Grassland Society of NSW Inc

Newsletter

Another successful conference - this year at Inverell (for the first time) - has come and gone. Congratulations to the hard working committee, the Northern Tablelands branch and the North West Slopes of the Grassland Society of NSW for hosting this years conference.

Once again the NSW Hay and Silage Awards were held in conjunction with the conference - a number of entries were received and worthy winners appointed in a number of categories. Congratulations must go to Neil Griffiths from NSW DPI for doing a great job coordinating these awards. Thanks must also go to our long-term sponsors Integrated Packaging, New Holland, Du Pont Pioneer and the NSW Feed Quality Service.

A report on the Hay and Silage Feed Quality awards can be found on page 5 of this newsletter.

On July 22 just prior to the conference the 2014 Grassland Society of NSW, Annual General Meeting was held at the Inverell RSM. At this meeting the State Executive and committee were elected for the next 12 months year – see the back page of the newsletter for a full listing of the executive and committee members for 2014/2015. Two committee members stood down this year - Hugh Dove and Hayley Pattison. On behalf of the members I would like to wish Hugh and Hayley all the best in the future and to thank them for their service on the Grassland Society of NSW committee. This means that we have two new faces on the committee - a big welcome to Clare Edwards and Helen Burns.

In this issue of the newsletter we continue with the article on rhizobia and inoculation (page 2), and carry on our series of articles reprinted from the International Grassland Congress in Sydney last year (pages 8 and 11) plus lots more.

If you haven't paid your membership subs for the 2014/2015 membership year, please do so as soon as possible. Payment details can be found in the box below.

Carol Harris
Editor

DON'T FORGET TO PAY YOUR 2014/2015 MEMBERSHIP

The annual Grassland Society of NSW subscription of $60 for 2014/2015 was due on July 1 2014. Have you paid your subs? If not please do so using one of the following methods.

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In this newsletter

Rhizobia and the rhizobia-legume symbiosis - Part 2

Editors Note: Part 1 of this article appeared in The Grassland Society of NSW Newsletter Volume 29, Number 2 2014. Part 1 covered - What are rhizobia, the specificity of rhizobia, what rhizobia need to prosper and the process of nodulation.

Root-hair infection

The rhizobia colonise the root surfaces including root hairs, and in response to chemicals released by the legume root, the rhizobia in turn manufacture specific compounds (Nod factors). These are released into the rhizosphere (area surrounding the root) and the legume responds. The rhizobia induces formation of an infection thread that grows back down the inside of the root hair, providing a channel for their entry into the root cortical cells and multiplication. The root cortical cells in the immediate region of the infection grow and divide repeatedly, ultimately forming an outgrowth (nodule) on the root. Once the rhizobia have reached these cells they are 'released' into specialised compartments where they change into bacteroids and then begin to fix nitrogen. It is important to note that infection of root hairs is most likely to occur while plants are young. Anything that affects normal root hair development may impede nodulation.

For nitrogen fixation to occur, two unique compounds are produced in the nodules:

1. **Nitrogenase** produced by the rhizobia – this is the enzyme that facilitates the conversion of atmospheric nitrogen (N2) to ammonia (NH3), i.e. nitrogen (N2) fixation. The enzyme requires molybdenum (Mo) to function optimally, which is why this micro-element is often added as a fertiliser when legumes are sown

2. **Leghaemoglobin** produced by the plant – this compound provides the characteristic pink/red colour of healthy nodules, and is essential for nitrogen fixation to occur.

The function of the leghaemoglobin in the nodule is similar to that of haemoglobin in our blood. Both compounds act as oxygen-transport molecules making sure the right concentration of oxygen is available for the rhizobia. Excess oxygen adversely affects the nitrogenase enzyme and stops nitrogen fixation. The colour of nodules is often used as an indicator of active nitrogen fixation as the presence of leghaemoglobin (pink colour) is a prerequisite for the process. In contrast, white nodules lack leghaemoglobin and cannot fix nitrogen. Green nodules usually indicate non-functional senesced nodules, with the green colour being a breakdown product of leghaemoglobin.

Nodule types

There are two basic types of nodules on agricultural legumes – determinate and indeterminate. The legume plant alone governs which type of root nodule occurs, irrespective of the species of rhizobia.

Determinate nodules are generally spherical, less than five millimetres in diameter and lack distinct internal zones. If the internal colour of these nodules is white or green rather than pink then they are unlikely to be fixing nitrogen. Soybeans, peanuts, serradella, lotus, navy beans, cowpeas and pigeon peas are legumes that form determinate nodules.

Indeterminate nodules can keep growing throughout the season and can remain functional to meet the nitrogen demand of the crop. These nodules can develop lobed finger-like projections to give a coralloid appearance. Internally they have distinct zones and grow from the outside tip, a region called the meristem. Although some part of the nodule may go green during the growing season, if the tip is pink the nodule should still be fixing some nitrogen. Peas, faba beans, lentils, chickpeas, Lucerne, medic, clover, biserrula and sulla are legumes that form indeterminate nodules.

Other important symbioses that fix nitrogen

i) *Acacia* (wattles) are a group of legumes that form nodules in association with rhizobia. Unlike all the agricultural legumes, acacias are native to Australia and their rhizobia already reside in the soil. The acacia rhizobia are very similar to the lupin and soybean rhizobia; however, there is (perhaps fortunately) no overlap (cross infection) between them.

ii) *Casuarina* are non-legume trees that can also fix nitrogen with very special and unusual soil bacteria. These bacteria are called *Frankia*. They grow as long filaments and appear more like fungi than bacteria.

Causes of poor nitrogen fixation – legume and rhizobia incompatibility

Although scientist expend a considerable amount of time and effort selecting elite strains of rhizobia, and provide these to the inoculant manufacturers for use in commercial inoculants, we cannot always control which strain of rhizobia is successful in forming the nodules on the growing legume. In many situations there are already rhizobia resident in the soil that can nodulate the legume in preference to the applied inoculant rhizobia. These resident strains may always have been present (unlikely), they may have colonised the soil after agricultural settlement (very likely), or they may have arisen from genetic changes of inoculant rhizobia after being introduced into the soil (also very likely). So, competition between the applied inoculant rhizobia and other strains of soil rhizobia. The quality of the inoculant and its survival during the process of inoculation is critical in this competition.

Scientist are just beginning to understand how resident strains of rhizobia evolve in the soil, and probably the best understood scenario in Australia is that of biserrula, an annual pasture legume and its inoculant rhizobia. At the time biserrula was introduced experimentally to Western Australia from the Mediterranean Basin in 1994, there were no rhizobia in Western Australia soils capable of nodulating it. All sown biserrula were inoculated with an elite strain. Within seven years we noticed that a small proportion of nodules formed on biserrula regenerating in the field were small and green, and occupied by rhizobia that differed considerably from the original inoculant. Research since then has led us to understand that the original inoculant strain for biserrula has shared its nodulation genes with bacteria that were already in the soil in Western Australia, but were not biserrula rhizobia. These bacteria were able to nodulate biserrula only when they received the genes for nodulation, but they do not have all the other genes required for high levels of nitrogen fixation.

Hence, the evolution of rhizobia like these in soil can significantly impair nitrogen fixation of legumes because they can successfully out-compete the highly effective inoculant rhizobia to form nodules but, once in the nodules, cannot fix nitrogen.

The only way we have of managing this is to periodically re-inoculate sown or regenerating biserrula with high numbers of the highly effective inoculant rhizobia (hoping to out-compete the soil rhizobia). More long-term research is underway to identify strains of rhizobia that do not share their nodulation genes with soil bacteria; such strains would be ideal for use as inoculants.

INOCULATION IN PRACTICE

Inoculation is the application of root nodule bacteria (rhizobia) to a legume seed or soil in which the legume is sown. It is done to facilitate root nodulation. Improving the nodulation of a legume can increase symbiotic nitrogen fixation, crop biomass and grain yield and quality, and increase the amount of organic nitrogen contributed to the soil from legume shoot and root residues.

Some precautions need to be taken to ensure delivery of large numbers of rhizobia to the vicinity of the legume roots. Whichever inoculant is used, rhizobia are living organisms and their growth and survival can be reduced by coming into contact with chemicals and fertilisers, heat or freezing temperatures, sunlight, desiccation, and acidic (low pH) and highly alkaline (high pH) soil

When is inoculation required?

When sowing legumes inoculation should always be considered due to the potential to increase nitrogen fixation and grain yield.

Important reasons to undertake inoculation include:

- the particular legume has not been grown in the paddock previously;
- it has been more than four years since that particular legume has been grown in the paddock;
- introduced newly selected strains with increased effectiveness and survival;
- the presence of acidic or highly alkaline soils in the paddock may limit survival of the rhizobia in the soil;
- the paddock is subjected to particularly hot, dry summers; and
- the legume has specific rhizobial requirements, eg lotus, biserrula, sulla.

Which inoculant group should I use?

Crop and pasture legumes must be inoculated with the correct rhizobial strain for nodulation and nitrogen fixation. For example, chickpeas and field peas each require different inoculant rhizobia and will not nodulate unless the correct inoculant is used (Table 1).

Which inoculant group do I need for a mixture of pasture species?

When using mixtures of different pasture legume species, each should be inoculated separately with the correct inoculant group. Once seed of each legume has been inoculated and dried off, the pasture species can be mixed together in the appropriate proportions for sowing.

What are the requirements for storing and handling inoculants?

For storage and transport of inoculants:

- always follow the manufacturer's instructions;
- keep inoculants in a cool dry area (ideally below 10°C), except for a few inoculants for tropical/sub tropical legumes, which should be stored at 20 to 25°C;
- do not freeze inoculants;
- store freeze-dried inoculants in the fridge, NOT in the freezer;
- use inoculants by their use-by-date;
- never expose inoculants to high temperatures, e.g. in a vehicle. Use an insulated box to keep them cool; and
- reseal inoculant packages after opening to reduce moisture loss and avoid contamination.

Can you use too much inoculant?

Inoculation of legumes at higher-than-recommended rates is not harmful to legume growth or production. Ensure blockages of equipment do not occur. Fewer problems result from liberal inoculation than from using inoculants at lower-than-recommended rates or not using inoculants at all. Unnecessary inoculation represents a small cost to production, whereas poorly nodulated and N-deficient crops will cause a substantial reduction of production and profit.

- ♣ Inoculation is relatively inexpensive and good insurance – always inoculate with AIRG-approved* inoculants.
- ♣ Match the correct inoculant group to each legume.
- ♣ Inoculants carry live root nodule bacteria (rhizobia), which die from exposure to sunlight, high temperatures, chemicals and freezing temperatures.
- ♣ Always use inoculants before their use-by-date has expired.
- ♣ Keep inoculants dry and cool, and reseal opened bags of inoculant. Use the resealed bags within a short time.
- ♣ Follow instructions on recommended rates of inoculation. Rates are either determined by the weight of seed (kilogram per tonne of seed) or by area (kilogram per hectare).
- ♣ Always sow freshly inoculated deed as soon as possible.
- ♣ When applying liquid or slurry inoculants, use clean, potable water and ensure the holding tank is free of toxic chemical residues.
- ♣ Do not add zinc or sodium molydate to liquid so slurry inoculants.
- ♣ Check the product label or contact the manufacturer for compatibility of inoculants with fertilisers and seed dressings.
- ♣ Ensure inoculants remain cool in transport and do not leave inoculants or inoculated seed in the sun.

* AIRG is the Australian Inoculants Research Group, part of the NSW Department of Primary Industries

Table 1. Inoculant groups for some common legume species and the maximum amount of seed that should be treated by a 250 gram bag of inoculant

Inoculant Group	Common name of legume	Seed Size	Maximum weight of seed treated by 250 g inoculant
AL	Lucerne, strand medic, melilotus, disc medic	Small	25 kg
AM	Burr medic, barrel medic, snail medic, sphere medic, murex medic	Medium	50 kg
B	White clover, red clover, strawberry clover, alsike clover, berseem clover, ball clover, suckling clover	Small	25 kg
C	Subterranean clover, balansa clover, crimson clover, purple clover, arrowleaf clover, rose clover, gland clover, helmet clover, Persian clover	Small-medium	25-50 kg
E	Field pea, vetch, narbon bean, lathyrus	Large	100 kg
F	Faba bean, lentil	Medium-large	50-100 kg
G	Lupin	Large	100 kg
H	Soybean	Large	100 kg
I	Cowpea	Large	100 kg
J	Pigeon pea, lablabm, horse gram	Large	100 kg
N	Chickpea	Large	100 kg
P	Peanut	Large	100 kg
S	French and yellow seradella	Medium	50 kg
Biserrula	Biserrula	Small	10 kg
Sulla	Sulla	Medium	10 kg

How are numbers of inoculant rhizobia related to legume nodulation and yield?

Large numbers of rhizobia inoculated onto seed increase nodulation and grain yields. For pulses and grain legumes, inoculants usually contain enough rhizobia to deliver around 10^{10}-10^{11} (ten to one hundred billion) rhizobia per hectare. The recommendation for rhizobial numbers on seed at sowing when inoculated by peat slurry inoculants are 100,000 rhizobia per large seed (chickpeas, lupins) and 10,000 for smaller seeds (mungbeans, lentils). For preinoculated pasture legume seeds, the recommendations are 1000 rhizobia per medium-sized seed, such subterranean clover and Lucerne, and 500 rhizobia per small seed, such as white clover.

Which formulation of legume inoculant should I use?

A range of different inoculant formulations are available to Australian legume growers (Table 2).

In selecting an inoculant formulation, consider the following characteristics:

- all inoculants are expected to work well when sown into moist soils, where rhizobial survival should be optimal;
- the cost of inoculants is influenced by such factors as the cost of production, the cost of freight and the rate of application. Peat inoculants are considered both the highest quality and least expensive option;
- soil-applied inoculants i.e. granular and liquids applied in-furrow allow the seperation of the inoculant from potentially harmful seed applications such as fungicides, insecticides and trace elements;
- Granular and in-furrow application of liquid inoculants have increased in popularity due to their ease-of-use. Granules are particularly attractive for large sowings of pasture legumes (i.e. more than one tonne of seed). Although the application of peat slurry to seed during busy seeding times is often viewed as inconvenient, it remains the most popular form of inoculation;
- Granular inoculants contain fewer rhizobia per gram than peat and need to be applied at higher rates and cost more per hectare;
- liquid inoculants should be used immediately after dilution. Freeze-dried inoculant should be sown within five hours after application to seed. Granular inoculants can be stored for up to six months after manufacture;
- current recommendations are that to ensure rhizobial survival, inoculated legume seed should not be sown into dry soil. In particular, freeze-dried and liquid inoculants should only be applied to moist seedbeds. Note that some manufacturers do recommend application into dry soil; and
- preinoculated pasture seed is seen as very convenient, but varies in quality, with the number of rhizobia on seed at the point of purchase sometimes inadequate. Preinoculated seed coatings can add significant cost to pasture seed.

This article has been modified from Chapter 2 and Chapter 5 in Inoculating legumes - a practical guide. This book is published by the Grains Research & Development Corporation.

Copies of this book are available from Ground Cover Direct - 1800 110 044 www.grdc.com.au/bookshop

This article will continue in the next issue of the newsletter and will discuss in more detail the various inoculant formulations.

Table 2. Inoculant formulations available to Australian growers

Inoculant formulation	Composition
Peat	High organic matter soil, milled and irradiated with rhizobia added in nutrient solution
Freeze-dried	Concentrated pure cells of rhizobia following extraction of water under vacuum
Granular	Clay or peat granules impregnated with rhizobia
Liquid	Suspension of rhizobia in a protective nutrient solution
Preinoculated seed	Seed coated with polymers and peat inoculant

PASTURE UPDATES

MLA Pasture Updates are an opportunity for beef and sheepmeat producers to hear from other local poducers, researchers and agronomists on local pasture issues and relevant research outcomes and resources that can be implemented on-farm.

Each pasture update will cover topics relevant to the local region.

Upcoming Pasture Update days being held by the Grassland Society of NSW in NSW are;

Tocal - October 16 at Tocal College, contact Neil Griffiths - 02 4939 8948

Narrabri - November 05 at Narrabri Golf Club, contact Naomi Hobson - 0407 936 140

Tamworth November 07 at NSW DPI, Tamworth Agricultural Institute, contact Lester McCormick - 0427 401 542

NSW Hay and Silage Feed Quality Awards 2014

Neil Griffiths, Technical Specialist Pastures NSW DPI

The NSW Hay and Silage Feed Quality Awards for 2014 were presented at the Grassland Societies annual conference held in Inverell in July. Award recipients were wide spread representing many areas of the state, and this year corporate enterprises picked up several awards.

We were again supported by our long term sponsors Integrated Packaging, New Holland, Du Pont Pioneer and the NSW Feed Quality Service who add interest to the awards by providing valuable prizes in the form of products. Plastic wrap or twine from Integrated Packaging, choice of a moisture meter suitable for either hay or silage from New Holland and silage inoculant for maize from Du Pont Pioneer. Unfortunately our sponsors were unable to be present at the conference with an unplanned hospital visit and an overseas work commitment considered fair reason, so society president David Harbison stepped up to present the awards on their behalf.

The highest testing maize silage analysed by the Feed Quality Service in the past year came from Manildra Group at Nowra. They grew maize under a centre pivot used to apply waste water from their ethanol plant for the first time in many years. The crop was Pacific Seeds 624, sown at 80,000 seeds/ha achieving 75,000 plants/ha. The crop was harvested on the 20th of April and tested on the 21st of May. Fertiliser was 125 kg/ha DAP, 250kg/ha urea and 120 kg/ha muriate of potash. The silage tested at 10.7 MJME and 5.9% crude protein.

The Lucerne hay category is very competitive and this year the highest test result came from a crop of L70 grown on the Dubbo City Council 'Greengrove' property managed by Trevor Sanderson from GHD consulting. Grown under a 50 ha centre pivot utilising treated effluent the stand was planted in May 2012 with 100 kg/ha single super after a break crop of wheat. It receives 1M L/ha of effluent each cut which equates to 2 kg/ha N and 6.55 kg/ha P. Each cut is tested and the top testing sample was from the 2nd cut of the season in mid-October, 39 days growth and just starting to flower. Baled 6 days after cutting into large square bales. Yield 2.74 t/ha. It was sold on to chaff, dairy and feedlot users. The feed quality was 11.1 MJME and 26.3% crude protein.

There was a wide range of test results from winter crop last season especially with widespread frost effecting crops. In the end an oat crop from Cowra cut at the end of October and baled a week later on the 7th November had the highest quality in this category. Congratulations to Robert Oliver on producing excellent hay from a crop of Yarren oats baled into small squares as it was coming out in head. This hay has been fed on farm to sheep with some also going to local and Canberra horse markets. Feed quality was 11.0 MJME and 16.5% crude protein.

The summer pasture category is one where we don't always present an award due to the difficulty in getting high quality results from this type of feed. This year we presented the award to Tocal Dairy which made a very good kikuyu silage. They had a shortage of high quality silage stored due to a difficult spring when they would normally make ryegrass silage so last year they were able to fill the gap by growing and cutting kikuyu with quality in mind. Test result of 10.2 MJME and 20.3% crude protein is outstanding for a summer forage.

We have a category for other summer crops. This is for summer crops other than maize. This award was presented for a batch of round bale silage made from the new soybean variety Hayman by James Thibault from Glen Innes. James made the soybeans into round bale silage in April and they were fed out to cows and calves with good results. The soybeans were cut early before pods developed partly because they were getting tall and would be difficult to feed out without a chopper. Test results of 10.7 ME and 10.8% crude protein were recorded.

We also have a general or other crop category which is not always awarded but this year Simon McRae from Temora had a very good result with hay made from Popany Vetch. The crop was grown as part of the crop rotation and cut with a mower conditioner. It was baled into 8x4x3 big squares and sold to a dairy on the South Coast. Feed quality was 10.5 MJME and 22.3% crude protein.

Winter pastures of all types often dominate the hay and silage made in most parts of NSW. Ryegrass silage has dominated these awards in the past however this year the award went to a sub clover hay produced by Mick Hansell from Collingullie near Wagga. It was a 2nd cut from a 4 year old stand of Woogenellup sub clover which had received 1 cwt/ac of single super in the autumn. The paddock was sprayed 3 times to achieve good weed control. Baled into both small and large squares and mostly being sold into the Sydney racehorse market. Testing 11.3 MJME and 16.8% crude protein this hay took out the major award for 2014.

Congratulations to all award recipients, the awards are presented in recognition of the importance of feed quality when feeding hay and silage and once again feedback confirmed that a high quality product is appreciated by the animals that eat it.

▲ President David Harbison presents the award for the Lucerne hay category to Trevor Sanderson Manager of the Dubbo City Council property 'Greengrove'.

▲ President David Harbison presents the award for the Other Summer Crop category to James Thibault, Glen Innes for his round bale silage made from a soybean crop.

▲ President David Harbison presents the award for the summer pasture category to Carol Rose, NSW DPI who accepted on behalf of Tocal Dairy

▼ Neil Griffiths presents the award for the Winter Crop category to Robert Oliver, Cowra for his oaten hay.

Photos: Jennie Coldham & Neil Griffiths

Research Update

Keeping you up-to-date with pasture and grassland research in Australia. Abstracts of recently published research papers will be reprinted as well as the citation and author details in you wish to follow up the full paper.

Volume 65(8) 2014 of Crop and Pasture Science is a collection of scientific papers from the Australian Grasslands Association - Perennial Grasses in Pasture Production Systems, held in May 2013.

Perennial pasture grasses—an historical review of their introduction, use and development for southern Australia.
K. F. M. Reed

Species such as perennial ryegrass and phalaris are vital contributors to the competitive productivity of Australia's livestock industries, underpinning an estimated 9 M ha of high carrying-capacity pasture. Their adoption, in conjunction with inoculated clover, rose steadily in Australian systems, designed with an appreciation of the marginal environment, and stimulated by advances in agronomic practice. Early forecasts for the area of improved pasture have not yet been realised. The history of influential collaborations, plant breeding, evaluation and adoption of perennial grasses, reveals opportunities for improving the direction of research and significantly expanding livestock industries in the high rainfall zone of temperate Australia.

Perennial pasture persistence: the economic perspective.
B. Malcolm, K. F. Smith and J. L. Jacobs

Determining the most profitable life of pastures involves technical and economic considerations, with pasture persistence meaning profitable persistence. To maximize profit over time, pastures should be renewed when the profit from one further year is less than the average annual profit of a replacement cycle of the pasture. The challenge for management and plant breeding is to have pastures producing near peak production for longer as this is the key to profitable persistence.

Interaction between plant physiology and pasture feeding value: a review.
D. F. Chapman, J. M. Lee and G. C. Waghorn

The quality of pastures for animals can be described in terms of feeding value (FV) which is a combination of feed nutritive value (NV) and voluntary intake. There are numerous, complex interactions between plant physiology and pasture FV and NV. This review focuses on these interactions in four key areas (plant growth strategies, phenological development, pasture regrowth, and response to environmental stress), extracting key principles and illustrating how plant breeding or management may be used to manipulate such interactions to improve FV.

Quantifying the interactions between grazing interval, grazing intensity, and nitrogen on the yield and growth rate of dryland and irrigated perennial ryegrass.
R. P. Rawnsley, A. D. Langworthy, K. G. Pembleton, L. R. Turner, R. Corkrey and D. J. Donaghy

Grazing management is a key drive of dairy business success. Conjecture exits regarding the agreed grazing principles and this study explores the interaction between grazing management, nitrogen and irrigation inputs on the production of perennial ryegrass. This study concluded that grazing of perennial ryegrass should always occur between the second and third leaf regrowth stage, with the interval closer to the third leaf stage during periods of low growth rate and closer to second leaf during periods of high growth.

Agronomic advantages conferred by endophyte infection of perennial ryegrass (*Lolium perenne* L.) and tall fescue (*Festuca arundinacea* Schreb.) in Australia.
D. E. Hume and J. C. Sewell

Perennial ryegrass and tall fescue are key grasses of sown pastures in the high-rainfall zone of south-eastern Australia. They may be infected by microscopic Neotyphodium endophytic fungi which are an essential component of the agronomic performance of these grasses in long-lived pastures. The best outcomes for Australian farmers will be achieved through a combination of elite selected endophytes and elite plant genetics adapted to each region, so that perennial ryegrass endophyte toxicosis is eliminated or greatly reduced, and the endophyte-enhancing effects on grass performance are captured.

Use of modelling to identify perennial ryegrass plant traits for future warmer and drier climates.
B. R. Cullen, R. P. Rawnsley, R. J. Eckard, K. M. Christie and M. J. Bell

Perennial ryegrass pasture production is likely to be negatively impacted by projected warmer and drier climates across southern Australia, but the capacity to select plants better adapted to these conditions has not been explored. A modelling approach was used to assess the production benefits of selecting for deeper roots, increased heat tolerance and greater growth responses under elevated carbon dioxide concentrations. Results indicated that all three traits have potential to increase pasture production in future climates, but that the most effective traits differed across regions.

Population biology of *Microlaena stipoides* in a south-eastern Australian pasture.
M. L. Mitchell, J. M. Virgona, J. L. Jacobs and D. R. Kemp

Microlaena stipoides, a Australian native perennial grass, is common within 3 million ha of grazed pastures in south eastern Australia. This paper reports the results of studies into the key attributes of the population dynamics of this species in grazed pastures. The research demonstrates that persistence of *Microlaena* is due to a combination of perennation of adult plants and seedling recruitment. The latter being a rare event, due to seed predation.

A molecular phylogenetic framework for cocksfoot (*Dactylis glomerata* L.) improvement.
Alan V. Stewart and Nicholas W. Ellison

The molecular phylogeny of the genus *Dactylis* provides a clear evolutionary history of the diploids from which modern tetraploid germplasm and cultivars have evolved. This will allow breeders to systematically use a wider range of both diploid and tetraploid germplasm for improvement of cocksfoot. Germplasm of many diploid and tetraploid forms are poorly represented in genebanks and require urgent collection, as many are under serious threat from habitat degradation and climate change.

Kikuyu-based pasture for dairy production: a review.
S. C. García, M. R. Islam, C. E. F. Clark and P. M. Martin

Non-edible feeds like grass-based pastures can be converted efficiently into high quality edible food like milk. 'Kikuyu' is a very productive subtropical grass with enormous potential to convert non-edible fibre into milk; yet quality aspects and utilisation losses, mainly due to inadequate input and grazing management, impair its use. This review attempts to identify the main losses in utilization of kikuyu-based pastures and proposes management approaches that can overcome its main limitations and result in substantial increases in milk production from kikuyu-based pastures.

Production and persistence of subtropical grasses in environments with Mediterranean climates.
G. A. Moore, T. O. Albertsen, P. Ramankutty, P. G. H. Nichols, J. W. Titterington and P. Barrett-Lennard

Growing subtropical perennial grasses in regions with Mediterranean climates may both increase production and have multiple environmental benefits. This paper addresses the shortage of information on the persistence of different species and their expected seasonal production and feed quality in these environments. The results suggest there is considerable potential for growing subtropical perennial grasses in many regions with a Mediterranean environment.

Spatial variability in pH and key soil nutrients: is this an opportunity to increase fertiliser and lime-use efficiency in grazing systems?
M. Trotter, C.Guppy, R. Haling, T. Trotter, C. Edwards and D. Lamb

Fertiliser-use efficiency is a key issue for grazing systems in Australia. This study found considerable spatial variability in soil pH, P, K and S at the sub-paddock scale which may affect the efficiency of utilisation of lime and fertiliser. The results suggest that site specific management of fertiliser and soil ameliorants could provide substantial improvements in pasture productivity as well as reductions in the total amounts applied.

Measuring dehydration tolerance in pasture grasses to improve drought survival.
M. R. Norton, the late F. Lelièvre and F. Volaire

Pasture grasses typically employ 3 strategies to survive periods of severe drought, dehydration avoidance, dehydration tolerance and summer dormancy. Deep rooting is the best example of dehydration avoidance while the ability of some grasses to become dormant over summer is also well known. Less is known about dehydration tolerance, allowing plants to tolerate low tissue water content. This work compared varieties of cocksfoot, tall fescue and phalaris for the trait. The highest levels of dehydration tolerance occurred in cocksfoot varieties of semi-arid origin with a similar observation made in tall fescue. Little dehydration tolerance was seen across the phalaris varieties. This is a powerful drought-survival trait, warranting increasing attention in plant breeding programs.

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Ryegrass seeding rate alters plant morphology and size - possible implications for pasture persistence?

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Introduction

Poor persistence of perennial ryegrass (*Lolium perenne* L.) is a major dairy industry issue in New Zealand and Australia. New ryegrass seed is often drilled at 18-30 kg/ha, although previous research indicated that pastures drilled at 10-12 kg/ha can be just as productive (Frame and Boyd 1986; Praat *et al*. 1996). High seeding rates increase competition between developing seedlings for light, water and nutrients, reduce plant size (Harris 1990) and potentially survival.

The experiment reported here investigated the effect of plant density (created by differences in seeding rate) on plant morphology and survival. The hypothesis was that plants established from high seeding rates will be smaller and, therefore, less likely to survive the first summer; a period of substantial environmental stress (e.g., high temperatures, low soil moisture, insect attack).

Methods

The experiment began in autumn 2011 at three sites in New Zealand, two in the North Island (Northland and Waikato, unirrigated) and one in the South Island (Canterbury, irrigated). Seed of modern diploid cultivars 'Alto' and 'Grasslands Commando', a modern tetraploid 'Grasslands Halo' (all infected with AR37 endophyte) and an old diploid 'Grasslands Nui' (with Standard endophyte) were direct-drilled into large plots at five seeding rates (equivalent to 6, 12, 18, 24 and 30 kg/ha of diploid ryegrass seed, adjusted upwards for heavier tetraploid seed) in a randomised split-plot design with five replicates. Coated white clover (*Trifolium repens* L. cv. 'Tribute') seed was broadcast at 8 kg/ha.

At all three sites, 10 individual plants per subplot were marked with a wire loop seven weeks after drilling. These plants were checked every 2-3 months for the first year and recorded as alive, dead, or missing. At the Waikato and Canterbury sites, the effects of seeding rate on early plant development were also characterised on randomly selected plants (i.e. not the marked plants) by measuring total tiller length (length of tiller from ground to tip of longest leaf), undisturbed pseudostem height (maximum vertical height above ground of the ligule of the oldest expanded leaf), tiller angle (angle between the tiller and ground level), number of tillers and lateral roots per plant, maximum root length, and the root and total dry matter (DM; shoot plus root) per plant. Data were analysed using GenStat 14.1 as a split plot design using REML with cultivar (main plot), seeding rate (sub-plot) and their interaction as fixed effects, and block, main plot within block and sub-plot within main plot as random effects. Marked plants recorded as missing were excluded from analyses. No interactions between seeding rate and cultivar were identified for any variable.

This paper will focus only on seeding rate effects, which were greater than any recorded cultivar effects.

Results and discussion

One month post-drilling at the Waikato site, the tiller length of plants in the 6 and 12 kg/ha treatment was similar to those in the 18-30 kg/ha treatments. The undisturbed pseudostem height was less, however, resulting in more prostrate tillers (smaller tiller angle; Table 1) with less leaf area available above grazing height (4-5 cm).

Eight months post-drilling at the Canterbury site, ryegrass plants in the 6 and 12 kg/ha treatments were larger than those in the 18-30 kg/ha treatments (Table 1). Lateral root numbers per plant

Table 1. Average seeding rate effects on perennial ryegrass plant morphology at Waikato and Canterbury sites

	Seeding Rate (kg/ha)						
	6	12	18	24	30	SED	P value
One month post-drilling (Waikato)	164	175	181	175	191	11.7	NS
Total tiller length (mm)	24	30	32	34	39	2.9	<0.001
Undisturbed pseudostem height (mm)	35	41	44	46	43	3.1	<0.01
Eight months post-drilling (Canterbury)							
Tillers per plant	24	18	13	13	10	1.3	<0.001
Lateral roots per plant	75	61	52	48	45	4.0	<0.001
Maximum root length (mm)	81	80	82	76	80	3.7	NS
Root mass per plant (mg DM/plant)	109	80	62	61	49	8.1	<0.01
Total mass per plant (mg DM/plant)	1094	780	598	569	444	68.1	<0.001
Mean tiller mass (mg DM, shoot+root)	45.6	43.3	46.0	43.8	44.4		

and total root weight showed similar differences. There were more tiller numbers per plant in the 6 and 12 kg/ ha treatments than the other treatments, but mean tiller weight was similar for all treatments (Table 1).

Plant survival during the first year in Northland and Canterbury was similar regardless of seeding rate. In the Waikato, however, more plants survived ($P<0.05$) from August to December in pastures drilled at 6 to 18 kg/ha than at 30 kg/ha.

The hypothesis that plant size (both shoots and roots) is reduced at high seeding rates was confirmed. These findings are consistent with Brougham (1952), who reported a curvilinear decline in tillers/plant as seeding rates of short rotation ryegrass increased from 11 to 67 kg/ha. However, the relationship between plant size and survival in the current study was variable. There was a significant effect of seeding rate on survival at only one of the three sites, Waikato, which had the highest overall plant mortality of all the sites. Under conditions which cause plant mortality, lower seeding rates may aid survival, but in less stressful environments, survival of smaller plants may be similar to that of larger plants.

Conclusion

Ryegrass seeding rate affects plant size and morphology. Its relationship with plant survival during the first year may depend on the amount of stress placed on the pasture, rather than plant size per se. The impact of ryegrass seeding rate on long-term pasture persistence is still to be determined.

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For the full paper and other papers from the International Grassland Congress go to www.internationalgrasslands.org/files/igc/publications/2013/proceedings-22nd-igc.pdf

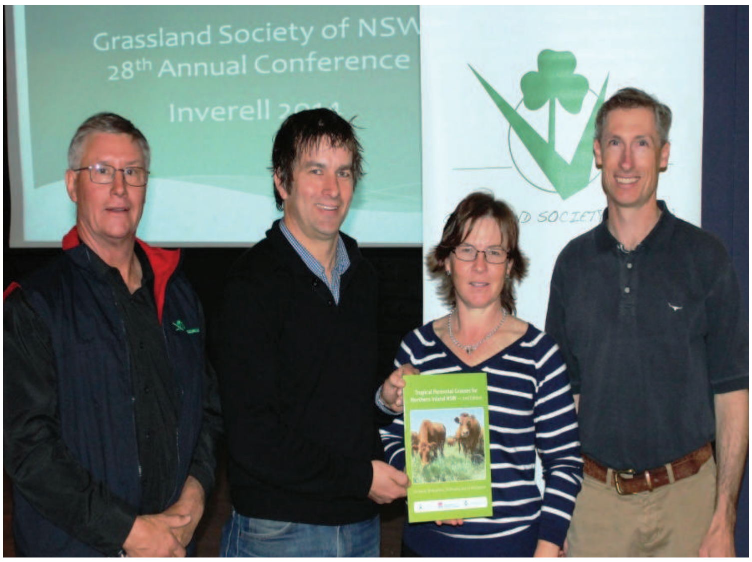
Photos from the conference

▲ President David Harbison officially opens the 28th Annual Grassland Society of NSW conference at Inverell.

▲ Conference attendees enjoying one of the conference sessions.

▲ Speaker Brendan Cullen delivering his presentation ' Climate variability: history and future predictions –what are the implications for pasture production and management?'

◄ Producer Nick Endacott delivering his presentation 'Using tropical grasses in a temperate environment'.



▲ Lester McCormick, Suzanne Boschma and Sean Murphy (NSW DPI) and Michael Friend (CSU)(second from the left) with the newly released second edition of Tropical Perennial Grasses for Northern Inland NSW which was launched at the conference by Michael on behalf of the Future Farm Industries CRC.

▲ Producer Greg Chappell delivering his presentation 'Soil fertility - a biological approach'.

Photos: Jennie Coldham

Plantain (*Plantago lanceolata*) in herb and legume pastures increases lamb growth relative to perennial ryegrass and white clover pasture

Peter D Kemp [A], Paul R Kenyon [B], Stephen T Morris [B] and Sharini C Somasiri [B]

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Introduction

Increased use of plantain (*Plantago lanceolata*) by New Zealand farmers has created a demand for a more complete understanding of the performance and management of plantain by itself and in various combinations with chicory (*Cichorium intybus*) and legumes such as white clover (*Trifolium repens*) and red clover (*T. pratense*). The objective of this study was to evaluate lamb finishing on plantain by itself and combined with chicory, white and red clover as part of a research programme to develop a temperate perennial pasture superior in animal performance to perennial ryegrass and white clover pasture for sheep production systems (Kemp *et al*. 2010).

Methods

Three field experiments on lamb finishing were undertaken at Massey University, Palmerston North, New Zealand (40°23'19.11"S; 175°36'46.22"E). The pasture species used were plantain cv. 'Ceres Tonic', chicory cv. 'Puna II, red clover cv. 'Sensation', white clover cv. 'Bounty' and perennial ryegrass cv. 'One50 AR1'. There were three randomised replicates of each treatment with three to six paddocks per treatment plot (0.25 ha/plot) depending on pasture growth rates. Lambs (initial live weight 30 – 35 kg) were stratified on weight before allocation to treatments. Lambs were rotationally grazed using the stocking rates and pasture heights in Table 1 with the objective of ad libitum feeding. In Experiment 1, two grazing heights of plantain were compared; in Experiment 2, plantain at two grazing heights was compared with a mixture of ryegrass and clover; and in Experiment 3, three mixed pastures were compared over a 12-month period. In experiment 3, four batches of lambs were finished on the herb pastures and five on the ryegrass pasture. All lambs were killed in a commercial abattoir at completion of each experiment.

Results

In summer Experiment 1, a high lamb weight gain was achieved by grazing laxly but not when the plantain was grazed for higher utilisation (Table 1). In summer Experiment 2, the average daily gain (ADG) of lambs on ryegrass/white clover was higher than that for the lambs on plantain at the two stocking rates. Plantain stocked at 24 lambs/ha produced more net carcass weight than the other two treatments. In Experiment 3 the addition of clovers or clovers plus chicory increased the ADG of lambs relative to ryegrass/white clover pasture to the extent that the net carcass weight of lamb produced in a year was 80 and 66% greater from plantain/clovers and plantain/ chicory/ clovers pastures, respectively, than from ryegrass/white clover pasture.

Discussion

The results indicate that plantain has a higher feeding value when it is combined with clovers than when grazed as a monoculture. The weight gain of lambs on the herb plus legume pastures demonstrated that these pastures were superior to a perennial ryegrass and white clover pasture for lamb finishing. The mix of plantain, chicory, red clover and white clover has also been shown to increase ewe milk production and lamb weight during lambing (Hutton *et al*. 2011). The results presented here lend support to a high-performance production system with ewes lambing on herb and legume

Table 1. Lamb average daily live weight gain (ADG) and net carcass weight produced during the experiment (net cwt) for three experiments. Summer experiment 1 and 2 had monocultures of plantain and the 12 months experiment (3) had plantain combined with white clover and red clover, or with chicory and the two clovers.

Pasture	Grazing Heights (cm)	Stocking Rate (/ha)	Grazing days	ADG g/lamb/day	Net cwt kg/ha
Summer experiment 1					
Plantain	13.4 - 8.5	45	30	219	296
Plantain	7.8 - 4.9	50	30	121	182
SEM				10	9
Summer experiment 2					
Plantain	7.0 - 5.1	18	35	205	129
Plantain	6.4 - 4.8	24	35	188	157
Ryegrass/white clover	5.7 - 4.4	18	35	231	145
SEM				13	9
Experiment 3					
Plantain/clovers	>12 - 7	32 - 40	159	223 - 336	717
Plantain/chicory/clovers	>12 - 7	32 - 40	159	210 - 360	664
Ryegrass/white clover	>10 - 5	32 - 40	215	152 - 322	401
significance					*P<0.05*

pasture followed by finishing lambs on the pasture, or grazing ewe hoggets so they attain a weight suitable for mating (Kemp *et al*. 2010).

The grazing management of plantain requires further refinement but the results in Table 1 suggest that a post-grazing height of 5 cm for plantain limits intake by lambs, consistent with the findings of Moorhead *et al*. (2002) who observed a post-grazing herbage mass of 1200 – 1400 kg DM/ha, equivalent to 5 cm high, limited lamb growth. A post-grazing height of 8.5 cm in the current study maximised lamb intake but was observed to increase the proportion of old un-grazed leaves and give poor utilization of the pasture. The pre- and post-grazing heights used in Experiment 3 produced lamb weight gains equivalent to the better live weight gains reported in other studies for (Kemp *et al*. 2010), which supports these heights as being effective for management of the herb and legume pasture. The interval between grazing in all three experiments varied with pasture growth rates but the aim was three to four weeks. When shorter intervals were used the pasture was later spelled for up to four weeks to ensure the three tap-rooted species (plantain, chicory and red clover) recovered their root reserves.

Conclusions

Plantain when combined with clovers was superior to a perennial ryegrass and white clover pasture for finishing lambs. Plantain as a monoculture provided similar lamb weight gains to ryegrass/white clover when grazed lightly. It is recommended that plantain is combined with clovers for lamb finishing.

Acknowledgements

Mark Osborne, Tayah Johnstone, Hannah Appleton, Hamish Best, Bill Pomroy, Peter Hutton, Sarah Pain, Simon Orsborn, Dean Burnham, Geoff Purchas provided technical assistance and advice with pasture and animal measurements. International Sheep Research Centre, Massey University; C. Alma Baker Trust and Gravida NZ provided research funding.

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New Book - Pastures in a farming system.

This publication covers where pastures fit in a farming system for livestock, cropping and the environment. The book comprises five sections covering topics such as;

Your farming system

- Where pastures fit in the farming system
- Pastures in a livestock system
- Pastures in a cropping system
- Fodder crops in a farming system

Establishing pastures

- The essentials of establishment
- Inoculating and pelleting legume seeds
- Selecting machinery for establishment
- Selecting the pasture species

Managing for sustainable pastures

- Grazing management
- Plants and animal health
- Conserving pastures
- Fertilisers for pastures
- Managing soils under pastures

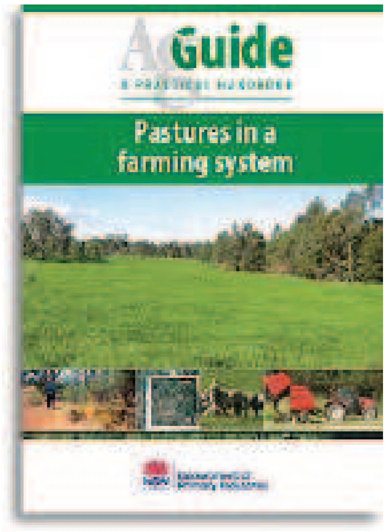
Water use and irrigation for pastures

- Planning for irrigation
- Pasture and crop requirements
- Irrigation systems

Managing risks to pastures

- Soil acidity
- Soil structural problems
- Soil erosion
- Soil salinity
- Weeds in pastures
- Pasture pests
- Pastures in a changing climate
- Dealing with drought
- Pastures and floods
- Pastures and fire

The book costs $34.00 AUD (inc GST) and can be purchased by contacting Tocal College, CB Alexander Campus, Paterson NSW 2421 or Phone: 1800 025 520 or Fax: 02 4938 5549



Grassland events around the globe

New Zealand Grassland Association - Annual Conference
Central Otago - a land of differences - farming in extremes
November 5-7 2014
Alexandra, New Zealand
www.grassland.org.nz

American Forage and Grassland Council - Conference
January 11-14 2015
St Louis, Missouri USA
www.afgc.org/

The Australian Rangeland Society - Biennial Symposium
Innovation in the Rangelands
April 12-16 2015
Alice Springs, Australia
www.austrangesoc.com.au

European Grassland Federation - Symposium
Grassland and forages in high output dairy farming systems
June 15-17 2015
Wageningen, Netherlands
www.egf2015.nl

Don't forget travel grants available for members

www.grasslandnsw.com.au/news/membership/travel-grants

International Grasssland Congress - XXIIIth Congress
Sustainable use of of grassland resources for forage production, biodiversity and environmental protection
November 20-24 2015
New Delhi, India
www.igc2015.in/

Why prepare low worm-risk paddocks?

Deb Maxwell, Operations Manager, ParaBoss

While many producers across Australia are coming up to lambing or weaning, when low worm-risk paddocks are valuable, other producers are in a position now to think about preparing these paddocks.

On a personal note, I have a sheep property near Guyra, northern NSW, where barber's pole worm reigns supreme. I have found that low worm-risk paddocks have had a major positive impact on my worm control. Not only have I been able to drop three or four drenches a year - yes, that big an impact - the preparation has been very easy to do.

The strategies and practices for worm control vary according to your region, but still use common principles across districts. This article considers the benefits of and ways to prepare low worm-risk paddocks for the most susceptible sheep on the property: mainly weaners and lambing ewes.

Classes of sheep that benefit most from low worm-risk paddocks

Weaners, at and in the weeks after weaning, are susceptible because they have an immature immune response to worms, suffer the stress of separation from their mother, and generally face either high summer worm burdens in the north or hot, dry summers with lower nutrition in the south.

In southern Australia, winter weaners are very susceptible after the break of the season, when they may be in light condition and are normally faced with a large winter worm challenge.

Lambing ewes are highly susceptible to worms as their natural immunity drops considerably around lambing time and into lactation. This is typically worse for maiden ewes and ewes rearing multiple lambs.

Preparing low worm-risk paddocks for use by these classes when they are most susceptible provides two major benefits.

Firstly, the sheep themselves will face a lower worm challenge, allowing for higher production (milk and lamb growth) and it provides the flexibility to use short-acting, rather than an annual reliance on long-acting, drenches as a pre-lambing treatment (where this is given). The benefits of this are also felt as better management to slow drench resistence.

Secondly, with a lower worm burden than if they were on unprepared pastures, these more susceptible animals won't be adding the large level of worm contamination to the paddock that they otherwise would have. This greatly reduces the build up of worms over the season that contributes to later problems (and the need for more drenching).

Preparing low worm-risk paddocks

Preparation involves identifying the weaning or lambing paddocks in advance, then using them in a way that prevents further contamination with worm eggs for 3 to 6 months before weaning/lambing/for winter weaners. During this time, you are aiming to have over 90% of the eggs and larvae already on the pasture die, and with no further contamination, a low worm-risk paddock is produced.

Paddocks don't have to stay empty! Cattle, or even sheep (for a period of time after an effective short-acting treatment or a longer period after an effective long-acting treatment) can graze them, and in some locations/times (very hot and dry or very cold), even wormy sheep can be grazed there. They can be used for crops or hay or spelled for a few weeks to allow new growth.

If you have multiple lambing and weaning paddocks, don't be overwhelmed - just try one paddock for one group next year and see how it compares.

The time of year, duration of preparation and sheep destined to use these paddocks varies according to region. Your program in WormBoss describes quite simply what to do to prepare low worm-risk paddocks.

The WormBoss Management Tools section also has a more detailed article on using grazing management to prepare low worm-risk paddocks.

Sign up for monthly ParaBoss e-newsletter for regional updates and feature articles on worms, flies and lice. ParaBoss is funded by Meat and Livestock Australia and Australian Wool Innovation and coordinated by the University of New England with industry oversight. WormBoss, FlyBoss and ParaBoss were developed by the Sheep CRC. LiceBoss was developed by Australian Wool Innovation.

Reprinted from Meat and Livestock Australia

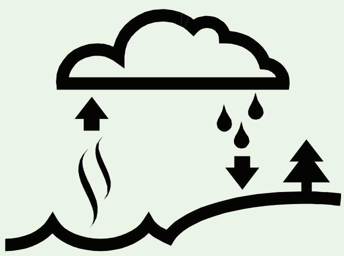
Climate outlook overview

The Bureau of Meterology released their Climate Outlook for October - December in late September 2014.

Key points include;

- A drier than normal October to December for broad areas of eastern Australia.
- The October outlook suggests drier conditions are likely over much of central and eastern Australia.
- The October to December temperature outlooks are for warmer than normal days over most of Australia particularly in the far southeast.
- Climate influences include warmer than normal temperatures in the tropical Pacific Ocean and a neutral Indian Ocean Dipole.
- Outlook accuracy for the season is moderate to high over most of Australia, although patchy around southeastern Queensland and parts of southern Australia.

For more detailed information go to http://www.bom.gov.au/climate/outlooks/#/overview/summary



From the President

Welcome to spring, as the calendar turns another day. For many in the south, a 'dryish' august and significant frost events have seen soil profiles dry out considerably, and sadly for the mixed farmers on the slopes and plains, frost has caused varying degrees of damage in winter crops.

In the north, it's slightly different. While fortunate for some, there has been patchy rain relief in parts of the north and north west, some even receiving follow up rain last week on the back of the huge rains on the coast. It is such a shame that the "rain" doesn't know there is much more country needing to share those big falls west of the range!

Hopefully as spring develops, the north will get their share that they have long been waiting for.
Our 2014 conference in Inverell delivered a very good program, with plenty of 'take home messages' focusing on the ability to convert 'water into product'. Various researchers and producers gave us insight into each of their activities, with plenty in the immediate vicinity of Inverell saying how tight conditions were. The tours further added that message for those that travelled.

The "Pasture Updates" will be conducted in some areas of NSW shortly. Dates and venues for the remaining updates for 2014 are; Tocal (Paterson) 16th October, Narrabri 5th November and Tamworth 7th November. For those close to these venues, I strongly encourage you to get along.
All the best for spring, and here's hoping 'Huey' looks after us all.
All the best,
Regards,

David Harbison,
President.

Disclaimer

While every effort is made to publish accurate information the Grassland Society of NSW does not accept responsibility for statements made or opinion expressed in this newsletter.

Inclusion of an advertisement in this publication does not necessarily imply an endorsement of the company or product of the Grassland Society of NSW.

The Grassland Society of NSW Inc is a unique blend of people with a common interest in developing our most important resource - our Grasslands

The Grassland Society of NSW was formed in March 1985. The Society now has approximately 500 members and associates, 75% of whom are farmers and graziers. The balance of membership is made up of agricultural scientists, farm advisers, consultants, and or executives or representatives of organisations concerned with fertilisers, seeds, chemicals and machinery.

The aims of the Society are to advance the investigation of problems affecting grassland husbandry and to encourage the adoption into practice of results of research and practical experience. The Society holds an annual conference, publishes a quarterly newsletter, holds field days and is establishing regional branches throughout the state.

Membership is open to any person or company interested in grassland management and the aims of the Society. For membership details go to www.grasslandnsw.com.au
or contact the Secretary at secretary@grasslandnsw.com.au or at PO Box 471 Orange 2800

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If you are interested in reactivating an old branch or forming a new branch please contact the Secretary at secretary@grasslandnsw.com.au or by mail at PO Box 471 Orange NSW 2800

Grassland Society of NSW News

Next Newsletter: The next edition of the newsletter will be circulated in December 2014. If you wish to submit an article, short item, a letter to the Editor or a photo please send your contribution to the Editor - Carol Harris at carol.harris@nsw.dpi.nsw.gov or DPI NSW 444 Strathbogie Road Glen Innes 2370. The deadline for submissions for the next newsletter is November 21 2014.

Electronic newsletter: Don't forget you can receive the Grassland Society of NSW newsletter electronically. Just email your details to Janelle (secretary@grasslandnsw.com.au) and you will be added to the list. Next newsletter you will receive an email notification with a link to the newsletter on the website.

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