Grassland Society of NSW Inc

Newsletter

The 2014 conference at Inverell is nearly upon us. Don't miss your opportunity to attend - the committee has put together a really informative and innovative program of speakers and bus tours. More details on the program and how to register can be found on page 2.

On behalf of the 2013/2014 committee I would like to thank our sponsors in 2012/2013 and 2013/2014, without their support Grassland Society of NSW activities such as the conference, the newsletter and the Pasture Update Series would be to difficult to organise and run.

The sponsors in 2011/2012 & 2012/2013 were;

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Pasture Update Series: Meat and Livestock Australia

Hay and Silage Competition: New Holland, Pioneer H-Bred Australia, Integrated Packaging.

In this issue of the newsletter we begin a series of articles that will continue over subsequent newsletters on all things Rhizobia (page 3). There are also some interesting articles reprinted with permission from the International Grassland Congress held last year in Sydney (pages 6 and 8).

Like many members I was very sad to hear of the passing of Mike Keys. Mike was a well liked and respected Agronomist and an active member of the Grassland Society of NSW. His contributions to the Society were numerous and he will be greatly missed.

Carol Harris
Editor

Grassland Society of NSW

Annual General Meeting

Tuesday July 22 at 5.30 pm at the Inverell RSM Club, 68-76 Evans Street, Inverell, NSW. All members are welcome to attend and contribute to the meeting.

2014/2015 MEMBERSHIP

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In this newsletter

THE GRASSLAND SOCIETY OF NSW INC.

28th Annual Conference

Versatile Production in a Variable Climate

22-24 July 2014

Inverell RSM Club - 68-76 Evans Street, Inverell, NSW 2360

Conference Program

Climate variability: history and future predictions - Implications for pasture production and management.

Future Farm Industries CRC - Innovation in profitable perennial farming systems - putting research into practice.

EverGraze - Research on the North-West Slopes of NSW.

The utilisation and management of tropical perennial grass based pastures.

Utilising tropical grasses in a temperate environment.

The role and use of traditional and alternative fertilisers.

Soil Fertility - a biological approach.

Hybrid white clovers for drought tolerance.

Management for high quality pastures and animal production - Producer Panel Session.

Perennial grass weeds - options for control and management.

Perennial grass weeds - practical control and management.

Coolatai grass management and utilisation.

Integration of pasture and cropping systems under irrigation.

Practical application of integrating pasture and cropping systems.

Full conference package

Includes conference sessions on both days, bus tours, conference proceedings, satchel, lunches, morning and afternoon teas, canapes, and conference dinner.

Members $280 Non-members $350

Registration forms available at www.grasslandnsw.com.au

or Register at Try Booking

www.trybooking.com/FEJZ

Conference Bus Tours

Tour A Glen Innes district

Visit Rangers Valley, a cattle station near Glen Innes. Better known for it's feedlot, the station also has 1600 ha of grazing country for backgrounding operations. This tour will also visit Ben Vale a family operated mixed-farming business (sheep, beef & cropping) at Emmaville.

Tour B Inverell district

Visit Newstead, a well known property in the Inverell district and part of the Sundown Pastoral Company. At this stop inspect improved pastures for cattle production. The second stop on the tour is Danthonia, a Bruderhof community near Inverell taking an alternative approach to sustainable land management.

Tour C Guyra district

Visit Blush Tomatoes Australia's largest and most advanced glasshouse facilities. The glasshouses occupy 20 ha of land and produces approx 11 million kg of truss tomatoes per year. The second stop on this tour is a Mannum Park Merino sheep stud with an emphasis on pasture improvement and innovative internal parasite control.

Tour D Bingara / Delungra district

Visit NSW DPI experiments at Bingara evaluating a range of temperate and tropical legumes for tropical grass based pastures. This tour will also visit Glen Ayr at Bingara and Magnet at Delungra - two properties incorporating tropical grasses into their cattle breeding operations.

For further information or enquires on the conference please contact the conference convenor Carol Harris at carol.harris@dpi.nsw.gov.au or 0458 206 973 or the Grassland Society of NSW Secretary at secretary@grasslandnsw.com.au

NSW GOVERNMENT Department of Primary Industries

Regional Landcare Facilitator

New England North West Landcare

NSW GOVERNMENT Local Land Services Northern Tablelands

Vale Mike Keys

Michael Keys started his agricultural career at Hawkesbury Agricultural College in 1965, and in 1968 was offered a position with the Department of Agriculture and was appointed to Wagga Ag College as Junior Poultry Officer. Mike changed to agronomy in 1978 before taking up the position of District Agronomist Queanbeyan at the start of 1979. He continued in that role until the late 1990s when he took up a state wide role as Agronomist , Special Projects . Mike retired from the NSW DPI in 2008 after 42 years of service and passed way in the Queanbeyan hospital on March 15th, 2014.

Mike was an excellent extension agronomist with a good mix of practical but thorough research skills and an effective communication style. As a district agronomist he worked on many agronomic issues of real importance to the farming community. These issues included pasture establishment and in particular direct drilling of pastures, where he showed considerable foresight and innovation both in the adaptation of technology and the extension of that information. Other agronomic matters that took much of his time included exploring control strategies for vulpia, native pasture management, dealing with acid soils, finding solutions for soil salinity and helping farmers to make better fertiliser decisions, to name a few.

Some of Mike's most notable achievements were later in his career in his role as Technical Specialist. His achievements during this period included initiatives such as long term lime trials and pasture persistence trials in the 'Acid Soil Action' program. There was also the highly regarded 'Prime Pastures Program', then the 'Newbridge Grazing Demonstration', as well as the highly regarded "LANDSCAN" training program that he co-developed. All of these initiatives were complex, most involved extensive travel, usually many of them ran concurrently and there was never enough money.

Mike had a knack for identifying opportunities and taking them well beyond what many of his colleagues thought was possible. The "Prime Pastures Program" resulted in 24 pasture establishment demonstrations being set up across the tablelands and slopes of NSW, from Inverell in the north through to the Victorian border. This project also resulted in the production by Mike and his technical team, of two high quality "Prime Pastures" publications that are still used as references by leading farmers and agronomists today.

Mike was a long-term member of the NSW Grassland Society and made significant contributions attending meetings and helped to organise several annual conferences held in the south of the state. He was also a regular contributor to the NSW Grassland Society newsletter.

Mike's cheerful disposition and generosity of spirit will be remembered by all, and his professional accomplishments highly regarded by his peers for many years to come. There is no doubt that Mike was the farmer's champion, and a champion bloke.

Prepared by Chris Houghton

RHIZOBIA AND THE RHIZOBIA-LEGUME SYMBIOSIS

Editors Note:

This article has been modified from Chapter 2 in Inoculating legumes - a practical guide. Reprinted with permission.

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

What are rhizobia?

Rhizobia, also known as root-nodule bacteria, are specialised soil bacteria that are prominent members of microbial communities in the soil and on plant roots. Due to their unique biological characteristic they are able to establish mutually beneficial associations with the roots of legume plants to fix atmospheric nitrogen. The availability of this fixed or reactive nitrogen can make the legume independent of soil/fertiliser nitrogen resulting in increased agricultural productivity.

This association results in the formation of specialised structures on the legume roots, known as root nodules. Within the root nodules the rhizobia absorb carbohydrate from the plant and in return fix atmospheric nitrogen for use by the plant. The nitrogen (N_2) is fixed by the rhizobia into ammonia (NH_3) that is then transferred to the plant and assimilated into organic compounds for distribution via the xylem part of the vascular system – the same part that transports water and nutrients from the soil to the shoots. Legumes are unable to fix atmospheric nitrogen by themselves, although they can absorb mineral nitrogen from the soil. Rhizobia only fix nitrogen when inside the root nodules.

Rhizobia are microscopic single-celled organisms. They are so small, being one millionth of a metre in length, that they can only be seen through a microscope. Many thousands of cells of rhizobia would fit on the head of a pin.

Although all rhizobia appear very similar, they are genetically diverse and markedly different organisms. There are about 90 named species of rhizobia, and scientists are discovering and describing about 10 new species each year. Most of these new species are being discovered as scientists explore the

- Rhizobia are bacteria that live in the soil, on plant roots and in legume nodules.
- Rhizobia only fix nitrogen when inside a legume nodule.
- There are many species of rhizobia.
- Rhizobia species are host (legume) specific. This means different legume species require different rhizobial species to nodulate and fix nitrogen.
- Rhizobia need nutrition, water and aeration for growth.
- Rhizobia in inoculants are killed by heat (>35°), desiccation, extremes of pH and toxic chemicals.

Table 1. Some of the legume inoculant groups used in Australian agriculture and their rhizobia

Taxonomy of rhizobia	Commercial inoculant group	Legumes nodulated
Sinorhizobium spp.	AL	Lucerne, strand and disc medic
	AM	All other annual medics
Rhizobium leguminosarum bv. *trifolii*	B	Perennial clovers
	C	Most annual clovers
Bradyrhizobium spp.	G[1]	Lupin, serradella
	S[1]	Serradella, lupin
Mesorhizobium ciceri	N	Chickpea
Rhizobium leguminosarum bv. *viciae*	E[2]	Field peas & vetch
	F[2]	Faba beans & lentil
Bradyrhizobium japonicum	H	Soybeans
Mesorhizobium ciceri bv. *biserrulae*	Biserrula special	Biserrula
Bradyrhizobium spp.	P	Peanuts
Rhizobium sullae	Sulla special	Sulla
Bradyrhizobium spp.	I	Cowpeas, mungbeans
Bradyrhizobium spp.	J	Pigeon peas

[1]Both inoculant groups G and S can be used for lupin and serradella
[2]Although group E is recommended for pea/vetch and group F for faba bean/lentil, if required group E can also be used for faba beans/lentils and group F used for peas/vetch

biodiversity of our planet with the majority of new discoveries associated with native legumes not used in agriculture. Given that there are more than 18,000 species of legumes, it is not surprising that we are continually discovering new rhizobia. At present in Australian agriculture we only use as inoculants a small number of species of rhizobia that fix nitrogen with the legumes we grow. As new legume genera and species with potential for agricultural use are developed, there will be new species of rhizobia available as inoculants.

Rhizobia can have thread-like flagella that allow them to move through water films in soil and on plant roots.

Each species of rhizobia comprise many thousands of genetically unique forms (strains) that vary in important characteristics that influence their interaction with the legume and adaptation to soil conditions. Commercial inoculants contain single strains of rhizobia that provide optimum nitrogen fixation with the target legume and adaptation to soils where the legume is grown.

Rhizobia can be considered to be ‘probiotic’ bacteria for legumes – beneficial bacteria that are not pathogenic to humans, animals or plants, and can only benefit the specific legumes they nodulate.

Specificity of rhizobia

The relationships between particular rhizobia and particular legumes are very specific – hence different inoculants are produced for the various legumes grown in Australian agriculture

An inoculant or inoculation group is a cluster of legumes nodulated by the same species of rhizobia (Table 1). Different inoculation groups are nodulated by distinctly different rhizobia. For example, lupins are nodulated by the slower-growing acid-tolerant *Bradyrhizobium* spp., whereas the medics are inoculated by the fast-growing, acid-sensitive *Sinorhizobium* spp.

The groupings provide a practical framework when considering if inoculation is needed based on the type of legume previously grown in a paddock, and for choosing the correct inoculant for the particular legume to be sown. Inoculants are produced and marketed commercially according to these inoculant groups.

What do rhizobia need to prosper?

Rhizobia only exist as vegetative living cells (i.e. they cannot form survival structures like spores) and this makes all rhizobia very sensitive to environmental stresses. They can easily be killed by exposure to stresses such as heat, extreme pH and toxic chemicals.

As will all bacteria, rhizobia will grow when the conditions are suitable, ie when they are provided with food (carbon and other nutrients) and water at a suitable pH (Table 2). rhizobia are aerobic organisms and need oxygen for respirations, just like us. Temperature also markedly affects rhizobia. Being single-celled microscopic organisms, rhizobia are always at the same temperature as their immediate surroundings. They have no insulation or ability to protect themselves from heat.

The conditions listed in Table 2 (substrate, air, water, pH and temperature) are what inoculant manufacturers try to optimise when they produce inoculants.

Table 2. Rhizobia are living organisms with simple needs for growth and survival

Requirement	**Comment**
Food and energy	Usually carbohydrates (sugars such as glucose)
Mineral nutrients	Essential macro and micro nutrients
Water	Rhizobia can only grow in moist conditions
Temperature	Preferred range is 15 to 30oC
pH	Preferred range is pH 6.0 to 7.5
Air	Rhizobia are aerobes and need oxygen for respiration

Rhizobia are killed in soil and on seed by heat (some die at 35°C), desiccation, extreme acidity or alkalinity, and the presence of toxic chemicals such as fertilisers, fungicides and heavy metals (Table 3). These stresses must be avoided when handling inoculants to ensure a maximum number of rhizobia remain alive, and are able to colonise the soil and legume roots in sufficient number to make nodules.

Table 3. Harsh environmental conditions kill rhizobia

High Temperatures above 35°C will kill most rhizobia	
Acid and alkalinity	pH sensitivity of rhizobia varies (see Table 4)
Toxic chemicals	Fungicides, solvents, alcohols and disinfectants kill rhizobia
Inorganic chemicals	High levels of heavy metals (Zn, Cu, co) kill rhizobia

The acidity or alkalinity of water and other additives used during the inoculation process can determine whether rhizobia live or die. All rhizobia survive well at neutral pH (7.0), although different species vary in their sensitivity to pH (Table 4).

The process of nodulation

Nodulation always begins with the colonisation of the legume roots by rhizobia. The earlier the colonisation of seedling roots, the sooner root nodules develop and the rhizobia begin to fix nitrogen. A specific sequence of events and optimal conditions are required for nodulation to occur, which can be within days of plant germination.

Nodule formation on legume roots is the result of a highly regulated process. This infection process is under the genetic control of both rhizobial and plant genes, and a high degree of genetic compatibility between partners is essential for the development of nodules containing highly effective rhizobia. This strong genetic compatibility is one of the key features of the elite inoculant strains currently available to Australian farmers.

An essential feature of nodule formation is the exchange of specific signal chemicals between the legume root and rhizobia. In other words, the two partners need to have a conversation with each other and 'communicate' in a language they both understand and then modify their behaviour to form a root nodule. Often, many species of rhizobia are present in the soil around legume roots but, because the rhizobia and plant are unable to communicate, there is no nodule formation.

While the rhizobia are the partner that fixes the nitrogen in this symbiosis, the legume plants generally determine the pathway of infection, and subsequently the type of root nodule that develops.

Nodule initiation can occur in three different ways:

i) via infection of the plant root hairs;
ii) via crack entry at breaks in the roots where lateral roots emerge; and
iii) between epidermal (root surface) cells.

For any specific combination of legume and rhizobia, infection will only occur by one of these processes. However, the majority of agricultural legumes grown in Australia are infected via root hairs.

This article on Rhizobia will continue in the next issue of the newsletter and will discuss the causes of poor nitrogen fixation including legume and rhizobia incompatibility

Table 4. Sensitivity of key rhizobia to pH, where red is sensitive and green is optimal

Rhizobia	Host legume	pH 4	pH 5	pH 6	pH 7	pH 8
Bradyrhizobium spp.	Cowpea, mungbean, lupin, serradella					
Bradyrhizobium japonicum	Soybean					
Rhizobium leguminosarum bv. *trifolii*	Clovers					
Rhizobium leguminosarum bv. *viciae*	Pea, faba bean, lentil, vetch					
Mesorhizobium ciceri	Chickpea					
Sinorhizobium spp.	Medics					

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.

Persistence traits in perennial pasture grasses: the case of phalaris (*Phalaris aquatica* L.)

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Abstract. Persistence is consistently claimed by Australian farmers as a high priority for perennial grasses in long-term pastures. Phalaris (*Phalaris aquatica* L.) is a productive perennial grass with proven persistence in south-eastern Australia. Nevertheless, factors that determine the persistence of pasture species in southern Australia related to climate (drought), soil (acidity), grazing pressure, and, importantly, their interaction can reduce persistence of phalaris and other species in various situations. These factors and their interactions are discussed in this review, and strategies to improve persistence with emphasis on plant breeding approaches are considered, with the most durable outcomes achieved when breeding and management options are employed concurrently. Two examples of breeding to improve persistence traits in phalaris are described. A program to improve acid-soil tolerance resulted first in the release of cv. Landmaster, and recently Advanced AT, which is the most aluminium (Al)-tolerant cultivar of phalaris to date. It was bred by recurrent selection on acid soils in a population containing genes from a related, more Al-tolerant species, *P. arundinacea*. The higher Al tolerance of cv. Advanced AT is of most benefit in more assured establishment on acid soils under variable moisture conditions and confers improved flexibility of sowing date. Cultivar Holdfast GT was bred to address complaints of poor persistence under heavy grazing by cultivars of the highly productive, winter-active type, since high grazing tolerance is needed to achieve profitable returns from developed pastureland. Evidence of good persistence under grazing for cv. Holdfast GT and possible tradeoffs with productivity are discussed. Maintaining high productivity under a predicted higher incidence of drought stress (climate change) and increasing areas of acid soils presents ongoing challenges for persistence in pastures.

http://www.publish.csiro.au/

Subsoil acidity determines survival of lucerne on a highly acidic soil

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This paper first appeared in "Revitalising Grasslands to Sustain our Communities: Proceedings 22nd International Grassland Congress". Reprinted with permission'.

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Introduction

Lucerne (*Medicago sativa*) is one of most productive perennial species in southern Australia. However, productivity is severely restricted under acid soils (Irwin *et al*. 2001). Fenton *et al*. (1996) reported that lucerne performs poorly if soil pH was below 5 and exchangeable aluminium was over 5%. It is estimated that there are 24 m ha of acidic subsoil in southern Australia (Dolling *et al.* 2001). A long-term liming experiment, 1992 to 2010, aimed to ameliorate subsoil acidity via a vigorous liming program (Li *et al*. 2001). This paper reports survival of lucerne during the 3rd cycle of the experiment from 2004 to 2009.

Methods

The experiment was located at Book Book (147°30′E; 35°23′S) 40 km south-east of Wagga Wagga, NSW, Australia. The soil was a subnatric yellow sodosol (Isbell 1996) soil pH 4.1 (in $CaCl_2$) 0-10 cm and 4.2, 10-20 cm (Li *et al*. 2001). The exchangeable Al% was 31% and 43% at 0-10 and 10-20 cm, respectively. The site had been limed every 6 years with an initial lime rate of 3.7 t/ha in 1992 and maintenance rates of 2.6 t/ha during the 2nd cycle and 1.6 t/ha during the 3rd cycle. By 2004, two contrasting soil profiles existed with soil pH of 4.0 and 5.5, 0-10 cm on the unlimed and limed treatments. The soil pH at 15-20 cm increased 0.05 units per year (Li *et al*. 2010) with exchangeable Al% below 10% since 2004 on the limed treatment. In 2004, the experiment was re-sown with the original pasture mixes as described in Li *et al*. (2001). A pair of unlimed and limed perennial pastures was chosen to monitor the persistence of perennial species over 6 years after being established in 2004. The perennial species included were lucerne, phalaris (*Phalaris aquatica*) and cocksfoot (*Dactylis glomerata*) sown with subterranean clover (*Trifolium subterraneum*). Pasture persistence was assessed using basal area as percentage of ground cover of crown or stem base of perennial species. Basal area was monitored over 5 years in autumn at break of season from the second year after pasture was sown. Data were analysed using a repeated measures model (Genstat Release 15.1).

Results and Discussion

Despite a drier than normal year in 2004 (Table 1) we had reasonable establishment of pastures for both

Table 1. Monthly rainfall from 2004 to 2009 and long-term average rainfall (LTAR) at the experiment site.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2004	19.4	7.0	13.4	16.0	50.0	92.4	58.2	74.6	53.6	22.6	93.6	39.0	539.8
2005	26.1	40.0	11.3	24.0	3.2	135.4	78.8	87.0	119.8	88.8	34.8	93.7	742.9
2006	29.6	0.4	20.2	27.2	8.4	47.8	57.2	19.2	28.8	6.4	42.0	1.2	288.4
2007	17.0	64.2	75.2	59.4	83.8	21.8	76.4	32.6	14.2	70.8	138.0	111.0	764.4
2008	81.6	69.0	27.4	16.4	25.6	57.6	116.6	37.8	30.2	29.0	68.6	54.2	614.0
2009	6.4	8.6	15.0	73.6	14.6	78.0	44.6	54.4	33.4	36.2	61.0	105.6	531.4
LTAR	34.3	43.2	49.8	38.1	47.9	58.8	65.5	58.3	59.1	70.7	60.7	58.6	645.0

limed and unlimed treatments. Seedling numbers at establishment were 13-23 plants/m2 for lucerne, 25-27 for phalaris, 25-31 for cocksfoot and 46-49 for subclover. In 2005, the site received above-average rainfall which help pasture establish, but it was an extremely dry year in 2006 (288 mm) which had a detrimental effect on the survival of perennial species.

The basal area of lucerne was 11% on the limed treatment and only 2% on the unlimed treatment in the 2nd year of its establishment in 2005 (Fig. 1a). The basal area maintained around 2-3% for the next 4 years on the limed treatment, but virtually no lucerne plants survived on the unlimed treatments. Prior to the 3rd cycle of rotation, there was only 6 plants/m^2 of lucerne on the limed treatment and 1 plant/m^2 on the unlimed treatment at the establishment year. None survived from the second season during the 2nd cycle of rotation (1997-2003). At the start of the third cycle in year 13, a reasonable numbers of lucerne plants (13-23 plants/m^2) survived at the establishment year and persisted over next 5 years with basal area from 2-3% on the limed treatment, indicating the significant improvement of subsoil acidity.

The basal areas of phalaris and cocksfoot reduced sharply in 2006 and were least in 2007 (Fig. 1 b and c). Phalaris recovered after above average rainfall in 2007, while cocksfoot never recovered from the drought due to its shallow root systems (Ridley and Simpson 1994). From 2008, the pasture was dominated by phalaris, especially on the limed treatment.

Conclusion

With a vigorous liming program, lucerne can be established on highly acidic soil as subsoil acidity was gradually ameliorated over the long-term, though phalaris was more responsive.

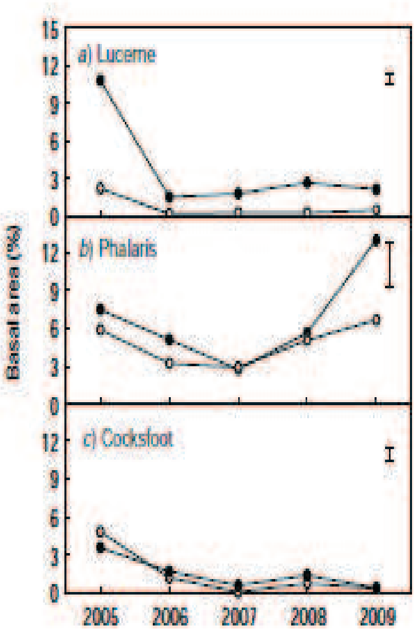

Figure 1. Basal area of a) lucerne, b) phalaris and c) cocksfoot on limed (●) and unlimed (○) treatments from years 2 to 7 after established in 2004. Vertical bars represented LSD at $P < 0.05$.

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Managing water resources in Australian temperate pastures

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Introduction

Currently in Australia there is a concerted effort to develop new perennial grazing systems to make agriculture more productive, adaptable, sustainable and diverse; i.e. resilient. Resilience is defined as the magnitude of the disturbance that a system can absorb without undergoing a regime shift (Holling 1973); or as the capacity to cope with and respond to change, such as increased climate variability or changes to terms of trade. At the farm scale, such changes may include drought or lower commodity prices. At the catchment scale, these changes may manifest as changes to water quantity or quality, reduced biodiversity or soil health. Increasing the area of perennial pastures is key to improving resilience, as perennial pasture is better adapted to a more variable climate and provides resilience in terms of both production and environmental outcomes (Cocks 2001; Dear and Ewing 2008). For example, in recent decades, increasing the area of perennial pasture has been major tool for managing dryland salinity (van Bueren and Price 2004; Ridley and Pannell 2005). However, increasing the area of perennials within a catchment will affect the catchment water balance in terms of both water quality and quantity. These effects may be adverse if land management changes are inappropriate in space, time or structure, and composition.

One of the major issues associated with landuse change is that of equity. This arises because of the asymmetrical nature of catchments, with upstream landholders able to change the quantity, timing and quality of flows for downstream users. It is argued that to share water equitably, upstream landholders have to forgo some potential water benefits in favour of downstream users, and that these downstream users should compensate the upstream landholders, either financially or otherwise (van der Zaag 2007). This compensation to balance this asymmetry takes the form of a reciprocating flux that flows upstream, and could consist of money or be symbolic such as power or solidarity (van der Zaag 2007). In Australia, billions of dollars has been spent on research, development and on ground works to encourage upstream landholders to plant perennial vegetation (e.g. NAPSWQ 2000, CRC FFI 2013), so it can be argued this policy approach has been adopted. However, the effect of this investment on sustainable irrigation diversions for down stream users has been a point of contention (e.g. National Water Commission Interception Position Statement, NWC 2010).

Exploring both agricultural and environmental water resource outcomes at a paddock/farm scale with agricultural and environmental outcomes at a catchment scale is the focus of this paper. This paper explores two case studies of landscape change; one at a farm scale, the other at a catchment scale and explores the interaction between landuse change (specifically increase in area of perennial pastures) and water management.

Method

Farm scale: Between 1993 and 1999, landuse changed from annual cropping to rotational grazing of perennial native pastures between tree belts on a farm near Boorowa on the south west slopes of NSW. For the purpose of this paper, the year 2000 is taken as the first year of post land use change. For a complete site description refer to Crosbie *et al*. (2007). A range of biophysical parameters have been continually measured at the site, starting between 1991 and 1996. These include monitoring of surface, ground and soil water, as well as climate.

Catchment scale: A modelling project was undertaken to determine the effect on stream flow of changing landuse at a catchment scale from annual cropping to perennial pastures, using the model CATPlus (Christie et al. 2011). This model links paddock-scale land-use, soils, topography and climate data to catchment-scale groundwater systems and stream flows on a daily time-scale. An ensemble of crop growth and farm management models allow various types of land-use, land cover, and management strategies to be evaluated relative to their impacts on surface hydrology and landscape system dynamics. The model simulated two catchments; the Glenelg Hopkins in western Victoria (3450 km^2), and the Tarcutta Ck (1700 km^2) in Southern NSW. A number of scenarios were used, from planting all current annual cropping to either plantation pines or perennial pastures, as well as differing level of adoption of perennial pasture based on EverGraze principles (Christie *et al*. 2011). The modelling used the rainfall record from 1900 through until 2008.

The EverGraze principles for the modelling study were based on the southern NSW/northern Victoria scenario of using a combination of fertiliser inputs and rotational grazing to increase productivity from introduced perennials while maintaining native perennials (EverGraze 2012 www.evergraze.com.au). At the same time, the current native perennial pasture base on the hills, which is not suitable to introduced perennials, was kept and improved.

Results

Farm scale: Long term median annual rainfall at Boorowa, located approximately 5 km away, is 596 mm. Median annual rainfall recorded at the site from 1996 to 2010 was 561 mm which is just over the 40th centile. Median annual rainfall during the pre change period (1995-1999) was 591 mm, 38 mm higher than the 553 mm/yr during the post-change period (2000-2010). The amount of run-off from the site between 1996 and 1999 was 148 mm or 8.4% of the total rainfall for the period (Table 1). By comparison, total runoff between 2000 and 2010 was 129 mm, or 1.9% of the total rainfall for the period (Table 1).

Table 1. Key on farm biophysical changes. Standard deviation represented by sd.

Key Indices	Pre change	Post change
Runoff coefficient	8.4%	1.9%
Salt exported kg/ha	59 sd (12)	28 sd (12)
Salt conc kg/m^3	0.9 sd (0.7)	0.8 sd (1.3)

Salt was exported at a rate of 59 kg/ha/yr during the pre-change phase and exported at a rate of 28 kg/ha/yr during the post change phase. The flow weighted mean salt concentration of the runoff water was 0.9 kg/m3 pre-change and 0.8 kg/m3 post change (Table 1).

Groundwater depth varied between 1 m and 12 m below the ground surface during the pre-change period. Rainfall strongly influenced the changes in groundwater depth during this period, the groundwater rising after rain (wet winters in 1993, 1995, 1996 and 1999) and dropping when no rain was recorded. However, in the post change period, rainfall was not significantly correlated to changes groundwater levels (for a more detailed analysis see McCulloch et al. 2006), with watertables steadily declining until the very wet 2010-2011 years when they rose and fell quickly.

Evapotranspiration (ET) as a proportion of the water balance increased from 85% of the received rain during the pre change phase to 96% of rainfall during post change phase. Between 2006 and 2009 all rainfall was converted to ET, as no runoff or deep drainage was measured.

Catchment scale: For the entire Tarcutta catchment the CATPlus model showed a 100% EverGraze adoption rate across the entire Tarcutta catchment would reduce the long term median flow by 37% (from 86 mm/year to 54 mm/year). If the tree cover was 100%, the model showed a reduction of flows under the same rainfall regime of 65% (from 86 mm/yr to 30 mm/year). At a probable adoption rate (10%), modelled streamflow was reduced by only 3% (from 86 mm/yr to 83 mm/yr). Changes to the behaviour of modelled stream flows showed that the creek became more ephemeral as the area of perennial vegetation increased, with the volume of baseflow decreasing and the volume of quick flow (direct runoff) increasing.

Under current conditions, CATPlus showed that farm dams maintained a sufficient water volume for stock for 96% of months. With increasing EverGraze adoption, the model showed that both the area with dry dams and the period of no water in dams increased. However, only the scenario with 100% adoption of EverGraze caused dams to be dry for extended periods.

Discussion

The two case studies described here show clearly that changing landuse changes the volume, timing and quality of water flowing from farms and catchments.

The change in landuse monitored at the farm scale coincided with the “millennium drought” (SEACI 2012). The effects of this on the outcomes discussed below were minimal and are described in detail by Crosbie *et al*. (2007).

The change from annual cropping to perennial pasture at the farm scale decreased salt and water exports, reduced recharge and reduced saline groundwater discharge. However, the flow weighted mean salt concentration did not change significantly, suggesting that the reduction in water export was the main driver for the reduction in salt export. The changes in streamflow at the farm scale showed that ET increased and both surface flow and deep drainage decreased. This would benefit pastures by increases to biomass, and potentially improved grazing. The decrease in deep drainage is usually a positive outcome, particularly in terms of salt mobilisation in this case the mean concentration of salt exported did not change (kg/m^3), however the mass of salt (kg/ha) halved. This decreases to surface flow again is usually a positive outcome in water quality terms, particularly reduction in the amount of salt that is washed into streams. However, reduced surface flows may be a cause for concern, as these flows are used to replenish on-farm water (dams, stock tanks). On specific farms, localised surface water deficits would be problematic to livestock grazing enterprises if there was widespread adoption of a perennial grazing system.

The depth to watertable increased and this contributed to the reduction in runoff as more water infiltrated and was stored in the soil profile. The change from annual cropping to perennial pasture deceased recharge and, as a consequence, reduced saline discharge, also in line with other studies in temperature SE Australia (Ridley and Pannell 2005). ET increased as a proportion of rainfall and it is assumed that the pasture was exploiting the rainfall where and when it fell and that this led to increased pasture growth and hence farm productivity and profitability (Hoque and Bathgate 2008). As a consequence of the landuse change, groundwater levels were no longer correlated to rainfall (McCulloch *et al*. 2006), suggesting that the groundwater was disconnected from the surface water. However, this disconnection did not reduce the mass of salt exported per cubic metre of water.

At the catchment scale, the decrease in water exports from this landscape was considered beneficial as the amount and concentration of salt was reduced. However, when salt was not a factor in the model and all the available land was converted to EverGraze principles, the volume of streamflow decreased by 37% (from 86 mm/yr to 54 mm/yr). A more sensible figure of 10% adoption of EverGraze showed reduction from 86 mm/yr to 83 mm/yr in the volume of streamflow.

Under the realistic adoption scenario (i.e. 10% adoption of EverGraze) the volume of streamflow was reduced by only 3%, so the equity of water sharing remained unchanged in terms of volume. However there maybe changes to the seasonality of the stream flow and this may have larger effects on equity than simply changes to streamflow. It is apparent from the model results that a larger uptake of perennial pastures will decrease streamflow. The risk of landuse change decreasing streamflow is then dependent on effecting the change itself (adoption rates) rather than the physical change to upstream landscapes.

Public investment in landuse change has been targeted to the upper catchments to counter the physical asymmetrical nature of catchments (van der Zaag 2007). This targeting has been by investing in research, development and on ground works at the landscapes in the headwaters of the catchments. On the evidence presented in this paper there is little effect on streamflow. It can be inferred that downstream users are also little affected by this decrease in streamflow; that the flows in the rivers appear to be more typical of pristine flows; and that upstream landholders are benefiting from improved resilience.

Conclusions

Managing water involves consideration of scale. The management of water at a field scale revolves around conserving or maximising productive use of water in the root zone as well as providing surface water for stock. Management of water at a catchment scale is concerned with allocation distribution and water quality. In the light of the above examples it can be seen that increasing the perennial pasture components of the landscape can have benefits at the farm scale, including reducing the runoff and increasing the store of rainfall in the rootzone and by extension potentially increasing biomass from increases in evapotranspiration. The reduction of runoff from saline landscapes reduced salt export, but also reduced surface water availability which, at the farm scale, resulted in reduced availability of stock water in times of low rainfall.
At the catchment scale, an increase in perennial vegetation reduced overall streamflow. However, at realistic adoption rates, this was insignificant. Interestingly the increase in perennial pasture at the farm scale causes the stream to revert to more pristine conditions with an increase in the volume of direct runoff as compared to baseflow.

The equity of the catchments appear to be in balance with public investment flowing into the upper catchment areas, while water flows remain unaffected downstream. The catchment as a whole has at least maintained resilience, as upstream users have improved landscapes and downstream users have had no change to water flows.

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New drought support arrangements from July 1 2014

Support for drought-affected farmers
From 1 July 2014, a range of drought support measures are available to help farmers prepare for and manage the impacts of drought under the new national drought program.

To support the rollout of the national program, the NSW Liberals & Nationals Government has announced a new $13 million funding package.

These measures include:

• $8 million for the popular Emergency Water Infrastructure Rebate (plus up to an additional $4 million from the Commonwealth Government);

• $1.9 million to continue the Department of Primary Industries' Rural Support Worker Program;

• $2.5 million to continue the Country Town Emergency Water Cartage and Infrastructure Scheme; and

• $350,000 for additional staff at the Rural Assistance Authority, to support the rollout of the new national program.

This is in addition to ongoing NSW Government drought support, which includes:

• continuing funding for the Farm Innovation Fund, to provide farmers with loans at concessional interest rates through the Rural Assistance Authority for in-drought support and drought preparedness;

• $840,000 for the NSW Government's ongoing commitment to the Rural Financial Counselling Service; and

• $500,000 for animal welfare cases, focused on stock going to sale or slaughter where there is significant risk to animal welfare.

Emergency water infrastructure rebate
Grants of up to $50,000 per producer are available to help farmers install on-farm water infrastructure, including bores, water troughs, pumps and tanks, under the Emergency Water Infrastructure Rebate.

Due to the popularity of the program, funding for the 2014-15 period is close to being fully subscribed. Landholders are encouraged to contact the Rural Assistance Authority to discuss the availability of funding and their eligibility.

Joint national and state support
The NSW Government is working closely with the Commonwealth Government to implement new drought support measures under the Intergovernmental Agreement on National Drought Program Reform.
This new approach includes;

• the new Farm Household Allowance;

• Farm Management Deposits and taxation measures;

• a national approach to farm business management training;

• a coordinated and collaborative approach to social support services; and

• tools and technologies to inform farmer decision making.

The NSW Rural Assistance Authority will also administer $100 million of the Commonwealth Government's Drought Concessional Loans Scheme to farmers for debt management and drought works.

An additional $2.4 million will be directed towards pest management in drought affected areas.

Guidelines for these initiatives are currently being finalised by the NSW and Commonwealth Governments and applications will open shortly.

Monitoring and reporting of seasonal conditions
The NSW Department of Primary Industries continues to publish a monthly State-wide Seasonal Conditions Report, and Local Land Services will soon publish monthly on-ground regional seasonal conditions reports.

The independent and expert Regional Assistance Advisory Committee (RAAC) will continue to closely monitor objective rainfall, pasture growth and soil moisture information, as well as on-ground information from Local Land Services.

The RAAC will also continue to monitor ongoing programs and support, and will provide advice and recommendations to the NSW Government as required.

Expert advice for farmers
Assistance and technical advice on drought management and preparedness, pastures and livestock is available from Local Land Services and the Department of Primary Industries.
Local Land Services can also refer landholders to appropriate support services.

More information
• Rural Assistance Authority
• Department of Primary Industries
• Rural Support Workers
• Rural Financial Counsellors

Conditions of Entry

- Samples (approx. 500g) are best sent using a Post Paid Feed Quality Service sample kit available from NSW DPI. Silage should be frozen in plastic bag then wrapped in newspaper before posting early in the week. If you don't have a green FQS bag, samples can be posted early in the week to: Feed Quality Service, NSW DPI, Locked Bag 701, Wagga Wagga NSW 2650.
- The aim of these awards is to promote the benefits of high quality hay and silage to all farmers with emphasis on the importance of feed quality in animal production and how to achieve feed quality in conserved forages.
- Awards will be based on feed quality analysis results from the NSW DPI Feed Quality Service with emphasis on metabolisable energy and crude protein. Results will also be compared with guidelines provided in NSW DPI Silage Note 4 (www.dpi.nsw.gov.au) and TopFodder Successful Silage manual.
- Awards will compare hays and silages in each category ie. one award for each crop or pasture type, not separate awards for hay and silage.
- Samples must be representative and must come from commercial lot size intended for feeding to animals. Minimum lot size 5 tonnes of product.
- Samples must be of forage (hay or silage) conserved and/or fed in 2013/2014.
- Limit of 4 entries (samples) per farm or producer.
- Awards will be presented at the NSW Grasslands Society Annual Conference to be held in Inverell 22-24 July 2014.
- It is desirable for all entrants to keep photos and an example of entries until after awards are announced.
- Winners agree to co-operate with the organisers (NSW DPI and Grasslands Society of NSW) to conduct relevant field days, press and media following the awards.

Closing date: 4 July 2014

Note: Results of early submissions will be sent out at the end of each month.

Further information phone (02) 6938 1957 (lab) or (02) 4939 8948

We thank sponsors of these awards:

INTEGRATED PACKAGING 'we go to greater lengths'

NEW HOLLAND AGRICULTURE

DUPONT PIONEER.

- NSW Feed Quality Service

Approximately $5,000 worth of prizes

NSW GOVERNMENT Department of Primary Industries

THE GRASSLAND SOCIETY OF NSW INC.

NSW Hay and Silage Feed Quality Awards 2014

Entry form to be sent with sample to Feed Quality Service

Name: .... **Business name:** ....

Postal address: ....

Phone: .... **Fax:** ....

Email: ....

Property address (if different): ....

....

Property Identification Code (PIC): ....

Sample details: ☐ Hay ($42.10) ☐ Silage ($70.40) Bale or pit size: ....

Note: You must enclose a cheque made payable to Trade & Investment NSW

Crop/pasture description (1 only)	Details/varieties
❒ Winter/temperate pasture	....
❒ Summer/tropical pasture:	....
❒ Winter crop:	....
❒ Maize:	....
❒ Other summer crop:	....
❒ Lucerne:	....
❒ Other:	....

Harvest: Date: .... Growth stage/maturity: ....

Machinery used to mow/bale/harvest etc: ....

....

Storage method/facility: ....

Additives applied at harvest: ....

Quantity stored: ....

Time from mowing till harvest or storage: .... days

Payment Authorisation (must be completed)
I hereby authorise Trade & Investment NSW to test the sample I have identified according to the above details as an entry in the 2014 NSW Hay and Silage Feed Quality Awards. I have enclosed a cheque for $__________

I accept that the judge's decision will be final and will not be challenged.

Name: .... Signature: .... Date: ....

Test results and findings may be provided to authorised staff and used for statistical, surveillance, extension, certification and regulatory purposes in accordance with Departmental policies. The information assists disease and residue control programs and underpins market access for agricultural products. The source of the information will remain confidential unless otherwise required by law or regulatory policies.

LABORATORY USE ONLY		
Date received:	Accession number:	Accessioned by:
Samples checked:	Total number of samples:	Testing authorised:

Closing date: 4 July 2014

NSW GOVERNMENT Department of Primary Industries

THE GRASSLAND SOCIETY OF NSW INC.

Target 100 gains 200th farmer story

After two years the Target 100 program has notched up its 200th farmer story.

Sixth generation farmer Jasmine Nixon's story is now live on the Target 100 website.

Together with her family, she runs a commercial Angus herd on their Southern Tablelands property in NSW, and in her story Jasmine describes the sustainability measures her family is taking to preserve the environment, livestock and land for future generations.

"While breeding and raising cattle is the main part of our day-to-day business, ensuring that we care for our animals and our land so it will be there for future generations has always been a number one priority for my family," Jasmine's says of her farming philosophy.

Target 200 was developed to create an open discussion between beef and sheep farmers and the community, and through its digital platform, helps to connect the community with how their beef and lamb is produced.

All 200-plus farming families involved with the Target 100 program have committed to share their stories and showcase their sustainability initiatives to the wider community.

In the last 12 months, almost 50 Target 100 producers alone have volunteered their time to interact with consumers, including Paul Crock from Gippsland Natural, Matt Dunbabin from Bangor, and Rob Lennon from Gundooee Organics, who invited consumers onto their farms, actively attended community events, they have been interviewed by media, taken part in documentaries and live audience forums, shared their produce, and presented on stage with celebrity chefs at community events.

Target 100's 200th farmer story represents a big step forward for the program in just over two years of development.

But a further 100 producers are still needed to join the campaign.

Beef and sheep farmers with a sustainable story to tell, are encouraged to take part and engage with the community, to help promote the industry to a wider audience about what they are doing in working towards a more sustainable future.

For more information visit Target 100 at www.target100.com.au/Home

Interested in attending an inter-state or overseas conference?

Why not apply for a Grassland Society of NSW Travel Grant?

Travel Grants are open to financial members of the Society with at least two years of continuous membership prior to the date of application - funding is available to attend conferences or other activities associated with grassland science. The committee are particularly interested in applications from our producer members.

More details can be found on the website (www.grasslandnsw.com.au) under the membership tab or by contacting the Secretary (secretary@grasslandnsw.com.au)

From the President

"Spring in the autumn for some, and as dry as ever for many of the rest" is how a colleague summed up the 2014 season so far, and I have to agree with him. Some parts of the state are looking for the last time conditions and pasture growth were this good at the end of May, and I have heard comparisons to 1973, and one in the south say 1956! Others in the north and north western areas of NSW are probably looking back just as far but sadly for the opposite reason.

Our thoughts go out to those who are consistently missing the rainfall events, and not even the cattle market is doing much to help out. High numbers coming through the yards are keeping a firm lid on pricing unfortunately, and only those in a great season have the ability to cash in. It will be a very tough winter for many, and here's hoping the talk of a particular spring event is just that, talk!

The "Pasture Updates" are off and running again, with a very successful day at Bathurst held at the end of last month. These events have seen more than 250 participants over the past 12 months tune in to much of the new research relating to pastures, some of it very localised for the respective update. Participants have been very enthusiastic in 'picking the brains' of the presenters to get the best of their knowledge, with many planning on implementing some changes back on the property. We have more "Pasture Updates" planned, with dates for some already announced, while others will be later in the year. Keep an eye on the web site for the next "Pasture Update" near you.

Our 2014 Annual Conference (July 22 – 24) at Inverell is all but upon us, with only six weeks to go. Much work is being channelled into what looks to be a very comprehensive program. I encourage all those that can get to Inverell to make the effort, it will be well worth while.

Here's hoping that mother nature finds a few spots she hasn't been to for a while very soon, and everyone can get a bit of relief. To those that have it, enjoy it and make the most from it. I look forward to talking with members and guests at Inverell to the sound of rain!

All the best,
Regards,

David Harbison,
President.

PHOTO COMPETITION

The winner is ....

Congratulations to Katie Austin from Armidale.

Katie has won a free membership to the Grassland Society of NSW for 2014/2015.

See future issues of the newsletter and the website for a new photo competition.

Grassland Scene from the top of Mount Rankin, between Uralla and Bundarra on the Northern Tablelands of NSW by Katie Austin.

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

Office Bearers of the Grassland Society of NSW – 2013-2014

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Mick Duncan (Northern Tablelands)
Cathy Waters (Central West Slopes and Plains)
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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 September 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 August 29 2014.

New members: The Grassland Society of NSW wishes to welcome new members Robert Drewitt, Bingara, Melissa Mooney Blanford, George Truman Gunnedah and Matthew Lieschke, Goulburn.

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.

Grassland Society of NSW - PO BOX 471 Orange NSW 2800, www.grasslandnsw.com.au

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