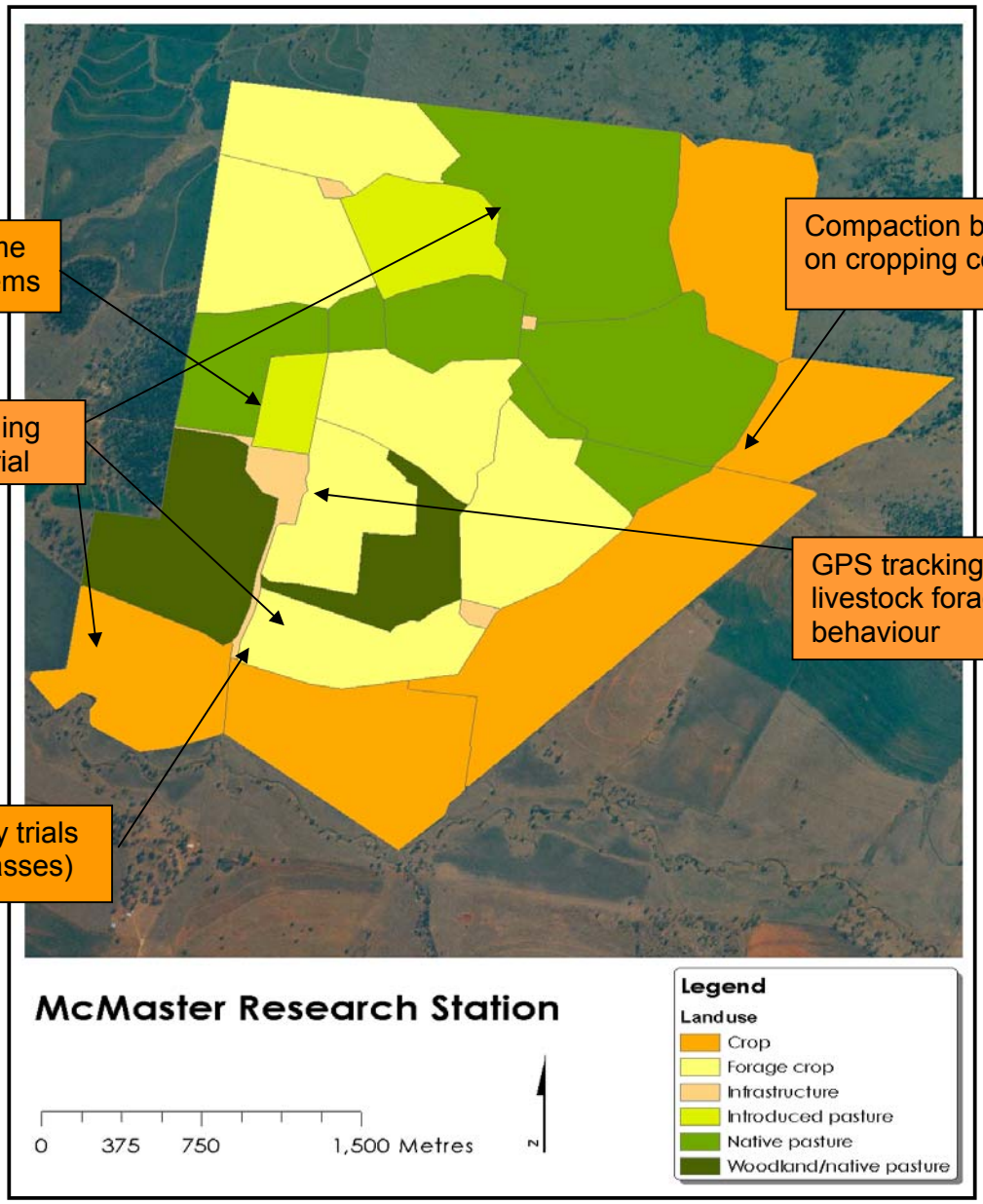
Douglas McMaster Research Station – Warialda



Grain & Graze™
Profit through knowledge
BORDER RIVERS

Grain & Graze in the Border Rivers

The Border Rivers region of southern Queensland and northern New South Wales is characterised by a highly variable summer-dominant rainfall pattern and predominantly (but not exclusively) heavy-textured soils. Pan evaporation is on average greater than rainfall for every month. Agriculture in the region spans the

range from almost exclusively cropping at one end of the spectrum to complete grazing with sheep and cattle at the other, but a large proportion of farms have both cropping and livestock production. Cropping systems comprise winter cereals, summer coarse grains and grain legumes. Livestock production systems involve breeding, store and finishing operations (including feedlots) for cattle, and sheep for wool and fat lambs. Feed sources for livestock are many and varied: native and improved pastures, lucerne and medics, summer forage legumes (e.g. lablab, burgundy bean and butterfly pea), crop stubbles, cotton seed, grain and supplements.

Climate variability is one of the major drivers of agricultural production in the region; however the rainfall pattern, allowing both summer and winter cropping, provides opportunities that do not exist in southern Australia.

The central question of the Border Rivers Grain &Graze project relates to the integration of pasture phases into farming systems - *Is the introduction of a short or long term grazing phase in cropping systems in the Border Rivers Catchment profitable and environmentally, financially and socially sustainable?*

The overall scope of the Border Rivers Grain & Graze projects is to develop farming systems for mixed enterprises that will enable management of the key risk factors – climate variability and physical resource distribution variability.

Specifically projects will provide information that will enable producers in the Border Rivers to evaluate the implications of short or long term grazing phases in their cropping systems in terms of:

- options to change enterprise mix (crop to pasture or pasture to crop) that are responsive to seasons and market
- a more evenly distributed feed source for livestock enterprises throughout the season when winter supplies may deplete
- options to landholders to reverse deteriorating soil condition where needed through the maintenance of groundcover
- options to landholders to incorporate natural resource planning of vegetation and water quality management into their mixed farming system decisions
- options to implement an enterprise mix that is responsive to landholder stage in life considerations

Grain & Graze has come to the Border Rivers region under a partnership between the Queensland Murray-Darling Committee, the Border River-Gwydir Catchment Management Authority, the Primary Industries Innovation Centre (NSW Department of Primary Industries/University of New England), the CSIRO and the Queensland Department of Primary Industries and Fisheries.

The focal point of the Primary Industries Innovation Centre research activities is on the University of New England property Douglas McMaster Research Station at Warialda. This research station is ideally situated in the Border Rivers catchment and is typical of farms in the area.

McMaster Research Station

Douglas McMaster Rural Research Station is approximately 1012 hectares in area. It is owned by the University of New England, Armidale, and was bequeathed to the University by the late Douglas McMaster in 1964.

Advice from the McMaster Farm Group

The McMaster Farm Group was established in December 2005 to set priorities and review progress of applied research and adoption of mixed farming enterprises. The vision of this group is to develop more profitable and sustainable whole-farm systems for the region and for the McMaster Research Station to be a credible source of information in the eyes of the farming and wider community.

Members of the McMaster Farm group include Chris Densley, Col and Felicity James, Phillippa Morris, Fred and Sam Dobner, Fergus Walker, Tom Ledingham, Ken McMaster (local producers), Laura McKinley (CMA),

Warwick Browne (DNR), Graham Crocker (NSW-DPI), Carol Harris (NSW-DPI), Brian Wilson (DNR), Andrew Stevenson (McGregors).

This group has meet on a number of occasions at McMaster Research Station to discuss whole-farm planning and research issues. In July 20, 2006 a meeting was held with the McMaster group to discuss research directions for the Grain & Graze project and the group was instrumental in defining 'what is a typical farm in the region' and the key themes to be investigated; tillage, integration, pastures and inclusion of grasses into lucerne.

The McMaster Mixed Farming Systems Trial

Three farmlets have been set up to compare three distinct management systems at a scale which allows credible, whole-farmlet comparisons - 46 ha each in size (138 ha trial in total).

We suggest that, provided the experiment is well planned in terms of land allocation and takes into account characteristics judged to be relevant by the local farming community, the comparisons are made in a way that is more realistic, in terms of cropping and livestock dynamics, than traditional small-plot research. Also, measuring climate, soil, crop, pasture, livestock, economic and environmental parameters will enable a more complete whole-farm picture of different mixed farming approaches to emerge over time.

Seeks to answer two questions

1) What are the effects of integration of livestock and cropping enterprises in a mixed farming enterprise?

2) What effects result from additional investments in the pasture component of an integrated, mixed farming enterprise?

Principles and Rotations

Each farmlet has been carefully mapped and assigned equal areas of rocky hilltops (with native pasture), red basalt slopes, black basalt flats and roughly equivalent areas of cropping and grazing each year.

TYPICAL farmlet

- Represents a 'typical' property in the region where livestock and cropping enterprises are often separated, with livestock not allowed to graze on the better cropping soil
- Native pasture hilltops remain unimproved
- Forages consist normally of lucerne and oats, sown only on the red slopes country.
- Cropping rotation based on cereals, fallow, sorghum and grain legume, all on the black basalt flats.

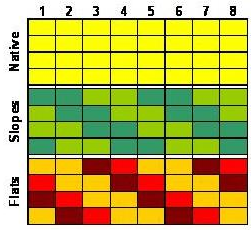
INTEGRATED farmlet

- Represents a property where livestock and cropping enterprises are mixed, with livestock allowed to graze on forages and pastures sown in rotation on good cropping soil (black basalt flats)
- Native pasture hilltops remain unimproved
- Forages consist normally of lucerne and oats sown into cropping rotations of both red slopes and black soil flats
- Cropping rotation based on cereals, fallow, sorghum and grain legume in rotation with lucerne and oats forages.

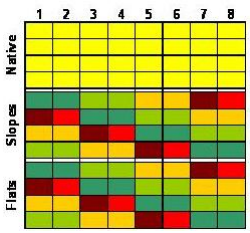
INTEGRATED PASTURES farmlet

- Represents a property where livestock and cropping enterprises are mixed, with livestock allowed to graze on pastures sown in rotation on good cropping soil
- Native pasture hilltops are fertilized according to soil test and sown with legumes
- Lucerne and oats forages replaced with 4-year perennial pastures customised for the red and black soil types
- Cropping rotation based on cereals, fallow, sorghum and grain legume in rotation with 4-year perennial pastures on both the red and black soil types.

The 8 year rotation sequence on each farmlet is indicated in the diagrams below. Years run horizontally for each of the 4 paddocks on each of the 3 soil types. The 3 soil types (rocky hilltops, red slopes, and black flats) run vertically.



TYPICAL



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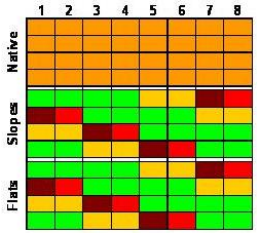


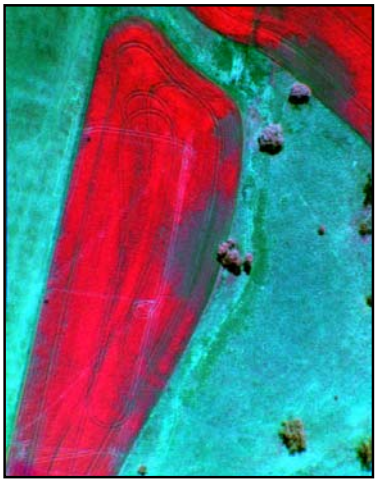
INTEGRATED PASTURE

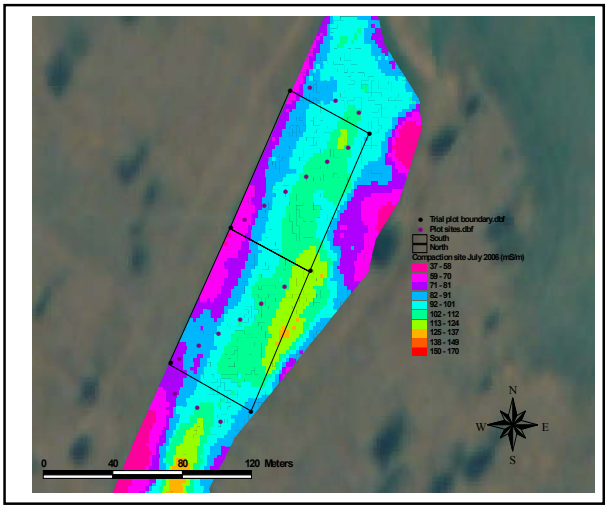
This experiment seeks to quantify the overall performance of each farmlet system. It is essential to integrate the measurements to gain an understanding of the trends over time in some components of 'sustainability' of each mixed farming system including estimates of risk management, ground cover, erosion, crop and pasture growth and nutrient audits.

Hence the following will be monitored:

Soils	Soil fertility (regular yearly soil sampling in each paddock) Soil moisture (physical factors such as infiltration/bulk density/moisture content)
Plants	Herbage mass & quality Pasture & fodder crop growth rates Ground cover
Productivity	Grain yield & quality Liveweight gain (stock weighed on and off each paddock)
Costs	Input costs (fertiliser, seed, pesticides, supplements, fuel, stock purchases, labour etc)
Prices	Output prices (average commodity (grain & beef) price/year, livestock sales, grain volumes sold etc).

In conjunction with this – Precision agricultural techniques will be applied to estimate grazing pattern, behaviour and compaction (GPS tagged cattle), soil water status (EM survey) and pasture growth and crop vigour (CropCircle) allowing for spatial data collection and assay on the environmental implications of the three systems in variable rainfall conditions.





Infrared satellite imagery and EM survey of black flat paddock used for compaction trial, images such as this routinely collected within the farmlet trial.

Investigations into compaction effects on crops following grazing

Two research questions are being investigated by UNE honours students.

1) Impact of stocking rate on soil physical properties and subsequent moisture storage and cereal establishment and vigour on black cracking clay soils.
2) Impact of rainfall volume on damage to soil physical properties on black cracking clay soils following cattle trampling.

GPS tagged cattle used to estimate grazing pattern, behaviour and compaction.

ⓘFor more information on the McMaster Mixed Farming Systems trial contact Chris Guppy, University of New England Armidale 02 6773 3567.

Pasture Legume Trial

The trial was sown to 30 different, mainly annual pasture legumes (see trial plan Appendix 1) on 20th June 2006 and 200 kg of Mo super was applied on 9/8/06. The soil analysis for this paddock in April 2006 was pH (water) 6, (CaCl2) 5.3, Organic Carbon 0.7%, Colwell P 45 ppm, S 5 ppm, NO_3-N 28 ppm, CEC 8, and EC 0.8

The paddock was taken out of lucerne in 2004, sown to oats in 2005 and cultivated before sowing in 2006. Trifluralin was applied at 1.5 L/ha on 3rd May but no rain was received until the long weekend in June. The trial was sown on 20th June and only received 100 mm rain in 6 falls up to November 2006.

Establishment counts on 9th August, 2006 give an indication of the density of the pasture legumes and are a reflection of the germination percentage, seeding rate and seed size. The seed was sown by hand and raked in after sowing. The poor establishment of some lines, notably the Medics, Sulla, Sainfoin and Caprera Crimson clover appears due to poor viability of seed coupled with no rain for 5 weeks after sowing.

Yields are low in October due to the late sowing and dry growing conditions. However, 5 lines still managed to yield over 2000 kg dry matter/ha, and all lines yielded over 1 tonne/ha. The best performing lines at present appear to be Arrowleaf, Rose, Persian and Gland clover, Serradellas plus the 2 perennial legumes, Sulla and Sainfoin. Sub clovers should not be overlooked, for although they are not among the top yielders they give good ground cover but have not produced a lot of material to actually harvest.

As most of the legumes are annuals they need to set seed to ensure regeneration in the next year. The early maturing lines such as the Medics, Frontier Balansa clover and Yelbini serradella had all flowered and set seed by October while the later maturing lines were still flowering and trying to grow. So the early maturing lines usually produce less dry matter, but set some seed allowing them to regenerate the following year. Fortunately good rains were received at the end of October allowing the later lines to also set seed. The advantage of the later maturing lines is that they will produce much more biomass. This is why it is a good idea to include early and later maturing legumes in your pasture. This is especially true with sub clovers where a mix of early, mid and late maturing cultivars is often used.

While the figures given for days to flower are a good guide, the actual numbers can change with time of planting and moisture stress as has happened with this trial. This has meant that most lines have started flowering earlier than they would under better conditions.

By the end of November, the later maturing lines such as arrowleaf and purple clover and the perennials (Sulla & Sainfoin) had benefited from the late season rains and continued to increase their production. Biserrula and Lotus also responded to this rain and is a characteristic of these species. On the other hand the rains did not appear to benefit the early maturing lines such as the medics, and most of the other clovers which yielded less than at the October harvests because they had matured. The sub clovers had a slight improvement in yield over the 7 weeks and it probably helped them set viable seed.

Table 1. Establishment, yield and days to flower of the legume varieties sown at McMaster.

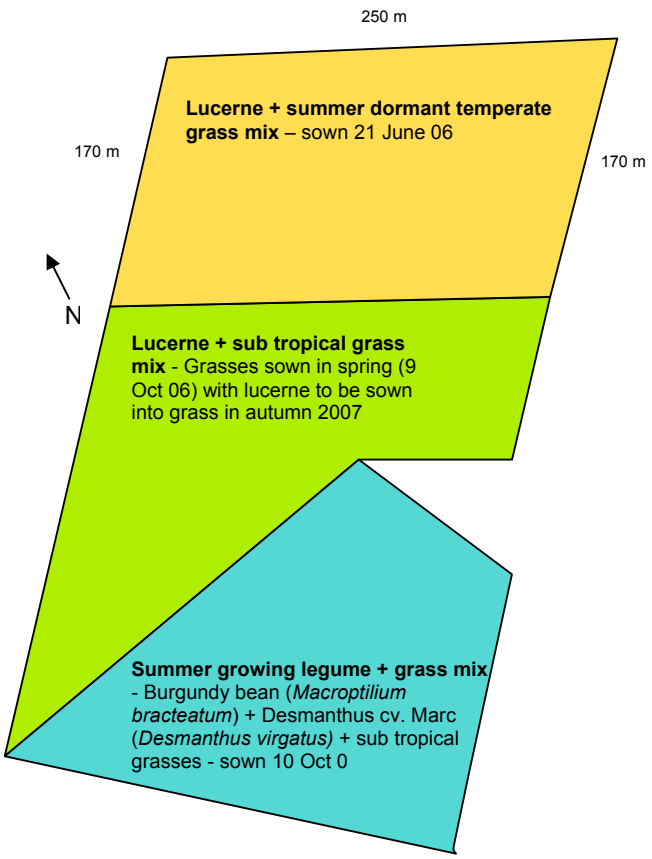
Cultivar or species	Establishment	Yield kg/ha	Days to flower	Yield kg/ha
	Plants/m2	10.10.06	at Tamworth	30.11.06
Aokau Sulla	55	**2033**	140	2517
Othello Sainfoin	40	1759	118	2019
Caliph Barrel Medic	36	1194	**89**	878
Jester Barrel Medic	47	1355	104	1639
Toreador Hybrid Medic	53	1000	**85**	1171
Cavalier Spineless Burr	80	1291	**96**	819
Herald Strand Medic	108	1065	**88**	937
Spotted Medic	79	1484	**95**	1258
Frontier Balansa Clover	49	1016	**89**	263
Prima Gland Clover	165	1823	**110**	615
SARDI Rose Clover	72	1468	135	702
Hykon Rose Clover	92	**2081**	133	1024
SARDI Persian Clover	104	**2146**	128	761
Caprera Crimson Clover	16	1194	136	907
Electra Purple Clover	121	1742	140	2400
Purple Clover	180	1468	138	2078
Cefalu Arrowleaf Clover	91	**2033**	137	**3805**
Zulu Arrowleaf Clover	197	**2150**	146	**3863**
Bladder clover	81	1565	100	878
Urana Sub-Clover	68	1226	115	1580
Seaton Park Sub-Clover	121	1307	120	1522
Mintaro Sub-Clover	101	1404	122	2429
Rosedale Sub-Clover	109	1484	124	1258
Clare Sub-Clover	104	1404	136	1873
Yelbini yellow Serradella	49	1404	**85**	1493
Charano yellow Serradella	35	1500	100	1844
Cadiz pink Serradella	47	1629	111	2107
Erica pink Serradella	81	1807	115	1961
Casbah Biserrula	115	1678	121	**3132**
Lotus ornithopodioides	84	1580	**98**	**3307**

ⓘ *For more information on the Pasture Legume trial contact Graham Crocker NSW Department of Primary Industries Tamworth* 02 6763 1138

Grass-Legume Pasture Systems for the Border Rivers

Aim: to evaluate 'best bet' mixed pasture systems for marginal soil types in the region, particularly, the complementarity of grasses and legumes for better cover, more soil organic matter build up, higher feed production and better timing to fill feed-gaps.

Trial description: Three 4 ha areas have been established to demonstrate and evaluate the persistence and production (pasture and livestock) of winter or tropical legumes sown in association with temperate (summer dormant) or sub tropical grasses. After consultation with local agronomists and researchers, 3 best bet pasture systems have been planted into 4 ha demonstration areas.



Treatments

- Lucerne + Summer dormant temperate grass mix: (Phalaris cv Atlas PG *Phalaris aquatica*) & Fescue cv. Flecha Max P. (*Festuca arundinacea)*
- Lucerne + Tropical grass mix: Premier Digit *(Digitaria eriantha)*, Katambora Rhodes *(Chloris gayana)*, Creeping blue grass (*Bothriochloa insculpta*)
- Summer growing legume + Tropical grass mix

Soil details

- Hardsetting, compacted red earth
- Organic carbon (0-15cm) 0.9 %,
- Low in sulfur (KCl40 S= 4.8 ppm),
- Marginal P (Colwell P = 25 ppm).

Sowing details

- Chemical fallow & 1 tillage from Nov 05 to reduce heavy weed burden (cost approx. $90/ha)
- Sown with Agrow drill planter with press wheels
- Grasses sown on surface mixed with DAP (25 kg/ha)
- Legumes inoculated with rhizobium and drilled to 5-7 cm depth.
- ~ 80 kg/ha of single superphosphate

Establishment: Excellent establishment of the lucerne (approx. 30 plants/m^2) and temperate grasses (26 plants/m^2) were observed in spring 2006. Summer sowings on 9 Oct 2006 were into good soil moisture, with good follow-up rainfall of 270 mm (Warialda) received from sowing until present. While initial establishment of the tropical pastures was good (> 8 plants/m^2 each of burgundy bean and tropical grasses) seedling numbers have been reduced, possibly due to competition from annual summer grasses (*Urochloa* spp.). Sowing rates, seed price and costs for establishing the pasture are provided in Table 1.

DM production: Lucerne + temperate grass pasture was sampled on 29 Nov 06 and had produced 770 kg DM/ha (70/30 lucerne/grass). The latter sown summer growing pasture mixes were first sampled in March and April 2007. The tropical grasses produced the most biomass during the warm summer period. Interestingly the mixture of tropical legume and grasses has produced more biomass than the tropical grass alone without a legume accompanying (the lucerne has not yet been sown) and consists of approx. 20% legume. The temperate grasses are dormant at present but it is hoped will compliment summer growth of lucerne during the cooler months.

Table 1. Sowing rate, seed price and costs for establishing pasture mixes

Pasture species	Sowing rate (kg/ha)	Price ($/kg)	Seed costs ($/ha)		
			Lucerne/ Temperate Grass	Lucerne/ Tropical grass	Tropical legume & grass
Lucerne cv. UQL-1	5	5.50	27.50	27.50	
Burgundy bean (coated)	5	13.50			67.50
Desmanthus cv. Marc	2	25.00			50.00
Tall fescue cv. Flecha Max PG	10	9.36	93.60		
Phalaris cv. Atlas PG	3	8.40	25.20		
Premier digit (coated)	2	18.00		36.00	36.00
Creeping blue cv. Bisset (coated)	2	18.00		36.00	36.00

Rhodes grass cv. Katambora	2	13.50		27.00	27.00
Total			146.30	126.50	216.50

Note: For experimental purposes higher sowing rate were used. These may be reduced considerably in commercial pasture mixes. Good quality seed is essential for reliable establishment and sowing rates and cost should consider the % seed germination.

Table 2. DM production and plant numbers of lucerne + temperate grass mix (L/Tp), lucerne + tropical grass mix (L/Tr) and burgundy bean + subtropical grass mix (BB/Tr).

	DM production (kg DM/ha)						Perennial plants (number/m^2)		
Treatment	15 Mar 06			26 Apr 06[A]			15 Mar 06		
Date	L/Tp	L/Tr	BB/Tr	L/Tp	L/Tr	BB/Tr	L/Tp	L/Tr	BB/Tr
Lucerne	790	[B]		360	[B]	530	33.3	[B]	
Burgundy Bean			360						1.3
Grass	0	1390	1640	510	1490	1270	6.8	7.6	9.6
Total	790	1390	2000	870	1490	1800			

[A] Some grazing has occurred
[B] Lucerne not yet sown

Future plans: Comparisons of the 3 systems under grazing are planned. Measurements of pasture species persistence and production, and livestock production and utilisation will be conducted.

ⓘ For more information on the Grass-legume pasture systems contact Lindsay Bell or Anthony Whitbread CSIRO Sustainable Ecosystems 07 46881221/08 83038455

Appendix 1 – Pasture legume trial plan and notes on pasture legumes

						Replication 1								
Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15
Casbah Biserrula	Urana sub clover	Cadiz pink serradella	SARDI Persian clover	Othello Sainfoin	Erica pink serradella	Frontier balansa clover	Hykon rose clover	Aokau Sulla	Clare sub clover	Cavalier spineless burr	Charano yellow serradella	Prima gland clover	Mintaro sub clover	Herald strand medic
Plot 30	Plot 29	Plot 28	Plot 27	Plot 26	Plot 25	Plot 24	Plot 23	Plot 22	Plot 21	Plot 20	Plot 19	Plot 18	Plot 17	Plot 16
Zulu arrowleaf clover	Caliph barrel medic	Seaton Park sub clover	Rosedale sub clover	Cefalu arrowleaf clover	Purple clover 117581 BW	Jester barrel medic	Bladder clover	Caprera crimson clover	Yelbini yellow serradella	Toreador hybrid medic	Lotus ornithopodioides mix	SARDI rose clover	Electra Purple clover	Spotted medic H7
						Replication 2								
Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15
Herald strand medic	Caprera crimson clover	Frontier balansa clover	Prima gland clover	Toreador hybrid medic	Spotted medic H7	Charano yellow serradella	Caliph barrel medic	Cefalu arrowleaf clover	SARDI Persian clover	Aokau Sulla	Purple clover 117581 BW	Cadiz pink serradella	Zulu arrowleaf clover	Hykon rose clover
Plot 30	Plot 29	Plot 28	Plot 27	Plot 26	Plot 25	Plot 24	Plot 23	Plot 22	Plot 21	Plot 20	Plot 19	Plot 18	Plot 17	Plot 16
Erica pink serradella	Electra Purple clover	Lotus ornithopodioides mix	Clare sub clover	Bladder clover	Casbah Biserrula	SARDI rose clover	Mintaro sub clover	Seaton Park sub clover	Cavalier spineless burr	Yelbini yellow serradella	Othello Sainfoin	Jester barrel medic	Urana sub clover	Rosedale sub clover
						Replication 3								
Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15
Charano yellow serradella	Purple clover 117581 BW	Yelbini yellow serradella	Hykon rose clover	SARDI rose clover	Toreador hybrid medic	Rosedale sub clover	Cadiz pink serradella	Electra Purple clover	Herald strand medic	Seaton Park sub clover	Clare sub clover	Caliph barrel medic	Frontier balansa clover	Casbah Biserrula
Plot 30	Plot 29	Plot 28	Plot 27	Plot 26	Plot 25	Plot 24	Plot 23	Plot 22	Plot 21	Plot 20	Plot 19	Plot 18	Plot 17	Plot 16
Mintaro sub clover	Cavalier spineless burr	Spotted medic H7	Jester barrel medic	Aokau Sulla	Urana sub clover	Zulu arrowleaf clover	Othello Sainfoin	Prima gland clover	Lotus ornithopodioides mix	SARDI Persian clover	Caprera crimson clover	Erica pink serradella	Bladder clover	Cefalu arrowleaf clover

New Pasture Legumes for Grazing, Forage and Crop Rotations

Graham Crocker, Senior Research Agronomist, Peter Sanson Technical Assistant, Tamworth.

With the increasing cost of nitrogen fertiliser and the continuing run-down of soil organic matter, pasture legumes offer an attractive alternative in their crop rotations.

Sulla (Hedysarum coronarium) also known as French Honeysuckle, Sweet Vetch, Italian or Spanish Sainfoin is a short lived perennial legume from the Mediterranean. It is a highly productive, non-bloating, palatable, good quality legume suitable for grazing, hay or silage. It is also reported to have a "by-pass protein" effect giving an extra 10-15% liveweight gain, an anthelmintic effect (reducing parasites), increase ovulation rates and reduce fly strike (reduced scouring) in sheep.

Ideally it should be sown in early autumn at 5-10 kg/ha at 1cm deep into a fine, weed free seed bed. Sulla prefers well drained alkaline soils and seems to do best on the heavier soils. Early growth is slow as the plants form rosettes and produce long tap roots. However, Sulla can grow to 1.5 metres in height, but does require strict rotational grazing. Sulla also makes good hay because it does not drop its leaf as readily as lucerne and makes excellent silage being more of a forage plant. Wrightson seeds are increasing 2 new cultivars selected in Australia. Wilpena is the more upright line and is more suited for forage production, while Moonbi is semi-erect and suited to grazing and forage use. A third cultivar, Flamenco, has been released in WA. Previously seed of Aokau and Necton were imported from New Zealand.

Sainfoin (*Onobrychis viciaefolia*) is an upright perennial forage legume. It is extremely palatable, non-bloating, and resistant to spotted alfalfa aphid, deep rooted and has drought and winter hardiness. It grows in sandy to heavy, alkaline soils that are not water-logged or saline. It must be rotationally grazed and makes good hay. Sow at 7-10 kg/ha but seed may be hard to obtain.

Angel strand medic is tolerant of sulfonylurea (SU) residues and was released in SA for the neutral to alkaline sands and loams with low to medium rainfall where SU residues often persist. It is a selection from Herald and has tolerance to aphids. Seed will be available in 2007 and is sown at 3-6 kg/ha.

Toreador (disc/strand medic) is a new hybrid developed for the light, sandy low rainfall country of South Australia but is doing well even on heavy black soils at Moree. It is early maturing, flowering in less than 3 months, which should allow it to set seed in most years, but still gave high production and it has spineless pods. Sow at 2-5 kg/ha.

Spineless burr medic. Scimitar is a newly released cultivar selected from Santiago for softer seeds and better production. It is early maturing like most burr medics, flowering in 3 months and is more productive and one week earlier flowering than Cavalier another spineless burr medic. Sow at 3-6 kg/ha.

Jester barrel medic is an improved selection of Jemalong for blue-green and spotted alfalfa aphid resistance. Flowers in 104 days, a bit later than Scimitar (burr medic) and Caliph, but again highly productive. Jemalong was a very successful cultivar before the aphids arrived. Sow at 3-6 kg/ha.

Lotus ornithopodioides is an annual, early maturing species that is non-bloating and adapted to alkaline to slightly acidic soils. Seed is not yet available but could be within 2 years. Being early maturing (it flowers in less than 100 days at Tamworth) allows it to grow in lower rainfall areas than the perennial species grown on the coast and tablelands.

Purple Clover is a new tall growing narrow-leafed clover that has the potential to yield over 10 tonnes of dry matter/ha. It is deep rooting, drought tolerant, late maturing and will tolerate short-term water-logging and acidic soils. Electra is the new cultivar released and has resistance to clover scorch disease and better harvestability. It is more suited to forage than continuous grazing. Little seed is expected to be available till 2008. Sow at 2-3 kg/ha

Arrowleaf clover is a late maturing annual suitable for grazing hay or forage production. It is a small seeded clover which produces a lot of seed that aids its dispersal. Although prostrate early, its later growth is erect with the plant having hollow stems. Is highly productive but will not tolerate water-logged soils. Cultivars are Zulu and Cefalu which flowers 1 week earlier than Zulu. Sowing rate is 1-3 kg/ha.

Sardi Rose clover has been selected for greater hard seededness and higher seed yields and hence persistence. It has wide soil adaptability and matures 1 week after Hykon rose.

New **sub clovers** cultivars with improved hard seededness and disease resistance include Izmir to replace Nungarin, Urana for Daliak, York for Seaton Park, Coolamon for Junee and Mintaro a more productive and persistent replacement for Rosedale on more alkaline soils.

Prima gland clover is a new species not previously available and its main advantage is resistance to red legged earth mite and other insects due to chemicals it contains. It has early-mid maturity flowering in 110 days and is very productive, due in part to the excellent stand density, achieved with a high seeding rate. Has small seed so sow at 1-3 kg/ha.

Frontier balansa clover, is an early maturing, highly productive clover adapted to a wide range of soil types and has excellent waterlogging tolerance. Sets a lot of seed and has good regeneration as long as competition is removed before the autumn break. Has small seed so sow at 1-3 kg/ha.

Yellow serradellas are plants best suited to acidic, low pH soils but do perform reasonably well on higher pH soils. They have high hard-seed levels that often give poor regeneration in the second year. There are many cultivars available ranging from Yelbini, a new very early maturing line (85 days to flower) through Charano, King and Santorini (110 days to flower) and later cultivars. Seed is difficult to dehull and so sow 1-3 kg/ha of clean seed or 5-10 of seed in pod.

Pink or French serradella. Cadiz is a productive soft-seeded cultivar that again although suited to acid soils is widely adapted to other soil types. The main problem with Cadiz is that the soft seeds germinate over summer and stands failed to persist. Two new hard seeded lines, Erica and Margurita, have now been released and should suit this environment and play an important role in pasture development, as serradellas are also non-bloating. The 2 new lines have about 50% hard seed by autumn and Erica is prostrate and Margurita more upright. They have also been selected for ease of harvesting and threshing.

Biserrula *(Biserrula pelecinus)* is a species suited to acidic, sandy soils and heavy grazing. It is deep rooted, hard seeded and drought tolerant, producing feed into late spring/early summer. It has mid season maturity with Casbah being about 1 week earlier than Mauro. Sow at 1-3 kg/ha.

This work was made possible by NSW Department of Primary Industries with funding from the Grains Research and Development Corporation (GRDC) and Australian Wool Innovations (AWI) through the National Annual Pasture Legume Improvement Program (NAPLIP).