. WA. pp 13-26).

Warren, B. (1991). Sheep performance on cereal stubbles. In 'Stubble management in farming systems' (Technical Report No 40, Western Australian Department of Agriculture. pp 44-52).

Merino ewes on a canola stubble. Canola stubble has a low feed value unless there is green regrowth and may be better utilised by older animals.

Grazing Sheep on Grain Legume Stubbles

Keith Devenish, Department of Agriculture, Northam

KEY MESSAGES

- Grain legume crop stubbles provide better quality sheep feed than cereal or canola stubbles.
- The feed value of the stubble is directly related to the amount of seed left after harvest.
- Sheep will preferentially select the seed first.
- Young sheep should be trained to recognise the seed.
- Sheep growth rates should be at least one kilogram per head per week.
- Sheep drink more water on a high protein feed.
- Grazing can be limited by the amount of ground cover available.

Introduction

Crop stubbles are the plant residues left after harvest. The major components of the stubbles of grain legumes in order of their feeding value to sheep are seed, leaf, pod, chaff and stem material. Weed residues in paddocks can also be of value as sheep feed.

Contribution to liveweight

The feed value of legume stubbles is directly related to the amount of spilt seed left after harvest. Therefore, the length of grazing depends on the availability of the seed and whether animals need to gain or lose weight. Providing there are no other limiting restrictions to animal performance, the legume crop stubbles generally have the highest summer feed value of all the crop stubbles.

Constraints to liveweight gain

There are several factors that can limit animal performance when grazing grain legume stubbles (see Sheep Health Issues). This section assumes the risk of the following problems are minimised:

- Lupinosis is the main threat on lupin stubbles. Deaths can occur, but even low levels of the toxin that produces lupinosis can limit weight gain.
- ARGT - watch for annual ryegrass toxicity if ryegrass plants are present in large numbers.
- Acidosis - grain engorgement generally has not been an issue, but theoretically could occur where large amounts of faba bean, field pea or chickpea seed are spilt.

Watering points

The most important factor influencing sheep performances during the hot summer period is the availability of good quality water. Sheep on a high protein diet can drink more than twice as much water per day as they do when grazed on other dry feed. Having a movable water point allows better utilisation of feed from large paddocks (see Farmnote 106/89 Moving water points on lupin stubbles).

Sheep should be removed from this lupin stubble to avoid wind erosion as ground cover is below 50 per cent.

Main issues

- Weaners tend to concentrate their grazing within 800 metres of water points.
- Moving the water point can increase the utilisation of the stubble material.
- A weaner grazing lupin stubble in hot conditions can drink up to nine litres of water per day.
- For water troughs, a fast delivery is as important as the water storage capacity.
- Check the quality of the water, particularly salt levels for young sheep.
- Clean water troughs every second day in hot conditions.
- Regularly inspect water troughs to make sure plenty of water is available.

Ground cover

For some grain legume stubbles the risk of wind erosion from a lack of ground cover restricts the length of grazing. A general recommendation is to remove livestock from a paddock once the amount of plant material present falls below 50 per cent ground cover.

Grazing lupin stubbles

Stubbles of Phomopsis-resistant narrow leafed lupin (*Lupinus angustifolius*) can provide grazing from one to five months, depending on the amount of residual seed available; the stocking rate; incidence of lupinosis; the risk of wind erosion and the amount of summer rainfall (see Farmnote 87/93 Grazing weaner sheep on Phomopsis-resistant lupin stubbles).

There is a greater risk of lupinosis developing in sheep grazed on the older lupin varieties such as Danja, Yandee, Chittick and Illyarrie (see Farmnote 109/88 Grazing management to minimise lupinosis). In the absence of lupinosis, stubbles from the older varieties should produce similar sheep performances as those obtained on the phomopsis-resistant varieties. Producers should check for information on newly released varieties before assuming that stubbles are safe to graze.

Weight gains can be expected from healthy weaners grazed on lupin stubbles with adequate seed available. Modern machinery and cropping practices have increased harvesting efficiency to a point where relatively little seed is left behind and so shorter periods of grazing can be expected on current stubbles.

Suggested management of prime lambs grazed on lupin stubbles

- Train weaners to recognise lupin seed before going onto lupin stubbles.
- Ensure a plentiful supply of water on hot days, up to nine litres per head per day is needed.
- Use a stocking rate of up to ten weaners per hectare.
- Do not graze paddocks with a ground cover less than 50 per cent.
- Consider moving prime lambs when seed levels fall below 100 kilograms per hectare.
- Use movable water troughs in large paddocks.
- Grazing can be deferred until late summer but summer rain can spoil feed.
- Regularly weigh and condition score about 30 animals in each mob.

Expected weight gains

Trials with Merino weaners have shown that they can gain up to 15 kilograms during 100 days of grazing on lupin stubble. This gives a growth rate of about one-kilogram per week. Some trials have produced half this rate, possibly due to sub-clinical lupinosis inhibiting optimum growth. Figure 1 provides an example of how stocking rates can influence the length of time that weaners can graze sweet lupin stubbles.

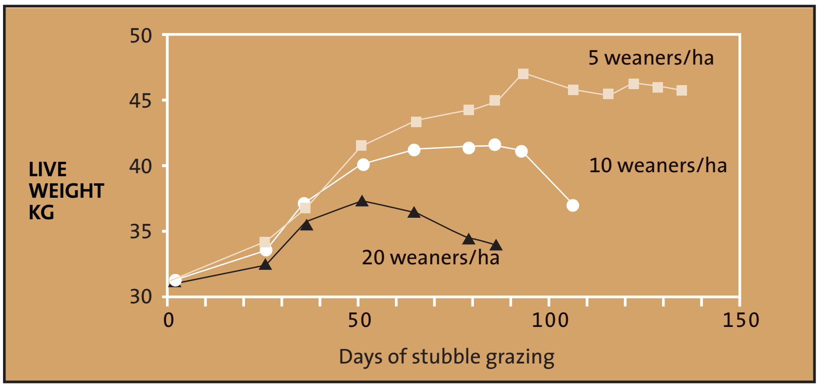


Figure 1. Liveweights of weaners grazed on Gungurru stubbles at three stocking rates at Chapman Valley in 1990–91.

Suggested grazing strategy for prime lambs

Lupin stubbles typically have between 150 and 350 kilograms per hectare of spilt seed per hectare after harvest. To finish prime lambs, liveweight should be at least 30 kilograms when the lambs are put onto the stubble and there should be at least 200 kilograms per hectare of seed before grazing begins. The optimum management technique may be to remove prime lambs when the amount of seed falls to about 100 kilograms per hectare (this is only a suggestion and not a blanket recommendation). This is twice the recommended level of 50 kilograms per hectare of seed when weaners often begin to lose weight and the risk of lupinosis increases due to higher stem intake. Growth rates decrease as the seed becomes limited and weaners begin to eat more stem and pod material.

Prime lambs should be moved to an ungrazed paddock of lupin stubble when feed starts to become limiting and before growth rates begin to decrease. If there is only one paddock of lupin stubble available then it might be better to ration the feed by temporarily dividing the paddock in half.

Residual grazing of stubble

After prime lambs are removed from lupin stubbles, older sheep such as shippers can then graze on the remaining material. Older shippers should still gain some weight where seed levels are between 50 and 100 kilograms per hectare. Ground cover may be the limiting factor rather than seed levels because lupins are grown predominantly on sandplain soils that are prone to wind erosion.

Seed is the most important component

Sheep selectively graze lupin seed rather than leaf or stem material. Seed intake is generally high during the first few weeks of grazing and growth rates are rapid once animals are used to the feed. Naturally, the higher the stocking rate the shorter the period of rapid growth.

Lupin seed is high in energy and lower in starch than cereal grains, making it a safer feed for sheep. Lupin seed has an average metabolisable energy of about 14 megajoules per kilogram, less than one per cent starch and about 30 per cent crude protein. However, these levels can vary considerably and it is important to be aware of this and perhaps have the seed tested by a laboratory.

Measuring seed levels

As a rough guide, an average of eight lupin seeds in a tenth of a square metre (e.g. a Hoegrass/Cropcheck square) is equivalent to 100 kilograms per hectare of lupin seed. You should average about 20 random throws across the paddock to get a reasonably accurate estimation of the amount of seed in the paddock.

Listed below is the number of seeds required in a Hoegrass/Cropcheck square (0.1 square metre) to be equivalent to 100 kilograms per hectare of seed.

Wheat/Oats	28
Barley	25
Lupins	8
Field Peas	5
Chick Peas	5
Faba beans	2

Training weaners to recognise seed

Feeding lupin seed for about ten days before sheep are put onto stubbles can train them to look for spilt seed. As a result they will eat the seed as soon as they are put onto the stubbles and should start growing immediately. Another training method is to trail feed lupins several times to the ewes before their lambs are weaned. These techniques are important for prime lamb production where time is critical for lambs to reach liveweight targets.

Case example

A trial was conducted on a Gungurru lupin stubble near Doodlakine. Merino weaners were grazed from 20 December 1992 to 16 February 1993. The weaners increased in liveweight by five kilograms during the eight-week grazing period. Their growth rate was 0.6 kilograms per week (86 grams per day) and lupin seed decreased from 251 to 136 kilograms per hectare during the period of grazing. (See Table 1.)

Albus lupin stubble

The management of sheep grazing Albus lupin (*Lupinus albus*) stubble is similar to those grazing narrow leafed lupins. However, the seed is almost three times bigger and consequently sheep select and eat the seed much more quickly. This could easily limit the grazing time of these stubbles by prime lambs to less than a month. Albus have a higher protein and energy content than narrow leafed lupins. In addition, Albus varieties such as Kiev are less prone to phomopsis infection than narrow leafed lupins.

Field pea stubble

There is considerable experience with grazing field pea (*Pisum sativum*) stubbles, which are high in protein and energy making them a good feed for all classes of livestock. Field pea seed is about 25 per cent crude protein and has 13 megajoules per kilogram making pea stubbles an excellent source of dry feed. As with lupins, sheep will preferentially graze the spilt seed first.

Because of the high starch content of peas, sheep are susceptible to acidosis. Introducing sheep gradually to a high starch diet can prevent this. Enterotoxaemia (pulpy kidney) can also occur when sheep are introduced to pea stubbles suddenly and young sheep are more susceptible than adult sheep (see Sheep Health Issues). The most effective preventative measure is to vaccinate against enterotoxaemia.

The risk of wind erosion is a major issue when grazing field peas. The grazing period for prime lambs is most likely to be less than four weeks (probably more like two weeks) because sheep powder up field pea stubble and it then blows away easily. Extra caution is needed to avoid wind erosion. In consequence, pea stubbles should only be grazed to use the spilt seed and then the sheep should be moved to a paddock not vulnerable to erosion (see Farmnote No 12/88 Introducing sheep to pea stubbles).

Faba bean stubble

Growth rates for sheep grazed on faba bean (*Vicia faba*) stubbles should be similar to lupin stubbles but the seed is larger than narrow leafed lupins and sheep are likely to target the seed first. About 20 seeds per square metre (two per Hoegrass or Cropcheck square) equate to about 80 to 100 kilograms per hectare (see Farmnote 55/96 - Faba bean production). Faba beans have one of the highest harvest indices of the grain legumes so there is only a small amount of seed left after harvest. Faba beans are about 27 per cent crude protein, have an energy content of 13 megajoules per kilogram. They are also high in starch.

Theoretically acidosis could occur if large amounts of spilt seed remained following harvest. However, generally few problems have occurred with these stubbles. The stubble minus the seed appears to be good value so feeding additional lupin seed might be an option for prime lamb production if

Table 1. Changes to sheep liveweights and lupin stubble components at Doodlakine

	Sheep weight *(kg)*	Lupin seed *(kg/ha)*	Stubble DM *(t/ha)*	Pod DM *(%)*	Leaf DM *(%)*	Stem DM *(%)*	Crude protein *(%)*	Digestibility *(%)*
Start	30 kg	251	4.49	20	34	46	8.0	43
Finish	35 kg	136	2.98	12	32	56	6.2	42

there is still some stubble value left. Take care not to overgraze paddocks with sandy surfaces that may be prone to wind erosion. If the harvester sample requires grading for size, the faba bean seconds are an ideal supplementary feed source.

A faba bean crop at Merredin in 1994 yielded 500 kilograms per hectare at harvest with the amount of spilt seed measured at 205 kilograms per hectare. After 19 days of grazing there were 53 kilograms per hectare of seed left. The 315 July-born ewe weaners (average weight about 25 kilograms) were grazed on 25 hectares of faba bean stubble and fed 20 grams per head per day of lupin seed. They increased weight at 154 grams per head per day or just over one kilogram per week. In this case a low level of ground cover was observed and it was suggested that this could lead to major problems in bigger paddocks.

Chickpea stubble

Chickpea (*Cicer arietinum*) stubble is a high value stock feed that should supply grazing for two to three weeks. The spilt seed is high in value but the biomass tends to be low. Hence, ground cover is the limiting factor. Often the harvested sample requires grading to meet grain size requirements and chickpea grain seconds make good feed.

Lentil stubble

The lentil (*Lens culinaris*) is an annual winter grain legume that is inclined to lodge at maturity. Lentils tend to produce a relatively low biomass and moderate harvest indices. The green lentil seed is twice as big as the red lentil seed. Evidence from India and Turkey suggests that lentil stubble is usually of high value as a stock feed, although lack of ground cover could limit the grazing time to two or three weeks.

Lathyrus stubble

There is very little experience with grazing *Lathyrus* crop stubbles as they are relatively new on a broadacre scale. Being a legume crop they should theoretically support animal grazing at similar rates to chickpeas. The seed is about half the size of a field pea. Many *Lathyrus* species contain a neurotoxin (ODAP). The consumption of large quantities of *Lathyrus* grain containing high concentrates of the neurotoxin causes some paralysis of the lower limbs known as lathyrism in humans and animals. This problem is mainly associated with *Lathyrus sativus* or grasspea.

The dwarf chicklings (*Lathyrus cicera*) have low amounts of the neurotoxin. These include varieties such as Chalus and Lath-BC. The stubble and seed of dwarf chickling is nutritious for sheep and cattle. Overseas evidence from preliminary feeding trials suggests that dwarf chickling grain contains about 27 per cent crude protein (see Farmnote 24/98 Growing dwarf chickling).

Merino lambs grazing a lupin stubble. Grazing pressure around water points on lupin stubbles will be high and can lead to a risk of erosion.

As with field pea stubbles, avoid over grazing, especially on sandy soils where erosion can be an issue. Limited grazing trials have shown that most seed is consumed in the first few weeks of grazing. These paddocks should be closely monitored for levels of seed and animals should be moved to another paddock before they begin to lose weight. Expect about two to four weeks grazing for prime lambs, depending on the amount of residual seed left after harvest.

Further reading:

Farmnote 24/98.
Growing dwarf chickling.

Farmnote 55/96.
Faba bean production.

Farmnote 87/93.
Grazing weaner sheep on Phomopsis-resistant lupin stubbles.

Farmnote 12/88. Introducing sheep to pea stubbles.

Farmnote 109/88.
Grazing management to minimise lupinosis.

Grazing Sheep on Matured Grain Legume Crops

Keith Devenish, Department of Agriculture, Northam

KEY MESSAGES

- The gross margins from grazing sheep on mature, grain-legume crops such as lupins can be greater than that achieved by harvesting and selling of the grain.
- Weaners can be grazed at considerably higher stocking rates on mature grain-legume crops than the stubbles from these crops.
- Young sheep have achieved growth rates of 1.1 to 1.5 kilograms per head per week when grazing mature crops.

Introduction

A strategy to finish prime lambs, or shippers, during summer and autumn is to sow an area to a grain legume crop, allow it to mature and leave it standing for use as sheep feed rather than harvest the grain. Seeds from sweet lupins, faba beans and field pea crops are a good source of energy and have the high level of protein that is needed by fast-growing young sheep. Sheep can be grazed on the mature crop at higher stocking rates than are possible on pastures or stubbles during summer and autumn and still achieve good rates of animal growth.

Results from trials

A trial using six-month-old crossbred ewe lambs (South Suffolk x Merino) conducted near Northam in 1995/96 indicated that the grazing of mature legume crops (lupins and field peas) could generate greater gross margins per hectare than are possible from harvesting and selling the grain. This result depends on grain type and prevailing commodity prices.

The higher gross margins generated in the trial were mostly due to the use of considerably higher stocking rates than those normally used to graze stubbles. The lambs were grazed for six weeks and the growth rates varied from 1.2 kilograms per head per week for the highest stocking rate of 49 per hectare to 1.5 kilograms per head per week for the lowest stocking rate of 28 per hectare.

Similarly, a South Australian study using young Merino wethers grazed at 40 per hectare for six weeks, found that under dry summer conditions grain legume crops could produce growth rates of more than 1.1 kilograms per head per week (that is, more than 160 grams per day).

Practical application

Sweet lupins are the crop most likely to show promise for this strategy because the grain is usually worth less than the other grain legume crops and there are fewer problems from acidosis. In addition, the stocking rates can be significantly higher on these crops and the grazing period will be longer than that obtained when only the stubbles are grazed.

Animal health issues

Sheep may need to be introduced to the crops gradually to avoid acidosis, especially for field peas or faba beans. They will also need to be monitored closely while grazing lupins to minimise their chances of developing lupinosis (see section on Sheep Health Issues).

Further reading

Warner, K.S.A.; Hepworth, G.W.; Davidson, R.H. and Milton, J.T.B. (1998). Grazing Mature Grain Legume Crops. *Proceedings of the Australian Society of Animal Production* **22:** 217-220.

Standing lupin crops provide an excellent feed resource for finishing lambs.

Increasing Lamb Growth on Medic Pasture Cover Cropped with Sweet Lupins

Keith Devenish, Department of Agriculture, Northam and Gary Hepworth and Natalie Coonan, Curtin University of Technology, Muresk, Northam

KEY MESSAGES

- Cover cropping legume pasture with a small amount of sweet lupin seed improved the performance of crossbred lambs grazed on matured medic pasture over summer.
- Sowing 15 kilograms of lupin seed per hectare with medic reduced the medic seed yield by less than ten per cent whereas sowing 30 kilograms of lupins per hectare reduced the seed yield of medic by 30 per cent.
- Weekly growth rates of up to 1.4 kilograms per head were achieved for crossbred lambs when lupins were added to the pasture mix.

Introduction

In the past, farmers have often under-sown oats with sub-clover to provide sheep with a cheap but valuable summer feed.

The usual recommendation for establishing a medic pasture is to sow it as a pure stand. However, one prime lamb producer has found that lupins are ideal to sow with new medic pasture; helping to increase growth rates of sheep without reducing the pasture's seed yield.

This technique has now been evaluated for use with sheep meat enterprises; the results of which are detailed below.

Trial results

A grazing trial was conducted during the summer of 1996/97 on a farm at Perenjori. Santiago medic pasture was established on a red loamy soil with, or without, a small amount of sweet lupin seed that was mixed with the medic at seeding time. The trial investigated the amount of lupin seed that can be sown with medic seed before the seed yield of medic is reduced. The benefits of using this pasture mix for prime lamb production were also evaluated.

The newly sown pasture was allowed to mature before the area was fenced into one-hectare plots. Each plot was stocked with store lambs (Border Leicester x Merino) at 6 DSE per hectare for eight weeks from 18 December to 12 February. The average weight of the lambs at the beginning of the trial was 32 kilograms.

The growth rates of the crossbred lambs grazed on a pure medic pasture sown with 15 kilograms per hectare of seed were compared with those of similar lambs grazed on medic pastures mixed with either 15 or 30 kilograms per hectare of sweet lupins (Merrit).

At the conclusion of the grazing period, all lambs were transported to the Linley Valley Abattoir where they were

Table 1. Growth rates and carcase values of prime lambs grazed on medic pastures with and without a narrow-leafed lupin cover crop

Pasture treatments	Medic seed *(kg/ha)*	Lupin grain *(kg/ha)*	Weight gain *(kg/hd)*	Growth rates *(g/hd/d)*	Final weight *(kg)*	Dress weight *(kg)*	Carcass value *($/hd)*	Meat value *($/ha)*
Medic	822	0	3.38	63	36	13	18.63	22
Medic + 15 kg/ha lupins	747	317	9.52	172	42	17	35.33	122
Medic + 30 kg/ha lupins	570	474	11.60	206	44	19	40.65	154

** Assumptions: initial lamb value $15 per head, stocking rate 6 head per hectare*

slaughtered and each carcase was evaluated in terms of its dressed weight and carcase quality.

Similar amounts of plant dry matter were produced by all treatments. Lambs on the mixed medic/lupin pasture grew more than twice as fast (172 to 206 grams per head per day) as those on the pure medic pasture (63 grams per head per day) (Table 1).

There was also a large difference in carcase value; with those from the lupin treatments achieving double the value of those grazed on pure medic pasture ($35.33 and $40.65 compared to $18.63 respectively). This was mainly because the dressed weight and condition score of lambs from the pure medic pasture failed to reach optimum slaughter weight and carcase characteristics.

Adding 15 kilograms per hectare of lupin seed to the medic at seeding only reduced the seed yield of the medic by nine per cent. However, at 30 kilograms per hectare, the lupins reduced the seed yield of the medic by 30 per cent.

Conclusion

Sowing a small amount of lupin seed as a cover crop with medic pasture increased the performance of prime lambs grazed on the mature pasture.

The pure medic pasture (more than 80 per cent medic) only produced a growth rate of 0.44 kilograms per head per week compared to the medic-lupin pasture which increased the growth rate to more than 1.2 kilograms per head per week. At low seeding rates of lupins, the impact of competition on medic seed production is minimal.

Cover cropping with lupins provides the opportunity to finish prime lambs (or any other meat sheep) during summer while recovering the costs associated with establishing a new legume pasture.

FODDER

Roy Butler, Department of Agriculture, Merredin and
John Milton, Department of Agriculture, based at the
University of Western Australia, Nedlands

KEY MESSAGES

- Fodder is the term that is usually applied to conserved roughages, but it may also refer to standing green crops ("fodder crops") or pastures.
- Silage, hay and straw are the most familiar fodders, however hay-frozen pasture or crop and windrowed pasture can also be used as fodders.
- Rarely does any fodder, alone, provide a complete diet suitable for growing or finishing sheep for slaughter.
- The nutritive value of different fodders is highly variable and difficult to estimate. Therefore, a laboratory analysis is recommended when planning a feeding program using fodders.

Fodder is not a complete ration

Fodder provides some nutrients for sheep and also has an important role in maintaining normal rumen function. Fodder alone, however, is rarely sufficient for prime lamb production. For older sheep, some high-quality fodders can provide a maintenance or slow-gain diet. More commonly, some grain or other concentrate is required in addition to the fodder. The higher the nutritive value (or quality) of the fodder, the more grain it can replace in a sheep's diet.

When given a choice, and fed *ad libitum*, sheep will generally consume a mixture comprising 15 to 40 per cent roughage and 60 to 85 per cent concentrate (grains). The precise proportions eaten will vary according to the palatability and nutritive value of the different feeds. Each day a sheep will consume a total weight of feed (concentrate plus roughage) equal to approximately two to four per cent of its body weight.

Without chemical treatment, the quality of conserved fodder can only, at best, match that of the parent material. Therefore, whatever the fodder, the choice of the base plant material and the time of cutting, are the critical factors that determine the final nutritive value of the fodder.

The cost of fodder

Fodder can be relatively expensive, especially on a cost per unit of protein or energy basis. In addition to the cost of growing it, there are costs with harvesting, storing and feeding it out. Insect and vermin control, further treatment, processing or mixing and wastage all add to the cost of a conserved fodder by the time it is actually consumed by an animal. When calculating the cost of fodder, and when comparing the cost of different fodder options, the best measure to use is the energy content of the fodder per kilogram of dry matter. This is expressed as megajoules of metabolisable energy per kilogram dry matter.

Possible problems with fodder

Some of the problems associated with fodder are obvious and well-known, while others may be unexpected:

- **Bulk and weight** - Special equipment may be required for handling fodder, and large structures for its storage. There may be occupational health and safety hazards in lifting bales.
- **Cost** - Fodder may be an expensive source of energy if energy is the primary need.
- **Wastage** - is generally high (30 to 80 per cent) in feeding out fodder, unless special measures are taken.
- **Weeds** - such as rye grass, barley grass, Paterson's curse and radish are readily spread in hay. The risk of weed introduction in silage is much less.

- **Diseases** - Hay made from lupins, (especially blue lupins) may cause lupinosis. Hay may contain toxic rye grass seed-heads that can cause annual rye grass toxicity (ARGT). The fungi in mouldy hay can cause abortions, feed refusal or respiratory problems in stock. Mites, dust and possibly fungi in hay can cause respiratory problems in humans (farmer's lung). Silage that has not been adequately fermented, or has been exposed to the air, may contain *Listeria* bacteria that can cause abortions or encephalitis (circling disease).

Test fodder for nutritive value

For most types of conserved fodder the nutritive value, in terms of protein and metabolisable energy, is highly variable and not easy to estimate. The data recorded in Table 1 show the wide variation in the nutritive value of a number of different types of fodders fed to sheep in Western Australia.

Ideally, samples of each different batch of fodder should be submitted for a laboratory analysis. This is especially important when purchasing large quantities of conserved fodders. Some vendors will supply this information for their produce.

If fodder is unable to be tested in a laboratory it should at least be closely inspected. Check its smell, colour and density, look for weeds and any sign of moulds. In pasture hay check the proportion of legumes to grasses. Sheep are very selective feeders and may refuse mould, insect or vermin affected feed. If a hay or straw contains annual rye grass and comes from a district where ARGT is known to occur, a sample of the rye grass should be tested[1] to determine its safety for stock.

Table 1. The dry matter, energy, protein and fibre content (dry matter basis) of green fodders fed to sheep. The average across the range of values is shown in brackets.

Green fodders	Dry matter *(%)*	Metabolisable energy *(MJ/kg)*	Crude Protein *(%)*	Acid detergent fibre *(%)*
Cereals				
early growth	12 – 22 (17)	9.5 – 11.0 (10.5)	14.0 – 24.0 (18.0)	23.0 – 27.0 (25.0)
before heading	18 – 30 (25)	9.0 – 10.2 (9.5)	9.0 – 15.0 (12.0)	28.0 – 32.0 (30.0)
Pasture				
Early				
grass - dominant	10 – 20 (15)	10.0 – 11.8 (10.5)	20.0 – 27.0 (23.0)	22.0 – 26.0 (24.0)
clover - dominant	10 – 20 (15)	10.0 – 12.0 (10.8)	24.0 – 32.0 (27.0)	21.0 – 25.0 (23.0)
Flowering				
grass - dominant	20 – 30 (25)	9.5 – 10.5 (10.0)	10.0 – 15.0 (12.0)	28.0 – 33.0 (31.0)
clover - dominant	20 – 30 (25)	9.8 – 10.8 (10.3)	13.0 – 18.0 (15.0)	26.0 – 31.0 (29.0)
Millet for grazing	15 – 30 (22)	9.0 – 11.0 (10.5)	9.0 – 24.0 (17.0)	24.0 – 32.0 (29.0)
Sorghum hybrids				
immature	12 – 20 (17)	9.5 – 10.5 (10.0)	15.0 – 22.0 (17.0)	24.0 – 29.0 (27.0)
heading	25 – 35 (30)	9.0 – 10.0 (9.5)	7.0 – 14.0 (10.5)	28.0 – 34.0 (32.0)
Lucerne				
immature	12 – 20 (17)	9.8 – 11.2 (10.5)	22.0 – 33.0 (26.0)	24.0 – 27.5 (25.5)
10% flowering	20 – 30 (25)	9.2 – 10.2 (9.6)	15.0 – 22.0 (18.0)	28.0 – 34.0 (30.0)
Annual Ryegrass	10 – 30 (22	8.5 – 11.5 (10.0)	10.0 – 30.0 (14.0)	21.0 – 30.0 (28.0)
Perennial Ryegrass	12 – 30 (22)	8.5 – 11.5 (10.0)	10.0 – 30.0 (14.0)	21.0 – 30.0 (26.5)
Phalaris				
closely grazed	12 – 27 (20)	9.0 – 11.0 (10.0)	14.0 – 28.0 (17.0)	21.0 – 28.0 (26.0)

These values were extracted from data collected by Independent Lab Services, Perth.

[1] *Further information is available via AgFax 1902 990 506, Document number 20224, or contact Andrew Gregory, ARGT Testing Service, Animal Health Laboratories, Department of Agriculture, South Perth WA 6151*

Wrapped silage in the Porongorups.

Well covered silage stack at Denmark Agricultural College.

Silage

Compared with hay, there can be a number of advantages in making silage:

- Silage will generally be of higher nutritive value than the corresponding hay. This is because silage is normally made at an earlier stage of plant growth, when its digestibility, protein and metabolisable energy levels are higher.
- The plant re-growth that may occur after cutting silage provides a valuable grazing bonus by extending the growing season of a pasture or crop.
- This regrowth forage, having not been grazed, should be free of worms and will provide valuable feed for grazing by weaned lambs.
- Early cutting of pasture for silage favours clover growth and removes excess forage that often shelters pasture pests such as the red-legged earth mite.

Farmers interested in conserving silage may be concerned about the cost of the machinery required to make it and feed it out, and also the time required and possible wastage during feeding out. If no more than 200 tonnes of silage dry matter is to be made, a contractor is likely to be the least-cost choice. There are contractors equipped for, and experienced in, silage making in most areas of Western Australia. Feeding out also need not be a problem because various simple systems can be devised, including a self-feeding system from the face of a stack of chopped silage.

Silage made from pasture or cereal crops can be quite high in nutritive value, but it will not provide a complete diet for finishing sheep. Silage made from a mixture of a cereal and a legume, such as vetch, peas, a clover or a medic, may, however, have a high enough nutritive value to allow growth of lambs without the need for grain supplementation. The variability in the nutritive value of silages is shown in the values in Table 2.

Silage can be conserved in wrapped round bales, pits or above ground stacks. Baled and wrapped silage is likely to be the most expensive option, but it is preferred by the majority of farmers because of the ease of feeding-out and the convenience of using bales. Whatever method is used to make silage, it is important to ensure adequate compression and exclusion of air.

The performance of lambs fed bale silage can be quite good if the forage is wilted to a dry matter content of around 50 per cent before baling, especially if the parent forage has a good percentage of legume. Being of lower moisture content, this will reduce the cost of storing nutrients as bale silage.

Urea treated cereal silage

In Western Australia, most silage is made without additives, but urea treatment of cereal crops is a technique that may be of interest to wheatbelt farmers. For urea treated silage, the cereal crop is harvested at the medium to hard dough stage, when the dry matter content is 60 to 70 per cent. This is in contrast to the usual high-moisture silages that are harvested at around 30 to 35 per cent dry matter. The urea can be applied dry by thorough mixing with the chopped crop material or it can be applied at baling. If the cereal crop is above 70 percent dry matter it may be best to apply the urea as a solution. The urea treatment procedure should improve the digestibility and nitrogen levels compared with conventional fermented silage. It may also be a useful way to salvage frosted wheat or barley crops.

Hay

Hay is the product from a cut and dried pasture or crop. It can be made into large round bales, or small, medium or large square bales. Large round bales are the most popular, being the cheapest to make and safest to store in the open, uncovered. Hay is usually baled, but if required for chaff it is sometimes harvested with a reaper and binder and made into sheaves.

In general, the later the hay is cut the higher the yield (in tonnes per hectare), but the lower the nutritive value of the hay, due to a decline in protein content and digestibility. For cereal hay, yield will be highest if cut in the mid to late dough stage, but protein and metabolisable energy content will be highest if the hay is cut between flowering and the milk stage.

Wrapping hay bales reduces waste and deterioration.

Table 2. The dry matter, energy, protein and fibre content (dry matter basis) of silages. The average across the range of values is shown in brackets.

Silages	Dry matter (%)	Metabolisable energy (MJ/kg)	Crude protein (%)	Acid detergent fibre (%)
Pasture				
direct-cut (chop)	21 – 33 (25)	8.5 – 10.5 (9.5)	12.0 – 22.0 (16.0)	28.0 – 35.0 (33.0)
wilted (chop & bale)	35 – 55 (45)	8.8 – 10.8 (9.8)	12.0 – 25.0 (17.0)	28.0 – 33.0 (32.0)
Sorghum hybrid	25 – 35 (30)	8.0 – 9.0 (8.5)	6.0 – 10.0 (8.0)	32.0 – 35.0 (34.0)
Cereal crops (bale)	35 – 45 (40)	8.5 – 9.8 (9.1)	7.0 – 13.5 (9.5)	29.0 – 35.0 (32.5)
Cereal/Vetch	35 – 45 (40)	8.8 – 10.0 (9.7)	10.5 – 16.0 (13.0)	30.0 – 33.0 (31.0)
Lucerne (bale)	45 – 55 (50)	9.1 – 10.7 (9.5)	15.0 – 28.0 (22.0)	29.0 – 33.5 (30.5)

These figures have been extracted from data collected by Independent Lab Services, Perth.

If hay feeders are poorly designed or maintained, or if hay is fed on the ground in wet weather, wastage levels can be high, even if the hay is very palatable. Hay wastage can have a significant effect on profitability when feeding carry-over lambs in autumn. In a study reported in the December 1998 issue of the 'Ovine Observer', Milton and Davidson showed that 43 per cent less hay was required to finish crossbred lambs fed from a covered rack compared to a control group offered the same hay uncovered in the bale on the ground. The growth rates and carcase characteristics of the two groups of lambs were similar but the overall feed costs (including the same amount of grain fed to each group) were 26 per cent less for those fed the hay in a covered rack.

Cereal hay

Most cereal hay is made from oats or wheat. In the wheatbelt, cereal hay is frequently made from crops sown for grain production, rather than for hay. Hay is commonly made from firebreaks and sometimes from failed, diseased or frosted grain crops.

Hay made from firebreaks can be of good quality if cut at the right stage of maturity, but if it is not given priority as a hay crop, it may be cut too late for optimum nutritive value. Hay that is made to salvage a diseased crop may be of poor quality for sheep, due to low palatability or low energy or protein levels. However, a frosted or failed crop may produce a hay of reasonable protein and metabolisable energy content if it is not allowed to deteriorate

A firebreak is created when hay is made around the perimeter of a crop.

before being cut. Frosted crops may produce a hay that is readily eaten by sheep as the sugars trapped in the plant material may make the hay very palatable. As it is difficult to predict the nutritive value of these hays, laboratory testing is strongly recommended.

Oaten hay is usually made from a crop grown specifically for hay production. Hay varieties include Esk, Hay, Kalgan, Saia, Swan, Winjardie and Vasse. It is important to seek advice on the oat hay varieties most suited to your region and the appropriate agronomic practices for hay production.

Only a relatively small amount of wheaten hay is made from crops grown specifically for hay. The only hay variety is Baroota Wonder. Most wheaten hay is made from varieties that have been bred solely for their grain-related qualities.

The average nutritive values of Western Australian hays are recorded in Table 3.

Hay made from bearded (or awned) wheat may cause problems, such as impaction and abscesses, particularly in the mouths of cattle and horses. However, such problems are rarely observed or reported in sheep in Western Australia. This is curious since most of the wheat varieties grown in Western Australia are bearded.

Cereal hay containing toxic rye grass has been responsible for ARGT deaths in sheep, cattle and horses in Western Australia. If there is a possibility that hay may contain toxic rye grass, testing is strongly recommended.

If a cereal crop is to be sown specifically for hay, consider instead to sow a mixture of a cereal and a legume. The legume may be a vetch, pea, clover or medic. The cereal and legume varieties chosen to grow together should have similar flowering times.

Table 3. The dry matter, energy, protein and fibre content (dry matter basis) of hays. The average across the range of values is shown in brackets.

Hays	Dry matter *(%)*	Metabolisable energy *(MJ/kg)*	Crude protein *(%)*	Acid detergent fibre *(%)*
Oaten				
early-cut	90	8.8 – 10.2 (9.1)	7.0 – 12.5 (8.5)	25.0 – 32.0 (30.0)
late-cut	90	8.0 – 9.0 (8.5)	4.0 – 7.5 (6.0)	30.0 – 37.5 (32.5)
Wheaten				
early-cut	90	9.0 – 10.0 (9.4)	8.0 – 11.5 (9.5)	25.0 – 31.0 (29.0)
late-cut	90	8.0 – 9.0 (8.6)	4.5 – 7.5 (6.5)	30.0 – 36.0 (32.0)
Barley				
early-cut	90	9.0 – 10.0 (9.4)	8.0 – 11.0 (9.2)	25.0 – 31.0 (29.0)
late-cut	90	8.0 – 9.0 (8.6)	4.5– 7.5 (6.5)	30.0 – 36.0 (32.0)
Pasture				
Grass dominant				
early-cut	88	9.0 – 10.8 (10.0)	12.0 – 18.0 (14.5)	24.0 – 30.0 (28.0)
late-cut	88	8.0 – 9.5 (9.0)	8.0 – 12.0 (10.0)	30.0 – 34.5 (32.5)
Clover dominant				
early-cut	88	9.5 – 11.2 (10.2)	15.0 – 23.0 (17.0)	23.0 – 29.0 (27.5)
late-cut	89	8.5 – 9.8 (9.5)	11.0 – 15.0 (12.5)	30.0 – 33.0 (32.0)
CLIMA legume	89	9.3 – 11.1 (10.2)	14.0 – 20.0 (16.0)	27.0 – 32.0 (29.5)
Cereal/Vetch	88	9.0 – 10.0 (9.5)	10.5 – 15.5 (13.0)	29.5 – 32.0 (31.0)
Pea	88	9.0 – 10.0 (9.5)	13.0 – 17.0 (15.5)	30.0 – 33.0 (31.5)
Lucerne				
early-cut	88	9.8 – 10.5 (10.0)	20.0 – 30.0 (26.0)	27.0 – 29.0 (28.0)
late-cut	89	9.0 – 9.8 (9.5)	13.0 – 20.0 (15.0)	30.0 – 33.5 (32.0)

These values were extracted from data collected by Independent Lab Services, Perth.

A mixed cereal-legume hay crop is potentially superior to oaten hay for the following reasons:

- The nutritive value for sheep will be greater, because it is likely to be more palatable and have a higher protein, calcium and metabolisable energy content.
- A following grain crop may benefit from the extra nitrogen provided by the legume.
- A greater weight of hay – as much as 20 per cent more - may be cut from the paddock than from the cereal alone.
- After the hay is cut, the paddock will provide more grazing because it will be more nutritious than that provided by a cereal stubble alone.

Pasture hay

The composition, and therefore the feed value, of pasture hay can be extremely variable. Generally, the higher the legume content the better. Remember that pasture hay may contain nuisance or toxic weeds, such as Paterson's curse, bracken, barley grass, Cape tulip or herbicide-resistant or toxic rye grass.

Windrowed pasture

The technique of mowing and windrowing spring pasture, to be grazed *in situ* later, has been suggested as a low cost alternative to the making of pasture hay or silage.

David and Lyn Slade, of Rocky Gully have followed this practice on their farm for some years, in preference to spray topping. The Slades mow their pastures in spring primarily to minimise grass-seed damage to the skins of their prime lambs. The additional benefit, they believe, is that in seasons of abundant growth the large windrows have a thick thatched surface that protects and preserves the nutritive value of the underlying mown pasture.

Lucerne hay

Lucerne is sometimes referred to as the "King of Fodders", for good reasons. Well-made lucerne hay is a highly valued fodder, particularly by feed millers, fodder exporters and horse owners. It can be an excellent feed for sheep but it may not be economic to feed it to them, especially if the feeding system allows high wastage, by shattering of the most valuable component, the leaves.

Lupin hay.

Lupin hay is a very palatable fodder, of reasonable quality, for sheep. However, the different types of lupins present different risks from lupinosis.

With the commercial narrow-leafed lupins, lupinosis can be avoided by cutting the lupins no later than the finish of flowering on the tertiary branches. Rapid drying is necessary, so it is recommended to condition the lupins as they are cut.

The strategic cutting time and rapid drying are crucial to avoid lupinosis. Unfortunately, the conditions are more difficult to be met with the blue or sandplain lupin. These plants are self-sown and there is always a considerable variation in the stage of growth of plants in the stand. They also tend to have thicker stems than the narrow-leafed lupins, so take longer to dry. The end result is that although sandplain lupin hay will be less toxic than adjacent standing lupins, the toxicity is often not reduced sufficiently to avoid lupinosis. Cutting the sandplain lupins closer to the start of flowering may overcome these problems. However, this reduces the amount made and wet weather is more likely to be encountered during the drying period.

Hay frozen pasture or crop

Hay freezing is the practice of spraying a green pasture or crop with a herbicide, such as glyphosate or paraquat, to stop further growth and conserve the nutritive value of the standing plants for later grazing *in situ*. A similar practice, called brown manuring, is done primarily for weed control.

The nutritive value of hay frozen fodder can be quite high, depending on its components and time of spraying. Time and labour are saved compared with conventional hay making. The technique is not suitable for areas with wet summers because rain will leach out and break down the nutrients in the plants.

Case study - A hay-frozen mixed fodder crop at South Kumminin

In 1994 Alan and Ray Sedgwick at South Kumminin sowed a cereal-legume mix (oats/lupins) and fertilised it but did not control weeds. In addition to the oats and lupins, the paddock contained cape weed, radish and medic. The paddock was sprayed with Gramoxone® when the lupins were flowering. The following analysis is the average of two samples of the available feed taken from the paddock in mid-January, 1995:

Moisture (%)	6.4
Dry matter (%)	93.7
Acid detergent fibre (%)	30.6
Digestible dry matter (%)	65.7
Est. metabolisable energy (MJ/kg DM)	9.3
Crude protein (%)	13.8

Five hundred and ninety Merino ewe lambs spent 32 days on this paddock, from 12 January 1995, and they gained an average of eight kilograms, or an average daily weight gain of 250 grams per head per day.

The Sedgwicks term their practice 'stubble mulching'. They practise it primarily for the benefits it gives to the land and the following crops. They consider that the practice aids soil structure, weed control and improves the soil nitrogen levels. The benefits provided to their stock are a bonus!

Straw

Most types of straw provide only roughage for sheep. This is because most have high levels of indigestible material and a low protein content. Not surprisingly, they are also usually not palatable to sheep. Nevertheless, the straws collected from the header rows of low yielding crops produced in the 2000 growing season have been found to be of quite good nutritive value. Furthermore, the performances of sheep that grazed the 2000 season stubbles, as well as their utilisation of these stubbles, amazed many sheep producers. Again, a good reason why baled straws should be tested for protein and metabolisable energy content.

Various methods have been tried to improve the nutritive value of cereal straws. These have included treatment with sodium hydroxide, ammonia or urea, or spraying with molasses. The treatments are relatively expensive, and some are potentially dangerous to the operator or toxic for sheep. In any case, no matter how straw is treated, sheep will lose weight if that is all they are fed.

Further reading

Barr, A.R. and Pelham, S (1996). Growing Oat Hay. Kondinin Group, Belmont WA.

Casey M. (Ed.) (1994). Cut and Dried. Kondinin Group, Belmont WA.

Evans, M. (Coordinator) (1997). Fodder Costs. Kondinin Group, Belmont WA.

Farmnote 98/99. Fodder conservation as silage.

Feeding Sheep. (Revised December 1997). Edited by Brian Ashton and Tony Morbey. Primary Industries and Resources South Australia.

Maximum meat: the complete guide to producing quality meat sheep. Department of Agriculture. 1998.

Supplementary Feeding of Sheep
FOR MEAT PRODUCTION

John Milton, Department of Agriculture, based at The University of Western Australia, Nedlands and Janet Paterson, Sci Scribe Scientific Copywriting, Brookton.

KEY MESSAGES

- The correct supply of protein and energy is required to maintain good rumen function for the efficient conversion of feed into meat.
- Supply the rumen microbes with the nutrients that are limiting in the sheep's diet for cost-effective supplementary feeding.

Supplementary feeding

Sheep are supplementary fed for either survival, or for production: reproduction, lactation, weight gain or wool growth. Efficient supplementary feeding of sheep for meat production aims to supply sheep with the main nutrients that are deficient in their normal basal diet.

The main nutrients that limit growth are energy and protein. Both nutrients are required for healthy rumen function and the efficient conversion of feed into meat products.

Feeding for energy

To maintain liveweight, each day a sheep will require about 10 per cent of its bodyweight as metabolisable energy plus a further 1.8 megajoules of energy. For example, a 50 kilogram sheep requires 5 + 1.8 or 6.8 megajoules of metabolisable energy per day (see Table 1). This estimate appears to be generous and there are examples of 50 kilogram sheep during confinement feeding, maintaining their weight when fed a diet to supply only 5.5 megajoules of metabolisable energy per day. That is, about 80 per cent of the recommended requirement for maintenance.

The average metabolisable energy content of oaten grain is 10.7 megajoules per kilogram of dry matter (see Table 2). The 50 kilogram sheep in the example above will therefore need 635 grams of oats each day (6.8 megajoules divided by 10.7 megajoules multiplied by 1000) to maintain liveweight. In reality, about 700 grams of oats would need to be fed to take into account the 8 per cent moisture in the oaten grain and any wastage that may occur during feeding.

Lupins contain more metabolisable energy than oats (at about 13.7 megajoules per kilogram of dry matter) and therefore fewer lupins are required to maintain the liveweight of sheep. A 50 kilogram sheep would maintain liveweight on about 500 to 550 grams of lupins per day.

When feeding for energy it is best to work out the cost of each megajoule of metabolisable energy to determine which feed is most economical. For example, oaten grain with 10.7 megajoules per kilogram of dry matter and 7 per cent moisture priced at $100 per tonne, costs around 11 cents per kilogram of dry matter. The price per megajoule of metabolisable energy is therefore 11 divided by 11 or one cent per megajoule. This calculation can be done with any feed using the current price per kilogram for that feed.

How to use Table 1:

A 50 kilogram sheep (shorn) needs 6.8 megajoules of metabolisable energy per day to maintain its liveweight. This can be supplied with 0.54 kilograms of a feed that contains 12 megajoule per kilogram (for example wheat grain) or 0.68 kilograms of a feed such as oats containing 10 megajoules of metabolisable energy per kilogram.

Feeding for protein and good rumen function

To use the energy supplied in the diet efficiently, a good source of protein must also be provided. Supplementary feeding with feeds that are high in energy but low in protein will lead to poor rumen function and inefficient conversion of feed into meat products. This is because the microbes in the rumen need a protein source to reproduce and grow and to maintain their population.

If the protein in the diet is low, the microbial population declines and consequently less

Table 1. The energy (megajoules per day) and kilograms of feed needed to maintain sheep of different weights

Shorn weight *(kg)*	Paddock weight *(kg)*	Energy requirement *(MJ/day)*	Metabolisable energy content of feed (MJ/kg DM) 8	9	10	11	12
			feed needed (kg/head/day) for maintenance				
20	21	3.8	0.44	0.38	0.33	0.3	0.26
30	32	4.8	0.59	0.52	0.46	0.41	0.36
40	43	5.8	0.75	0.65	0.57	0.51	0.46
50	54	6.8	0.89	0.77	0.68	0.61	0.54
60	64	7.8	1.03	0.89	0.78	0.7	0.63

microbial protein is available to the sheep for growth. In addition, if the microbial population is lowered, there are fewer microbes to break down the feed eaten by the animal and feed is wasted through inefficient digestion. Feed intake also will be reduced as a result of the slowing of digestion in the rumen since the rate at which feed particles are broken down and leave the rumen will decline. Thus, there will be less space available in the rumen for more new food to enter.

An example of this is when adult sheep are fed straw alone to maintain their liveweight. Straw is made up largely of complex carbohydrates (energy) and is inherently low in protein - as little as three per cent crude protein content. Because of this, the rumen microbes become deficient in protein and are not able to maintain their population. Less microbial protein is then available for the sheep to convert into muscle or meat.

As the microbial population declines, the straw can not be fully digested and the energy it contains remains unavailable to the sheep. This reduction in digestion causes the feed to bulk up in the rumen of the animal and will lower its rate of feed intake. All of these factors combine to cause the animal to lose weight and body condition.

In this case, adding a protein-rich feed such as lupins would improve the protein supply to the rumen microbes which in turn will allow the sheep to make better use of the energy available in the straw. As little as 80 grams of lupins per day may provide the extra protein required by an adult sheep grazing dry pastures or cereal stubbles or being fed a low-quality hay.

The protein and energy contents of feeds can vary widely between and within paddocks and years, and between varieties and for different fertiliser inputs, so it is important to have feeds tested for protein and energy levels. Knowing the protein and energy contents of feeds is particularly important when growing sheep out for meat production; it will help with ration formulation and for comparing the costs of different feeds on a nutrient basis as well as reducing wastage of feedstuffs. The ranges in protein and metabolisable energy contents of some common feeds fed to sheep in Western Australia are given in Tables 2 to 5 in this section.

Problems with grain supplements

Apart from being a good source of protein, lupins also have a major advantage over cereal grains and most other grain legumes because they contain virtually no starch (a form of carbohydrate). The starch in these other grains is rapidly fermented in the rumen to produce acidic conditions (that is, a lowering of pH). A low pH will eventually kill the fibre digesting microbes in the rumen and consequently reduce the amount of energy and protein that becomes available to the sheep. In this situation, the sheep will reduce their feed intake and substitute the supplementary grain for dry roughage.

In the worst case scenario, there may even be a '*negative efficiency of supplementation*' when the intake of the basal forage is reduced by more than the amount of supplementary grain eaten. In other words, the consumption of the supplementary feed actually causes the animal to lose weight rather than maintain or gain weight. This is typical of what can happen when sheep are supplemented with cereal grain at the end of the pasture growing season. In this case, feeding a small amount of lupin grain is the best form of supplementary feeding to supply protein and energy to encourage the utilisation of the dry roughage.

Although lupins are a good source of protein, the nitrogen (N) to sulphur (S) ratio can be too wide and cause deficiencies of particular amino acids in the animal. In this case, microbial protein synthesis may be reduced and the protein supplied to the sheep's small intestine may not contain adequate sulphur amino acids for both wool and muscle growth.

A wide N:S ratio can be overcome by providing a mineral supplement containing sulphate sulphur or by providing the sheep with a supplement of organic sulphur in the form of expeller canola meal to supply extra sulphur amino acids to the small intestine.

Successful supplementary feeding

A good indicator of the time to start supplementary feeding is to note when sheep begin to access water points towards the end of the pasture growing season. The sheep seeking water indicates that the pasture is beginning to dry off and lose its nutritional value to stock. At this point it is important to start trailing out some lupins (about 50 grams per head per day) to maintain a supply of protein and non-starch energy to the sheep, especially young sheep that have a high nutrient requirement for growth. Young sheep will not have experienced lupins before and for them to recognise lupins as a feed it is important to start feeding lupins to the lambs with their mothers before they are weaned This allows the ewes to teach the lambs all about eating supplements of lupins.

As the feed quality drops off, it is prudent to increase the supply of lupins up to about 200 grams per day. Feeding above this level of lupins may lead to a *substitution effect* whereby the sheep will wait for the next feed of lupins rather than go out and eat more of the dry forage. If weaner growth falls below 100 grams per day they will need to be moved to a new paddock with more dry feed available, or better quality feed. Young sheep will often require a complete mineral mix to maintain good growth rates, particularly if the dry feed has had essential minerals leached out from being rained on.

When feeding supplements to sheep, the goal is to achieve the maximum production returns from the minimum costs of feed inputs. An understanding of the special energy and protein requirements of the microbial population in the rumen can help to achieve this. The most important point to remember is to supply the correct balance and form of protein and energy to the microbes in the rumen. In short, cost effective supplementary feeding of sheep is really about supplying the rumen microbes with the nutrients that are limiting in the basal diet.

All feeds contain some water and it is important to compare feeds on a dry-matter basis to eliminate the differences in water content. To convert the energy and protein contents expressed on a dry matter basis to a fresh or 'as fed' basis, multiply the energy or protein value by the dry matter percentage of the feed and divide by 100.

The energy content of most grains and pulses ranges from 10 to 13 megajoules per kilogram of dry feed (see Table 2). Lupins provide the highest energy content. Lupins are particularly good as an energy source because they contain no starch and will not cause acidosis. The lower the energy content of a feed, the more feed that must be fed to maintain a sheep or to achieve some growth.

The protein content of a feed can vary widely with season and feed-type. In most years oaten grain is relatively low in protein (7 to 10 percent on a dry matter basis) and will need to be supplemented with lupins to supply adequate protein for growing sheep or lactating ewes. However, a high proportion of the light oaten grain from the 2000 growing season was high in protein (12 to 16 per cent on a dry matter basis). This allowed many producers to reduce, by half, the amount of lupins in the feed mix fed to maintain sheep which resulted in a big saving because lupins were in extremely short supply and consequently were very expensive.

Oaten grains can also vary by as much as 1.5 megajoules of

Table 2. Grain-based sheep feeds: the dry matter, energy, protein and fibre contents (dry matter basis). The average across the range of values is shown in brackets.

Feed grains	Dry matter *(%)*	Metabolisable energy *(MJ/kg)*	Crude protein *(%)*	Acid detergent fibre *(%)*
Cereals and Pulses				
Wheat	91	12.4 – 13.3 (12.9)	7.5 – 15.0 (11.5)	2.5 – 4.5 (3.0)
Barley	91	11.6 – 12.2 (11.9)	7.0 – 13.0 (11.0)	7.0 – 9.5 (8.0)
Triticale	90	12.0 – 13.0 (12.5)	7.5 – 14.0 (11.0)	3.5 – 5.0 (4.0)
Oats	92	10.4 – 11.3 (10.7)	5.5 – 13.5 (9.0)	16.0 – 21.5(18.5)
Narrow leaf Lupins	92	13.1 – 14.1 (13.7)	27.0 - 42.0 (34.0)	17.5 - 23.0 (20.0)
Albus Lupins	92	13.4 - 15.0 (14.0)	34.0 - 44.0 (38.0)	17.0 - 21.0 (19.0)
Peas	91	12.5 – 13.5 (13.0)	21.5 – 30.0 (25.5)	6.0 – 10.5 (9.0)
Vetch	91	12.4 – 13.2 (12.8)	26. 0 – 34.5(29.0)	7.5 – 9.5 (8.5)
Chick Peas	91	12.0 – 13.0 (12.4)	18.0 – 24.0 (21.0)	12.0 – 16.0 (14.0)
Faba beans	90	12.4 – 13.2 (12.9)	22.0 – 30.0 (26.0)	7.5 – 9.5 (8.5)
Canola (>35% Oil)	95	15.0 – 17.0 (16.0)	20.0 – 25.0 (22.0)	22.5 – 26.5 (24.0)
Cereal seconds				
Wheat	92	11.8 – 12.4 (12.1)	12.5 – 17.0 (13.5)	3.5 – 5.5 (4.5)
Barley	93	11.1 – 11.8 (11.4)	11.0 – 14.5 (12.5)	9.5 – 12.5 (10.0)
Triticale	92	11.3 – 12.1 (11.7)	10.5 – 15.5 (13.0)	4.5 – 6.5 (5.5)
Oats	93	9.8 – 10.5 (10.3)	4.5 – 16.0 (12.5)	21.0 – 26.0 (23.5)
Sheep pellets				
Maintenance	90.0	8.0 – 9.0 (8.5)	8.5 – 9.5 (9.0)	29.5 – 32.0 (31.0)
Production	91.0	10.6 – 11.4 (11.0)	13.5– 16.0 (15.0)	20.0 – 25.0 (23.0)

These values were extracted from data collected by Independent Lab Services, Perth.

Table 3. Hays fed to sheep: the dry matter, energy, protein and fibre contents (dry matter basis). The average across the range of values is shown in brackets.

Hays	Dry matter *(%)*	Metabolisable energy *(MJ/kg)*	Crude protein *(%)*	Acid detergent fibre *(%)*
Oaten				
early-cut	90	8.8 – 10.2 (9.1)	7.0 – 12.5 (8.5)	25.0 – 32.0 (30.0)
late-cut	90	8.0 – 9.0 (8.5)	4.0 – 7.5 (6.0)	30.0 – 37.5 (32.5)
Wheaten				
early-cut	90	9.0 – 10.0 (9.4)	8.0 – 11.5 (9.5)	25.0 – 31.0 (29.0)
late-cut	90	8.0 – 9.0 (8.6)	4.5 – 7.5 (6.5)	30.0 – 36.0 (32.0)
Barley				
early-cut	90	9.0 – 10.0 (9.4)	8.0 – 11.0 (9.2)	25.0 – 31.0 (29.0)
late-cut	90	8.0 – 9.0 (8.6)	4.5– 7.5 (6.5)	30.0 – 36.0 (32.0)
Pasture				
Grass dominant				
early-cut	88	9.0 – 10.8 (10.0)	12.0 – 18.0 (14.5)	24.0 – 30.0 (28.0)
late-cut	88	8.0 – 9.5 (9.0)	8.0 – 12.0 (10.0)	30.0 – 34.5 (32.5)
Clover dominant				
early-cut	88	9.5 – 11.2 (10.2)	15.0 – 23.0 (17.0)	23.0 – 29.0 (27.5)
late-cut	89	8.5 – 9.8 (9.5)	11.0 – 15.0 (12.5)	30.0 – 33.0 (32.0)
CLIMA legume	89	9.3 – 11.1 (10.2)	14.0 – 20.0 (16.0)	27.0 – 32.0 (29.5)
Cereal/Vetch	88	9.0 – 10.0 (9.5)	10.5 – 15.5 (13.0)	29.5 – 32.0 (31.0)
Pea	88	9.0 – 10.0 (9.5)	13.0 – 17.0 (15.5)	30.0 – 33.0 (31.5)
Lucerne				
early-cut	88	9.8 – 10.5 (10.0)	20.0 – 30.0 (26.0)	27.0 – 29.0 (28.0)
late-cut	89	9.0 – 9.8 (9.5)	13.0 – 20.0 (15.0)	30.0 – 33.5 (32.0)

These values were extracted from data collected by Independent Lab Services, Perth.

metabolisable energy per kilogram of dry matter between high and low lignin oat varieties. Therefore, it is important to have feeds tested for energy and protein contents so that you can be sure the sheep are receiving the correct amount of energy and protein for maintenance or growth as well as to provide them with the most cost-effective diet.

Early-cut hays generally have higher energy and protein contents than later-cut hays (see Table 3). Legume-based hays have higher protein contents than cereal-based hays. As with grains and pulses, the protein content of hays will vary with the growing season and agronomic practices making it important to have hays tested so that precise feed-rations can be calculated. In most cases cereal hays and late-cut pasture hays will need to be supplemented with lupins to provide adequate protein to growing sheep and lactating ewes.

Generally stubbles and straws that have low values for protein and metabolisable energy are of little nutritional value for sheep apart from providing fibre (see Table 4). They will need to be supplemented with a grain to maintain adult sheep and certainly to grow out weaners. However, many of the stubbles from the 2000 growing season had high values for protein and metabolisable energy and were a valuable feed resource.

Chaff-cart residues will maintain adult sheep, but they may need to be supplemented

Table 4. Straws and stubbles fed to sheep: the dry matter, energy, protein and fibre contents (dry matter basis). The average across the range of values is shown in brackets.

Straws/ stubble	Dry matter *(%)*	Metabolisable energy *(MJ/kg)*	Crude protein *(%)*	Acid detergent fibre *(%)*
Oat	89	6.0 – 7.7 (6.8)	4.0 – 6.5 (5.0)	38.0 – 45.0 (43.0)
Barley	89	6.0 – 7.5 (6.7)	4.0 – 6.5 (5.0)	38.0 – 47.0 (44.0)
Wheat	91	5.8 – 7.0 (6.5)	2.5 – 6.5 (3.5)	43.0 – 52.0 (47.0)
Triticale	89	5.5 – 7.0 (6.3)	2.5 – 6.0 (3.5)	44.0 – 52.0 (48.0)
Lupin	92	5.5 – 9.5 (8.0)	6.0 – 10.0 (8.0)	36.0 – 44.0 (42.0)
Pea	90	6.5 – 7.8 (7.2)	6.0 – 8.5 (7.5)	38.0 – 44.0 (42.5)
Canola	92	5.5 – 7.5 (6.5)	4.0 – 7.5 (6.0)	42.0 – 50.0 (47.0)
Sorghum	88	5.5 – 7.0 (6.5)	3.5 – 6.0 (4.5)	45.0 – 54.0 (48.0)

These values were extracted from data collected by Independent Lab Services, Perth.

Table 5. Chaff-cart residues: the dry matter, energy, protein and fibre contents (dry matter basis). The average across the range of values is shown in brackets.

Chaff-cart residues	Dry matter *(%)*	Metabolisable energy *(MJ/kg)*	Crude protein *(%)*	Acid detergent fibre *(%)*
Oat	90	6.5 – 8.0 (7.2)	5.0 – 7.0 (6.0)	36.0 – 44.0 (41.0)
Barley	90	6.5 – 8.2 (7.5)	5.0 – 7.5 (6.5)	37.0 – 45.0 (42.0)
Wheat	90	6.2 – 8.5 (7.5)	4.5 – 8.0 (6.5)	39.0 – 50.0 (45.0)
Canola	92	6.0 – 8.5 (7.5)	5.0 – 9.5 (7.5)	42.0 – 50.0 (45.0)
Lupin	92	7.5 – 9.5 (8.5)	7.5 – 11.5 (9.5)	35.0 – 43.0 (41.0)

These values were extracted from data collected by Independent Lab Services, Perth.

with additional protein if the protein content of the diet consumed falls below seven per cent. The average contents of the nutrients in chaff-cart residues are given in Table 5.

Further reading

Farmnote 74/2000.
Achieving production targets for prime lambs.

Farmnote 35/95.
Supplementing weaner sheep grazed on oat stubbles with sandplain lupin seed.

Farmnote 65/91.
Selection of supplementary feeds.

Farmnote 79/91.
Lupins versus feed blocks for sheep.

Farmnote 56/89.
Hand feeding sheep; add finely ground limestone to grain.

Farmnote 99/85.
Boosting nitrogen content of oats for sheep feed.

Lot-Feeding PRIME LAMBS

John Milton, Department of Agriculture, based at
The University of Western Australia, Nedlands

Lot-feeding prime lambs

Lot-feeding can be defined as feeding animals in a confined area with all required nutrients being brought to the animals. The area available to the animals is generally small so that their movement is restricted to minimise energy expenditure. Good quality water must be available for the animals and it is preferable to also provide them with shade and protection from inclement weather.

Lot-feeding prime lambs in Western Australia is often an opportunistic and value-adding activity with the objective to bring unfinished lambs up to market specifications when there is a shortage of quality paddock feed. Some lot-feeders operate year-round as specialists and they may house the lambs in sheds, mainly to provide protection from cold rainy weather.

Factors to consider when setting up a feedlot

Site of the feedlot

Feedlots can generate dust and smells, and water run-off from a feedlot may pollute waterways. Consideration must be given to the location of the feedlot in relation to watercourses, public roads and houses. Use natural vegetation wherever possible to provide lambs with shade and shelter from wind and inclement weather. However, the vegetation will also need to be protected from damage by the lambs.

Soil type and slope are also important factors. Sandy soils may drain well, but can be prone to wind erosion if the surface becomes bare and the soil is disturbed. Heavy soils are less prone to wind erosion, but may become muddy when wet and this can lead to the spread of footrot, foot abscesses, salmonellosis and coccidiosis. A good slope aids drainage, but if too steep the site may be predisposed to water erosion. It can be beneficial to establish the feedlot on the north or north east side of a hill or mound so the site gets maximum sun in winter.

Water availability and quality

To maximise feed intake, lambs must have an adequate supply of cool, clean water with a maximum of 5000 parts per million of total dissolved salts (approximately 900 milliSiemens per metre). If the total dissolved salts in the water is above 1000 parts per million it is wise to have the water analysed so the level of minerals added in the diet can be adjusted if necessary. Allow at least four litres of water per lamb per day when calculating daily water demand and provide at least 75 centimetres of water trough length per 100 lambs on feed. Inadequate space at the water trough, high salt levels, or contamination of water with algae, feed, dust or faeces can result in reduced water intake, and consequently reduced feed intake and lamb performance.

Area per lamb

The area allocated per animal will vary with the type of feedlot. In a confined, indoor set-up it can range from 0.5 to two square metres per lamb. In small paddocks the area needs to be small enough to prevent the lambs chasing 'green pick' thereby wasting energy, but large enough to prevent boggy conditions when it rains. It may be an advantage to have a larger area available when the lambs first enter the feedlot, and to subsequently reduce the area to prevent the generation of dust. However, if the area is too large when the lambs first go into the feedlot some may hang-back and be slow to eat from the feeders. Generally an area of about 0.5 square metres per lamb is adequate for mobs of up to 500 lambs.

Mob size

A maximum of 500 lambs per mob with mobs of 300 to 400 is preferred for ease of management. It is often wise to draft lambs into mobs based on sex, size, condition or similar feed history.

Feeding systems

The choice of feeding system is influenced by commitment, cost and convenience.

Complete mixed rations can be fed once or twice a day in open troughs. This is a more labour-intensive option. The ration is generally quite bulky because roughage (hay or silage) is mixed with the grain. This system gives good control of

Carryover lambs in an indoor feedlot at Donnybrook.

the diet consumed, but a mixer (Mixall) or feed wagon is required to mix the grain and feed-out the ration.

Lambs generally need about 25 centimetres of trough space per lamb with open feed troughs. It is important that troughs be adequately protected so that lambs can not get in the troughs and foul the feed.

Various options to provide feed at all times are available and include:

- *Ad libitum* access to a complete mix of grain, milled roughage, minerals and vitamins.
- *Ad libitum* on a grain, mineral and vitamin mix or pellet in feeders and roughage in separate troughs.
- *Ad libitum* access to a pellet ration of grains/roughage /minerals and vitamins.

Self-feeders are convenient, reduce the need for regular feeding and require less trough space per lamb with *ad libitum* access (only four to five centimetres per lamb). Lambs go onto the feed quicker if there is plenty of space and if space is inadequate there may be a 'tail' of lambs because of shy feeders. Round feeders allow better access than straight troughs.

With the first option listed above the hay or stubble has to be milled to mix it with the grain. This requires special machinery and can be labour intensive. There can also be problems with the ration 'bridging' and the sheep may selectively eat the grain from the mix. Silage can not be fed in this system.

The second option requires only basic equipment to mix the grain with a mineral/vitamin pre-mix and deliver the mix or pellets to the feeders. Hay or silage can be put in racks or the bales rolled out. With this option, the lambs have a choice and may eat different proportions of the grain mix, pellet or roughage. This ability to choose their diet can affect growth rates and may result in acidosis if the lambs do not eat adequate roughage. The roughage, especially hay, must be protected from rain to avoid it getting wet and being rejected by the lambs.

The third option of using a formulated pellet is a convenient way to provide a complete diet. It may be beneficial if the pellet contains some long fibre to maintain good rumen function. There is a cost for pelleting, but as well as being convenient, appropriate pellets may allow rapid introduction and good growth from day one.

Finishing in small paddocks

Hay or silage can be fed *ad libitum* with a grain trail offered two or three times per week. Conveyor belting makes a handy trough to feed silage. Guttering can be used as a trough to feed grain. It may be possible to feed silage *ad libitum* from a clamp with grain offered two or three times per week. The amount of grain fed is used as the 'throttle' to control the lambs' growth rate. These cheap feeding systems can be used to achieve modest growth of 50 grams per head per day for carryover lambs through to higher growth rates of 175 grams per head per day to finish lambs for slaughter.

Lupins can be trail-fed on clean, hard ground. However, there is likely to be some wastage with cereal grains in wet weather and these grains are best fed in a simple trough or guttering.

In a production situation, it is possible that the mineral levels in roughage and grain may be marginal or deficient for maximum growth rates. Minerals with or without canola meal can be fed 'free-choice', or mixed with the grain.

Ration considerations

Introducing high grain diets

There is always some risk of acidosis when lambs are fed high grain diets, so these rations must be introduced carefully. Even minor acidosis can result in serious losses. Apart from the loss of animals, time and grain, there may also be a lengthy recovery for some animals. This can set back the program a number of weeks and you may miss a contract or prices may have fallen by the time the lambs are suitable for slaughter.

The risk of acidosis can be minimised by ensuring the lambs are adapted to the high grain diet and that they consume enough roughage to stimulate 'chewing the cud'. The following practices will reduce the incidence of acidosis:

- Gradually switch from a high roughage to a high grain diet over ten to 14 days and keep adequate roughage in the ration. Growth during this introductory period is often slow.
- Start with a high percentage of lupins and roughage and gradually raise the percentage of cereal grain and reduce the lupins and roughage to the desired level. (This may allow good growth from day one).
- Whole cereal grain is less likely to cause acidosis than milled grain. Milling or processing the cereal grain component of rations provides little if any nutritional benefit to lambs and generally increases the risk of acidosis. However, coarse milling of lupins may help deter lambs from selecting out this grain from other ration components.

Some producers incorporate additives with the grains fed to lambs to reduce the chance of the animals developing acidosis or at least to reduce the severity of acidosis. These products and compounds include ground limestone (calcium carbonate), bentonite, and sodium bicarbonate.

For further advice on the use of additives with grain rations contact your consultant or local office of Department of Agriculture.

As discussed in an earlier section of this bulletin, the main nutrients to be supplied in rations are:

- Crude protein expressed as a percentage of the total dry matter. The protein level required in the diet depends on the liveweight of the lambs to be fed and their potential for muscle growth. The level of crude protein required is usually in the range of 14 to 16 per cent.
- Metabolisable energy expressed as megajoules of metabolisable energy per kilogram of dry matter. The dietary requirement for metabolisable energy is influenced by lamb liveweight and the desired growth rate and the potential intake of the ration to be fed. Usually it is in the range of 10.5 to 12.0 megajoules per kilogram of dry matter.
- Minerals both major (grams per kilogram) and minor (milligrams per kilogram) must be adequate to support high growth rates as deficiencies will limit performance.
- The body stores of vitamins A and E may be low if lambs have been off green feed for more than a few months. Backward lambs may need to be injected with vitamin B_{12} on entry to the feedlot. Lambs fed indoors may need vitamin D and vitamin B_1 deficiency may be a problem with diets that do not encourage good rumen function.

Lambs in an outdoor feedlot at Williams with large square bales providing shelter from the wind.

It is essential to know the nutrient content of the available feeds. There is a wide variation in crude protein and metabolisable energy between feeds and within feeds between years. Season, fertiliser inputs, variety and yield all influence the level of protein and energy in feeds.

It is recommended that feeds be analysed for dry matter, crude protein and energy content so that a ration can be formulated to meet the nutrient requirements that will achieve the desired growth rate and degree of fattening. Feed analysis information can also be used to compare different feeds based on their cost per unit of crude protein and metabolisable energy.

Economics

It is important to do an economic analysis before starting to feed. The economics of lot-feeding relies on the cost to effectively combine feedstuffs to supply all the nutrients required for optimum lamb growth and to achieve carcases with meat of desirable eating quality.

- Know the buy-in price of lambs (put a value on your own lambs).
- It is preferable to have a signed contract with an agreed sale price for lambs.
- Estimate the ratio of feed intake to liveweight gain (feed conversion ratio).
- If possible, know the genetic ability of the lambs fed (potential growth rate and fatness).

Calculate the costs per kilogram of weight gain, including:

- The cost of capital items used for lot-feeding.
- Feed stuffs (realistically value your own feed ingredients).
- Labour.
- Health and management costs.
- Lambs fed that are unlikely to finish (this may be up to 20 per cent).

Performance indicators for 35 kilogram lambs finishing at 45 kilogram liveweight are:

1st cross lambs:

- Growth rates of 250 to 350 grams per head per day. Feed conversion ratios of 7:1 to 5.5:1 for rations of about 90 per cent dry matter.

Merino lambs:

- Growth rates of 220 to 320 grams per head per day. Feed conversion ratios of 7.5:1 to 6:1 for rations of about 90 per cent dry matter.

Health

- Drench on entry to the feedlot with an effective broad-spectrum drench.
- Control lice - they affect performance and can cause cotting of fleeces.
- Vaccinate with 3:1 or 6:1 (with or without selenium and Vitamin B_{12}) to control Clostridial diseases, especially enterotoxaemia or pulpy kidney that is favoured by diets high in starch. Selenium can be deficient in many areas of Western Australia and can be administered in drenches as well as with vaccines.
- Inject vitamins A, D and E if the lambs have been off green feed for more than two months and these vitamins are not being supplied as a pre-mix. Low vitamin E levels must be corrected with the use of a powdered formulation, either as a drench or mixed with grain.
- Inject with vitamin B_{12} if lambs are low in condition on entry to the feedlot.
- Avoid feeding lambs affected by lupinosis, especially those showing signs of jaundice.
- Urinary calculi (water belly) can occur in lambs fed grain rations for prolonged periods, especially wethers. Add calcium to the ration to correct the calcium to phosphorus imbalance from cereal grain and ensure there is adequate roughage so that lambs 'chew the cud'. Finely ground limestone is probably the best source of calcium, but gypsum can also be used.
- Check for grass seeds in the skin and/or eyes.
- Pink eye - reduce dust and remove infected lambs. Provide good access to feed and water, especially if lambs are blind.
- Scabby mouth - avoid abrasive roughages. The virus can quickly spread to many lambs, but mortality is generally low. Feed intake is probably affected with severe lesions on the lips causing a reduction in growth rates. A vaccine against the disease is available and is now widely used in Western Australia. Animals with an unknown vaccination history should be vaccinated before entry to a feedlot.
- Coccidiosis - caused by overcrowded, unhygienic conditions and faecal contamination of feed, especially in wet weather. The problem is precipitated by stress and infected lambs may remain poor doers. Lasalocid is registered for use in sheep diets and is effective for the control of coccidiosis.
- Pneumonia - is a bacterial infection aggravated by dust and cold stress. The disorder can be treated with antibiotics, but it is important to adhere to withholding periods.

Husbandry/management

- Weigh and fat score lambs to monitor growth and to check that they are on target for the proposed slaughter date. Adjust the rations if necessary to keep lambs on target to meet specifications.
- Only send those lambs for slaughter that will meet the specifications. Fat score, weigh and make an assessment of the likely dressing percentage after allowing for the factors that affect dressing percentage; time off feed, length of wool, fat score and transport stress.
- Woolly lambs are best shorn on entry to the feedlot, but consider their skin value at slaughter. Shearing raises feed intake in warm weather and can improve growth rate. Shorn lambs need less feed space, are less prone to fly strike but are very prone to cold stress.
- With large numbers of lambs, separate the ewes from wethers to facilitate monitoring so that the ewes in particular do not get too fat. It may be necessary to feed ewes and wethers different diets if ewes are to be lot-fed to produce heavy carcases.
- Sick lambs are best removed from the feedlot.
- Shy feeders need to be drafted off early and fed separately or put out on pasture.
- Minimise stress; dogs must not be allowed to annoy lambs. Handle lambs carefully at all times.
- If feeding-out a complete mixed ration, feed at the same time each day and by the same routine. Keep self-feeders full at all times once the lambs have adapted to the ration.
- Be vigilant for things going wrong, for example, dirty water troughs, fly strike, lambs not 'chewing the cud', lambs scouring, lambs not eating roughage or selecting out individual components of the ration. Problems can quickly turn into financial disasters with lambs under intensive management, so attention to detail is essential.

Welfare and safe food issues

Follow best practices, keep records of all health and husbandry practices. Follow withholding periods for drenches, chemicals and antibiotics. Clean up daggy lambs and allow lambs to empty-out for at least 8 hours, preferably on grating, before trucking.

Further reading

Farmnote 72/2000.
Sheep health in a feedlot.

Farmnote 73/2000.
Lot-feeding prime lambs.

Farmnote 74/2000.
Achieving production targets for prime lambs.

Farmnote 25/99.
Preparation and assessment of sheep and lambs for slaughter.

Maximum meat: the complete guide to producing quality sheep meat. Department of Agriculture. 1998

Feeding for MEAT COLOUR

Robin Jacob and Graham Gardner,
Murdoch University, Murdoch.

KEY MESSAGES

- Meat with a pH above 5.7 tends to be darker than that desired by consumers and has poorer keeping and eating qualities than meat with a pH below 5.7.
- Meat pH is determined by the amount of muscle sugar (glycogen) in the muscle when the animal is slaughtered.
- High-energy diets (above 11 megajoules metabolisable energy per kilogram) before slaughter will increase reserves of muscle sugar and help to maintain good meat colour.
- Stressful activities such as handling or transport will deplete reserves of muscle sugar.
- Merino sheep tend to be more susceptible to stress than British breeds or cross breds.
- Magnesium oxide supplements (one per cent for four days before slaughter) will reduce the stress response.

The Significance of Meat Colour

Colour is a key issue in the eating quality of meat. The trade discounts dark cutting meat, as consumers prefer meat to be "cherry red". Dark cutting meat:

- is less visually attractive to consumers;
- takes longer to "bloom" on exposure to air;
- is tougher;
- has poorer keeping qualities;
- takes longer to cook;
- has a stronger flavour, and
- yields less.

Acidity determines colour

Acidity interacts with the pigments in meat and is a major determinant of meat colour. Acidity is measured by pH. If meat has a pH greater than 5.7 it tends to be dark and have the properties listed above.

Muscle sugars determine acidity

Meat acidity depends on the amount of lactic acid formed from muscle sugar (glycogen) after the animal is slaughtered. High sugar levels before slaughter result in a low pH, around 5.5, and desirable colour.

Nutrition and stress are the key determinants of muscle sugar. Nutrition can fill the glycogen reserves similar to filling a bucket, while stress can drain glycogen reserves as holes would drain a bucket. Merino sheep are more susceptible to dark cutting than British breeds and crossbred sheep because of their increased susceptibility to stress.

Finish on high energy diets

Feeding high-energy diets of around 11 megajoules of metabolisable energy per kilogram will increase stores of muscle glycogen. Grain-based diets are generally required to achieve this level of energy. However, research has shown that high energy feeding is only required for seven days to increase muscle sugar.

In practice, 14 days is recommended to allow safe introduction to grain diets and to ensure that all animals in a group are eating the diet. In other words, sheep that reach marketable weight and fat score ranges on low-energy paddock diets, will require a final two-week grain-based feeding program to ensure desirable meat colour.

Shearing and Feeding

Feeding is especially important for sheep shorn within four weeks of slaughter and exposed to cold or wet conditions. Without the insulating properties of their fleece, sheep exposed to cold conditions will draw on energy reserves to balance energy requirements. This can have a direct effect on muscle sugar if dietary energy is limiting. If sheep are fed high-energy diets after shearing they can compensate to the point where stores of muscle sugar are unaffected by cold. Again, feeding need only be for two weeks before slaughter.

Feed additives to prevent stress

Adding magnesium oxide to the diet at a rate of one per cent (10 kilograms per tonne) for four days before slaughter, can reduce the losses of muscle sugar caused by the stress of transport and lairage.

Magnesium blocks the effects of adrenaline and therefore prevents stress from causing muscles to use up stored sugar. However, it should not be added to diets for longer than four days as the effect wears off when it is fed for longer. Also, adding magnesium is not as important as the energy in the diet that will ensure sheep start with high stores of muscle glycogen before they leave the farm for the abattoir.

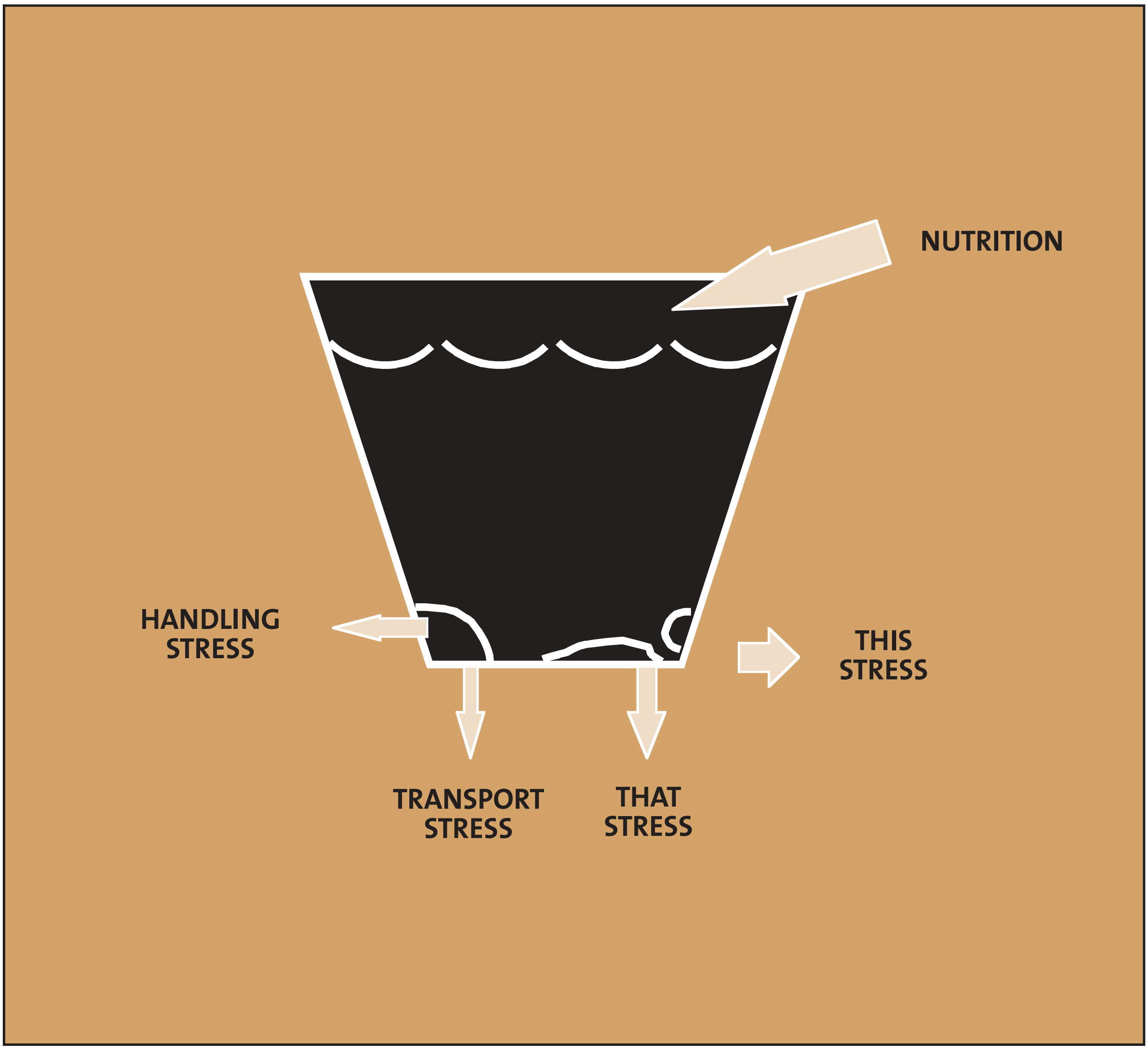
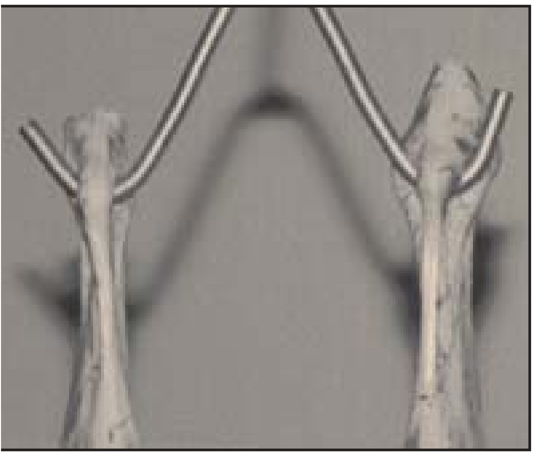


Figure 1: Nutrition fills the glycogen bucket and stress can empty it.

Sheep
HEALTH ISSUES

Don Moir, Department of Agriculture, Narrogin



Hock joint swollen with arthritis.

A few of the most common conditions affecting sheep used for meat production are considered briefly. For more detailed information, readers should consult their private veterinarian or consultant.

Enterotoxaemia (Pulpy Kidney)

This is a disease caused by changing diets from low to high quality feeds as occurs with grain feeding, or moving sheep onto crop stubbles or good green feed. It also may be seen in lambs suckling ewes on lush green feed.

This disease is most often seen in lambs and weaners but can affect sheep of any age.

Signs

- Sudden death. Sheep are usually found dead without any symptoms having been observed.
- The head may be thrown back, and there can be convulsions.
- There can be frothing at mouth.

Control

- This is by a vaccination given to lambs at marking and weaning, and annually thereafter. Ewes are given an annual booster four weeks before lambing to protect the lamb for the first six weeks of life.

Arthritis

This is a common condition in lambs after marking, or less often in the first four weeks of life. It is caused by the entry of bacteria into the body via marking wounds or the umbilical cord in new- born animals.

Arthritis is due to a high environmental contamination with specific bacteria (*Erysipelas, Streptococcus, Haemophilus*) that build up in sheep yards and under conditions of high stocking densities.

Signs

- Hot painful swelling of one or more joints in the legs. Lambs are lame, reluctant to walk, and become ill thrifty. They may die through poor mothering.

Control

- Carry out marking and mulesing in temporary yards in a clean paddock. Ensure the use of hygienic measures with clean instruments. Clean the wounds and change disinfectant solutions often. Wash blood from hands often.

- For persistent problems consider the options of vaccination or prophylactic treatment with your veterinary consultant.

More information about this problem is available in the Farmnote 4/94, Sheep Arthritis.

Internal Parasites

i) *Worms of sheep* are a major cause of economic loss due to mortalities, ill thrift, reduced wool growth and scouring with subsequent fly control measures (crutching, jetting, strike treatment). Also, they can contribute to other conditions such as nutritional ill thrift of weaners and pregnancy toxaemia. Sub clinical production losses occur without the producer's knowledge.

The widespread incidence of resistance to drench chemicals has made control programs more complex.

Signs

- These may be sub clinical, that is, no obvious signs.
- There can be various combinations of ill thrift, anaemia, scouring and death.

Control

- Biannual test for drench resistance.
- Use a control program that incorporates paddock and stock management, worm egg count monitoring, chemical rotation and a drenching strategy.
- Prime lambs may need to be drenched on a lower worm egg count than is used for

other lambs to maintain maximum growth rates.

ii) *Coccidiosis*. This is caused by a protozoan parasite of the small intestine that is present in virtually all sheep flocks. It is normally present in sheep in small numbers and causes no harm. However, when seasonal conditions result in poor conditioned ewes with reduced milk production, lambs are forced to graze pasture at an earlier age and to a greater degree than normal and this results in an increased intake of coccidia. Increased intakes of the parasite in lambs can also occur in hand feeding situations where patches of ground become heavily contaminated.

The condition is usually seen in lambs up to eight weeks of age. Most of the lambs will self-cure and then become immune.

Signs

- A dark scour, sometimes containing blood.
- Lambs are unthrifty, anaemic with a low mortality rate, except where poor nutrition continues.

Control

- Supplementary feeding of the ewes.
- Change the trail-feeding site regularly.
- Affected prime lambs can be treated (consult a veterinary practitioner).

Scabby Mouth

This disease is also known as contagious ecthyma or Orf. It is caused by a virus that can live for years in the environment.

Scabby mouth is important because it is a threat to the viability of the live sheep trade, but it can also cause economic loss of condition in young sheep during outbreaks on farms. The virus gains entry through skin damage to the mouth that can be caused by thistles and stubble or via damage to the feet caused by long, wet grass.

The disease can cause skin lesions in humans.

Signs

- Scabs develop around the mouth, above the hoof or less commonly on the udder of ewes and scrotum of rams.
- Animals may have difficulty eating or walking with subsequent loss of condition. Self-cure takes three to four weeks.

Control

- Vaccinate lambs at marking. It is important that all sheep to be exported have been vaccinated.

There is more information about this problem in the Farmnote 19/97, Scabby Mouth.

Acidosis (Grain poisoning)

This is caused when sheep are introduced too quickly to diets high in grain. It also is seen when self-feeders run out of grain for several days and are then refilled with a consequent engorgement by sheep.

Signs

- Scouring, rapid breathing, inappetance, depression.
- Occasionally lameness, bloating.
- Death in severe cases.

Control

- Introduce sheep to grain feeding gradually over a two-week period.

Bloat

This is not a common problem in sheep. However, it may occur on young, rapidly growing legumes such as lucerne or clover. It is caused by froth forming in the rumen, which prevents the animal from belching.

Signs

- Swelling of the left flank.
- Discomfort, rapid breathing
- Sheep get up and lie down frequently. They may collapse and die in severe cases.

Control

- Treat affected animals with a drench of 40 millilitres of paraffin or any vegetable oil for short-term control.
- Restrict grazing time on dangerous pastures.
- Provide access to hay.
- Strip graze.

Lupinosis

This is a disease caused by consumption of the toxic phomopsins that are produced by a fungus that colonises lupin plants. Although the fungus infects the plant while it is growing, it only produces enough of the toxin to produce lupinosis after the plant has died and has subsequently been exposed to rainfall or heavy dews. For this reason lupinosis is usually a disease seen in summer and autumn when sheep are grazed on lupin stubbles.

In the feedlot, lupinosis may also occasionally result from the feeding of crop fines collected when harvesting lupins, or the feeding of lupin seconds containing large proportions of discoloured seeds.

The phomopsins primarily damage the liver, so the clinical signs are usually related to liver disease. However, in young growing sheep the liver damage may also cause altered metabolism of selenium and vitamin E, resulting in the development of lupinosis-associated myopathy, a disease similar to white muscle disease or nutritional myopathy.

Signs

- These may vary greatly depending on how much toxin is consumed. Feed intake may be reduced, or there may be a complete loss of appetite.
- Sheep may not put on weight in a situation when they should, or there may be obvious loss of weight and condition.
- As the disease progresses there will be lethargy, wandering and "star gazing", jaundice, depression and death.

Control

- Plant only *Phomopsis*-resistant lupin cultivars.
- Observe sheep regularly while grazing lupin stubbles or stands of sandplain lupins during summer and autumn. If they are not growing as well as might be expected, always suspect lupinosis and move the sheep to non-lupin pasture.
- Do not feed lupin seed to sheep suspected of having lupinosis; their livers cannot handle the high protein diet and they develop ammonia toxicity.
- Sheep should be removed from lupin stubbles at least a week before going to the abattoir. Some may have internal jaundice associated with subclinical lupinosis, and their carcases will be rejected. The one-week break from lupins is usually sufficient to allow the jaundice to resolve.
- Ensure that young sheep grazed on lupin stubbles have adequate selenium and vitamin E.

Pregnancy Toxaemia

This is caused by an inadequate intake of energy during late pregnancy and is exacerbated by ewes having multiple foetuses. It may be induced by a sudden cessation of eating caused by adverse weather, or the moving or yarding of flocks. Over-fat ewes are most prone to the problem. It can also result in the birth of dead lambs.

Signs

- A loss of appetite.
- Sheep become separated, depressed and wander aimlessly.
- They appear blind, ignore dogs and people, become recumbent, comatose, and die.

Control

- Monitor the condition of pregnant ewes by weighing and/or condition scoring.
- Be prepared to supplementary feed pregnant ewes.
- Pregnancy-test high multiple birth flocks and feed according to their pregnancy status.

Cheesy Gland

Also known as yolk boils, abscess and caseous lymphadenitis (CLA). The bacterium *Corynebacterium pseudotuberculosis* causes abscesses to form in lymph nodes and lungs of sheep and goats, leading to losses in wool production, carcase condemnation or trimming at abattoirs and some mortalities. Spread is commonly associated with shearing and dipping.

Signs

- Abscess formation under skin or internally.
- Pus is light green to cream colour.

Cheesy gland abscess in the hindleg of a mutton carcase.

- Occasional death in adults for no obvious reason.

Control

- Vaccinate lambs at marking and weaning. Yearly boosters before shearing are essential to lower flock prevalence.
- Minimise the time sheep are kept in close contact after shearing.
- Avoid dipping sheep if no lice are present.

Pink Eye

A bacterial infection of one or both eyes. It is aggravated by congregation in dusty conditions and irritation by flies. Most sheep recover from pink eye. However, up to four per cent may become permanently affected if left untreated. This problem may be confused with grass seeds in eyes.

Signs

- Inflammation and tears from affected eyes.
- Cornea becomes red then white as condition progresses.

Control

- Avoid yarding during outbreak. If necessary, draft-off affected animals and isolate them.
- Treat with antibiotic eye ointment.

Pneumonia

Caused by a variety of bacteria. Pneumonia is most commonly seen in young sheep on dry, dusty feeds. Irritation from dust allows bacteria to invade and cause inflammation and infection.

Signs

- Nasal discharge, coughing, high temperature and lethargy.

Control

- Avoid finely hammer-milled feeds.
- Dampen feed or add a dust suppressant, for example, tallow.
- Treatment of clinical cases may require antibiotic treatment as advised by a veterinarian, with strict adherence to withholding times.

Salmonellosis

Contamination of feed or water sources with faecal material can lead to infection with salmonella bacteria. Trail-feeding grain in the same area can lead to a build up of faeces and result in disease, especially if sheep are under nutritional stress or subject to adverse weather. Summer storms may wash large quantities of faeces into water supplies leading to salmonellosis.

Signs

- Scouring, high temperature, lethargy, death.
- Abortion in pregnant ewes.

Control

- Prevent faecal contamination of feed and water.
- Change trail-feeding sites regularly.
- Withhold sheep from affected mobs from slaughter until the outbreak is over.

Hydatids

Hydatid disease is caused by the tapeworm *Echinococcus granulosus* which lives in the intestines of dogs, foxes and dingoes. The tapeworm eggs pass onto the ground in the dog faeces where they may be ingested by grazing animals. These eggs then develop into multiple cysts within the liver and lungs and will result in condemnation of the carcase at abattoirs.

Hydatid disease is a major human health hazard. Dog tapeworm eggs ingested by humans develop into cysts that can only be treated surgically.

Signs

- Infected sheep show no external symptoms.
- Autopsy reveals multiple fluid-filled cysts in the liver, lung and occasionally the brain.

- Dogs infected with *E. granulosus* show no signs of a problem.

Control

- Treat dogs every two months with the drug praziquantel.
- Do not feed dogs raw meat or offal. Prevent access to any carcases on the farm (including kangaroo, wallaby and pig). Burn carcases as soon as possible.
- Control fox and dingo populations.

Sheep Measles

As with hydatid disease, sheep measles is the intermediate stage of a dog and fox tapeworm called *Taenia ovis*. Eggs on pastures picked up by sheep develop into small cysts in the muscles and heart. Old cysts become hard, fibrous and sometimes gritty, and are known as "measles". Infected carcases are rejected at abattoirs.

Signs

Severe infection may cause production losses.

- There are no other external signs of infection in sheep.
- Carcases show small cysts in the heart, diaphragm and meat.
- Dogs infected with *T. ovis* may pass segments in faeces resembling grains of rice.

Control

- As for hydatid disease.

Annual Ryegrass Toxicity

Seed heads of annual ryegrass infected with the nematode *Anguina funesta* and the associated bacterium *Clavibacter*, become toxic to livestock. The danger period starts after flowering in spring and lasts while infected heads remain in the paddock. The infection can be transferred to new areas by contaminated machinery and hay.

Signs

Disturbance of the nervous system. Collapse, convulsing and then apparent recovery after driving is common. Animals may have a stiff-legged gait.

- Seriously affected sheep will remain down until they die.
- Pregnant ewes may abort.
- Mild cases can recover with rest.

Control

Use of the twist fungus on pastures.

- Reduce reliance on annual ryegrass as major pasture species.
- Seed set control in early spring by heavy grazing or chemical application.
- Autumn burn of affected paddocks.

Other disease conditions

Other common conditions that can affect lambs include trace element deficiencies, weaner ill-thrift, perennial ryegrass staggers, toxic algae, hypocalcaemia, hypothermia, foot abscess, Eperythrozoonosis (*E. Ovis*) and photosensitivity.

Water requirements

The provision of adequate supplies of good quality water is important. The consumption of water increases as the concentration of salt in the water increases. Therefore, it is essential to monitor the quality of the water and to ensure that the supply can meet the expected demand.

Lambs can only tolerate water with about half the total salts that can be used by adult sheep (1100 compared to 1650 to 2200 milliSiemens per metre).

Weaners grazed on feeds with a high content of soluble-protein during summer, can drink large quantities of water (up to 9 litres per head per day). Grown sheep can drink even more water than this. This reinforces the need to have a plentiful supply of good quality water for sheep grazed on these feeds.

Similarly, supplementary-fed sheep need a good supply of water.

INFORMATION

Pastures

Farmnote 1/99. Puccinellia: for productive saltland pastures.

Farmnote 26/99. Establishing balansa and persian clovers on waterlogged, mildly saline soils.

Farmnote 98/99. Fodder conservation as silage.

Farmnote 4/98. Dryland lucerne: establishment and management.

Farmnote 11/98. Well-adapted perennial grasses for the Esperance sandplain.

Farmnote 76/96. Harvesting balansa clover for seed.

Miscellaneous Publication 3/2000. Pasture Growth Rates on Farms in the south of Western Australia (2000). Department of Agriculture.

Miscellaneous Publication 2/98. Perennial grasses for animal production in the high rainfall areas of Western Australia. K. Greathead, P. Sanford and L. Cransberg (1998). Department of Agriculture.

Woolprose. Department of Agriculture, Albany.

Pasture Update. Department of Agriculture, Albany.

Ovine Observer. Department of Agriculture, Narrogin.

Pasture Plus. Kondinin Group, Belmont WA.

Farming Ahead. Kondinin Group, Belmont WA.

TIMERITE®, the Kondinin Group can provide information on this package.

Lot-feeding and drought feeding

Farmnote 72/2000. Sheep health in a feedlot.

Farmnote 73/2000. Lotfeeding prime lambs.

Farmnote 74/2000. Achieving production targets for prime lambs.

Bulletin 2/94. Feeding sheep, including lot feeding and drought management (1997). Primary Industries and Resources, South Australia.

Easton, W.S. (1994). Opportunity lot-feeding of lambs. Agriculture Victoria, Swan Hill.

Reproduction

Farmnote 74/99. Pregnancy diagnosis in ewes.

Farmnote 132/99. Teasing ewes for early breeding.

Farmnote 46/97. Consequences of underfeeeding the pregnant ewe.

Bulletin No. 4148. Management for high lambing performances from ewe flocks in the Agricultural Area (1989). Department of Agriculture, Western Australia.

Genetics

Farmnote 58/96. LAMBPLAN for ram breeders.

Farmnote 63/95. LAMBPLAN for lamb producers.

LAMBPLAN Breeders Directory (see website;http://lambplan.une.edu.au)

LAMBPLAN Flock Genetic Merit Listing (see website; http://lambplan.une.edu.au)

Merino Bloodlines: The Comparisons: 1989-1999. Agnote DAI-52, Second Edition, July 2000. K.A. Coelli, K.D.Atkins, A.E.Casey and S.J. Semple Orange Agricultural Institute, NSW Agriculture, Orange

Merino Superior Sires, Central test sire evaluation results No. 6 (1999). Division of Animal Production , CSIRO, Armidale, NSW (also see website: http://mss.anprod.csiro.au)

Residues

Factsheets 1/2001. Commonly used chemicals to treat sheep lice and blowflies.

Farmnote 12/2000. Wool residues – market, environmental and occupational health issues.

Farmnote. 13/2000. Sheep lice – cost effective management to minimise wool residues.

Health and Welfare Issues

Bulletin No. 4345. Controlling Sheep Meat Disorders (1997). Department of Agriculture.

Miscellaneous Publication No. 16/90. Code of practice for the welfare of animals No.4 Sheep (1991). Department of Agriculture, Western Australia.

Miscellaneous Publication No. 19/87. Code of practice for the welfare of animals No. 3 Road transport of livestock (1987). Department of Agriculture, Western Australia.

Market Information

Farmnote 25/99. Preparation and assessment of sheep and lambs for slaughter.

Production and marketing of large lean lambs (1995). Australian Meat and Livestock Corporation. Compiled by Laurie Thatcher

Processing of large lean lambs (1996). Meat Research Corporation. Compiled by David Hopkins.

Marketing lambs over the hooks, a step by step guide (1999). Victorian Department of Natural Resources and Environment. Editor Kristy Howard.

2000 Lamb Survey (2000). Market Information Services, Meat and Livestock Australia.

OUTLOOK - AGWEST Trade and Market Development Quarterly Newsletter for Western Australia's Agribusiness Industry. To request the newsletter telephone 08 9322 7141, or Fax 08 9322 7150.

LiveWire – AGWEST Trade and Market Development WA Live Export Quarterly Newsletter. To request the newsletter telephone 08 9322 6141, or Fax 08 9322 7150.

WEBSITES

Websites of Interest

AGWEST Trade and Market Development – Market information
http://www.agric.wa.gov.au/programs/trade/html/reports.htm

State Departments of Agriculture:

Department of Agriculture (Western Australia)
http://www.agric.wa.gov.au

NSW Agriculture
http://www.agric.nsw.gov.au/reader/2177

Queensland DPI
http://www.dpi.qld.gov.au

Department of Agriculture, Fisheries and Forestry – Australia
http://www.affa.gov.au

CSIRO
http://csiro.au

MLA
http://www.mla.com.au

Kondinin Group
http://www.kondinin.com.au

Sheepmeat Council – Sheep industry news
http://www.farmwide.com.au/nff/sheepmeat/mews.htm

The Woolmark Company
http://wool.com.au

Flockcare
http://www.ausmeat.com.au

Lambplan
http://www.ansc.une.au/lambplan

Merino Superior sires
http://mss.anprod.csiro.au

Residues
http://www.agric.wa.gov.au/wooldesk/chemresi.html
http://www.cleangreenwool.com

GLOSSARY

Ad libitum	fed without restriction.
Annual plants	these plants have a life cycle each year.
Cellulose/lignin	main chemical constituents of plant cell walls.
Condition score	an estimation of the fatness of live sheep based on the flesh cover over the back bone and short ribs. Condition score correlates with fat score on the carcase.
Crude protein (CP)	the nitrogen containing constituent of feedstuffs. It is determined as the total nitrogen (N) content of the feed multiplied by 6.25.
Digestion	the process by which food is digested.
Dry matter (DM)	the weight of feed (pasture, fodder or grain) with all the moisture removed.
Dry Matter Digestibility (DMD)	is the proportion of the dry matter (DM) consumed that is not excreted in the faeces. DMD is usually expressed as a percentage.
Enzymes	any protein capable of causing a chemical reaction necessary to a cell.
Fat score	an estimation of fatness over the twelfth rib on a carcase. Fat score correlates with the condition score on live sheep.
Fat tail lambs	lambs from fat tail sheep breeds, eg Awassi, Damara.
Feed intake	the amount of feed eaten by sheep.
Feed on offer (FOO)	the amount of feed available to sheep in paddocks. It is expressed as kilo gram of dry matter per hectare.
Fodder crop	crops (cereals, legumes and specific fodder crops) that are specifically planted for use as fodder by animals – conserved or standing.
Leaf area index (LAI)	the ratio of total leaf area per unit of soil surface. It is the area that influences the amount of photosynthesis. The larger the leaf area, the greater is the surface for the absorption of sunlight and so plant growth is enhanced.
Maintenance energy requirement	is the energy needed so that the liveweight of a sheep can be maintained.
Metabolisable energy (ME)	is the unit used to measure the energy content of feeds. It is the amount of energy available to the animal after taking into account the energy lost in the faeces, the energy lost in the urine, plus that lost as gases (methane and carbon dioxide) produced when the rumen microbes ferment the feed. It is measured as millions (Mega) of Joules per kilogram of feed dry matter (MJ per kilogram of dry matter).
Non-protein nitrogen (NPN)	the nitrogen available for use by sheep that does not come from the proteins eaten.
Nutritive value	the nutritional worth of a feed.
Perennial plants	plants that survive from year to year.
Phase pasture	is the term used to describe a short period of legume pasture (one to three years) which is then followed by a 'cropping phase' of three to eight years.
Organic compounds	substances containing carbon.
Rumen	the main part of the stomach of a ruminant where feed is fermented and digested.
Rumen degradable protein (RDP)	includes the dietary protein that is soluble in the rumen plus any non-protein nitrogen.
Rumen microbes	the mixed population of bacteria and protozoa that are responsible for the digestion of feed in the rumen.
Undegradable dietary protein (RUP)	is that portion of protein that is not digested in the rumen.

INDEX