

New and improved legumes for pastures and crop rotations

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Abstract. Pasture legumes are vitally important to the livestock and to a lesser extent the grain industries of NSW. Research has found many legumes growing in various parts of the world which are adapted to the diverse environments in Australia. While lucerne, subterranean clover and white clover are the dominant pasture legumes used in Australia, there are many other legumes adapted to our environment, that can out-perform these legumes in particular situations such as acid sandy soils, waterlogged soils and low rainfall.

Some recent releases include a new medic which is a hybrid between disc and strand medic, 2 hard seeded pink serradellas, 2 spineless burr medics, an improved aphid resistant barrel medic and gland clover a new species with excellent insect tolerance. There are 2 other legumes, sulla and purple clover that are showing great potential and cultivars of these will be available in 2-3 years. The features of 18 legume species are briefly discussed here.

Introduction

Pastures, either native or introduced, cover over 80% of the total area of NSW (ABS 2001), and so contribute greatly to the State's economy. Legumes are the key component of a successful pasture as they provide nitrogen (N) which drives the pasture system and improves soil fertility for subsequent cropping. Unfortunately, Australia has very few native legumes. This has led Australian scientists to search overseas for legumes suited to our environment. The Mediterranean region has proved to be an ideal source as it has many native legume species and a similar environment, to southern Australia.

While pastures for southern NSW have been largely based on subterranean clover, the northern wheat belt of NSW consisting mainly of neutral to alkaline soils, is better adapted to lucerne and annual medics. Subterranean clover, white and red clover are however, grown on the Slopes and Tablelands where livestock enterprises dominate.

However, there are other species that are specifically adapted to certain niches such as acid sandy soils (e.g. serradella and biserrula), water logged soils (e.g. balansa and persian clover) and the need to have other species and cultivars available in case of disease or insect outbreaks as occurred with lucerne aphids.

A national project, titled National Annual Pasture Legume Improvement Program (NAPLIP) is

evaluating the most promising material collected from overseas and releasing new and improved cultivars from these selections. While this project, funded by the Grains Research and Development Corporation (GRDC) and Australian Wool Innovations (AWI), concentrates on annual temperate legumes, it also includes sub-tropical legumes, most of which are perennials. Other programs looking at perennial legumes in northern NSW, include the NSW Lucerne Improvement Program (Tamworth), the lotus and white clover improvement programs (Glen Innes) and the Cooperative Research Centre for Plant-Based Management of Dryland Salinity.

This paper briefly discusses some of the new legume cultivars that have been or are nearing release from the programs and these are listed in Table 1. A more comprehensive list of legume cultivars commercially available can be found in "Pasture grasses, legumes and herbs used in NSW" (McDonald 2003), especially lucerne and white clover cultivars which are not covered here.

New legume species and cultivars

Lucerne (*Medicago sativa*) is a perennial and is still the main legume grown for grazing and crop rotations in northern and central NSW. The importance of lucerne to Australia agriculture is indicated by 2 State government supported breeding programs and several private companies. Lucerne rotations can

Table 1. List of the latest legume cultivars released or nearing release

Winter-growing legumes	Summer-growing legumes
Lucerne	Perennial lablab
Jester barrel medic	Burgundy bean
Toreador disc-strand medic hybrid	Butterfly pea
Spineless burr medic	Desmanthus
Yellow serradella	Astro
Hard-seeded pink serradellas	
Biserrula	
Gland clover	
Balansa clover	
Purple clover	
Lotus species	
Subterranean clovers	
Sulla	

increase grain yields and protein, improve environmental sustainability and increase whole-farm profitability (Crocker 2002a,b). However, lucerne does have some disadvantages such as bloat, its requirement for strict rotational grazing management, and it is difficult to remove at the end of the pasture phase before returning to cropping.

Lucerne also dries the soil profile to depth and while this can be an advantage in preventing rising water tables to reduce salinity, it can severely reduce wheat yields following lucerne if soil moisture reserves are not replenished. This requires about 9 months of average rainfall (Crocker 2002a).

To overcome these deficiencies, NSW Agriculture's Lucerne Improvement Program is based at Tamworth. This program seeks to breed improved lucernes to be used in better ways by more farmers across increasing proportions of the cropping zone. New lines will incorporate specific traits in adapted backgrounds to make lucerne easier to establish, easier to manage and easier to remove than current varieties. This program also evaluates and screens breeding lines in field trials throughout northern and southern NSW while the Queensland Department of Primary Industries & Fisheries (DPI&F) runs trials in southern Q.L.D.

There are currently at least 36 cultivars on the market coming from the various lucerne breeding programs both in Australia and overseas. A list of these cultivars with their various characteristics can be found in the latest NSW Agriculture Agnote (McDonald 2004).

Sulla (*Hedysarum coronarium*), also known as French honeysuckle, sweet vetch, Italian and Spanish sainfoin, is a short lived perennial legume from the Mediterranean region. It is a highly productive, non-

bloating, palatable, drought tolerant, good quality legume suitable for grazing, hay or silage. It is also reported to have a "by-pass protein" effect giving an extra 10-12% liveweight gain, an anthelmintic effect (reduced parasite burden), increased ovulation rates and reduced fly strike (through reduced scouring) in sheep.

Although there are no cultivars currently available in Australia, Aokau and Necton are available from New Zealand. However, 3 Australian cultivars will be released in 2005. The 3 cultivars will be a prostrate grazing type, an erect fodder type suitable for use in crop rotations and a soft seeded line to allow sowing of pods to reduce seed costs. Sulla should be sown in early autumn at 5-10 kg/ha, 1 cm deep into a fine, weed free seed bed. It 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. Sulla can grow to 1.5 m in height, but it does require strict rotational grazing. Sulla should fit well into farming systems as an alternative to lucerne. Being short lived it is easier to remove at the end of the pasture phase than lucerne and it should fix as much (if not more) N than lucerne as it is more productive over the first 2 years. Being deep rooted like lucerne, it is believed to have similar water extraction. Water use and N fixation will be compared with lucerne this year.

Dry matter yields and time to flowering of some of the new legumes at Tamworth from an early May sowing are shown in Table 2

Table 2. Days to flowering (DTF) and dry matter yields (kg DM/ha) in September and November 2003 of 12 legumes at Tamworth

Legume cultivar	DTF	Sept	Nov
Toreador disc/strand medic	85	4800	3750
Nungarin subterranean clover	90	1820	1785
Scimitar spineless burr medic	91	5167	4240
<i>Lotus ornatipodoides</i>	98	4440	5400
Jester barrel medic	104	4950	5165
Prima gland clover	110	5225	5825
Santorini yellow serradella	110	3150	5600
Cadiz pink serradella	111	3315	6150
Margarita pink serradella	115	4330	6400
Purple clover	136	4730	10800
Clare subterranean clover	136	3640	5650
Aokau sulla	140	4515	7750

Lotus has >180 species and most would be familiar with birdsfoot trefoil (*L. corniculatus* cv. Goldie) and greater lotus (*L. uliginosus* cv. Maku), both perennials, currently growing on the Coast and Tablelands. The Glen Innes Program is planning to release a birdsfoot

trefoil cultivar more suited to our conditions in 2005. *Lotus ornithopodioides* is an annual, early maturing species that is non-bloating, resistant to red legged earth mite, aphids and lucerne flea. It is adapted to a wide range of soil types, especially light alkaline to slightly acidic soils (pH >5.5), requiring lower rainfall than the perennials. Lines are available having maturity ranging from very early flowering (70 days), to mid-late maturity (135 days). At least one cultivar is expected to be released in 2005.

Jester barrel medic (*Medicago truncatula*) is an improved selection of Jemalong, an old cultivar that was very popular before the arrival of lucerne aphids. Jester was selected for blue-green and spotted alfalfa aphid resistance and is a mid-season, hard-seeded cultivar adapted to a wide range of soils. It has the distinctive leaf mark of Jemalong and is highly productive. It is adapted to alkaline soils and can be used as a pasture for grazing or in crop rotations.

Toreador disc-strand hybrid medic (*Medicago tornata-M. littoralis*) was developed for light, sandy low rainfall country, but also performs well on loam and heavy black soils at Moree. It is early maturing which should allow it to set seed in most years, but still gives high production. It has spineless pods and is resistant to blue-green aphid with lower resistance to spotted aphid. It can be used for grazing or in crop rotations on alkaline soils.

Spineless burr medic (*Medicago polymorpha*). There are several new cultivars released for soils with pH >6 (water), but adapted to a wide range of soil types. Scimitar is an early maturing cultivar selected from Santiago for softer seeds and better production. Cavalier is a selection from Circle Valley and flowers about 1 week later than Scimitar. It also is softer seeded than its parent line, but has excellent dry matter and seed production. Both cultivars have spineless burrs which will reduce contamination of wool.

Yellow serradella (*Ornithopus compressus*) plants are suited to acidic, low pH (<5) soils, but also 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, Madeira and Avila.

Pink or French serradella (*Ornithopus sativus*). Unlike yellow serradella which have high hard seed levels,

Cadiz, which until recently was the only cultivar available, is a productive soft-seeded cultivar that is widely adapted to a range of soil types. The main problem with Cadiz was that in our summer rainfall environment the soft seeds germinated during summer then failed to persist. Two new hard seeded cultivars have been developed that should suit this environment and play an important role in pasture development, as serradellas are also non-bloating. The new lines, Erica and Margarita, have about 50% hard seed by autumn. Erica is a prostrate line, while Margarita is more upright and about 1 week earlier flowering than Erica. They have also been selected for ease of seed harvesting and threshing.

Casbah biserrula (*Biserrula peccinns*) is a new hard-seeded legume, well adapted to light textured sandy soils similar to serradella. It produces well in spring and into early summer due to its deep rooting habit, but needs to be grazed hard over summer as seeds passed through livestock help break down hard seededness. Casbah is 1-2 weeks earlier maturing than Mauro the newest cultivar. Although biserrula is more susceptible to some herbicides, it less palatable during flowering and in WA is heavily stocked at this time to remove weeds and other species.

Prima gland clover (*Trifolium glanduliferum*) is a new species not previously available. Its main advantage is resistance to red legged earth mite, and blue-green and cowpea aphids. It is a semi erect, small seeded cultivar, relatively early maturing with excellent dry matter and seed production. It is adapted to a wide range of soil types from neutral to mildly acidic soils and will tolerate some waterlogging. It is used mainly for grazing, but could also be used in crop rotations, where it is more likely to be sown with other species.

Balansa clover (*Trifolium michelianum*) is a small seeded, productive clover growing in autumn, winter and early spring. It is adapted to a wide range of soil types and has excellent waterlogging tolerance. It sets a lot of seed and has good regeneration as long as competition is removed before the autumn break. There are 3 cultivars available, Frontier, Paradana and Bolta. Frontier is an early maturing cultivar that flowered in 89 days at Tamworth, while Paradana was 35 days later and Bolta about 14 days later again.

Purple clover (*Trifolium purpureum*) is a new upright narrow-leaved clover that has the potential to yield >10 tonnes of dry matter/ha. It is deep rooting, drought tolerant, late maturing and will tolerate waterlogging. A new cultivar is being selected for clover

scorch tolerance and easier harvesting, and should be released in 2005. This species is ideally suited for hay or silage production and for use in crop rotations, but can also be used for grazing. It has good hard-seed levels which gives good regeneration without germinating too early. Like many of the new lines it is an aerial seeder which allows direct harvesting by conventional machinery.

Subterranean clover (*Trifolium subterraneum*) had 3 new cultivars released in 2003; Izmir, Urana and Coolamon. Izmir is a very early maturing replacement for Nungarin, suited to areas with a growing season <4.5 months. Its good seed production and high hardseededness will give greater persistence, especially in crop rotations. Urana is a hard-seeded, early to midseason cultivar, flowering between Dalkeith and Seaton Park. It has no leaf mark, excellent dry matter production and is suited to areas with a growing season of 5-6.5 months. Coolamon is a midseason replacement for Junee, with clover scorch resistance. It is moderately hardseeded and suited to areas with a growing season of 6.5-8 months. It is well suited to permanent pastures or farming systems with infrequent cropping.

Summer-growing legumes

Sub-tropical legumes are summer-growing, N fixing drought tolerant plants with high growth rates, and spreading and climbing growth habits giving good ground coverage. They have high dry matter production in spring, summer and early autumn. Growth stops with the first frost, but plants shoot from the base again in spring. All species have lower bloat risk than winter-growing legumes such as lucerne, medics and clovers. They do however, require more lenient grazing management. Grazing should aim to remove most of the leaf whilst leaving much of the stem, as regrowth comes from the leaf axils on the stem.

Successful plant establishment requires good soil moisture to at least 60 cm at sowing with good weed control in early establishment. Species should be shallow sown (1-2 cm) in November-December at 3-20 kg/ha (depending on seed size) when soil temperatures reach 18°C. Larger seeded species such as cowpea and lablab can be sown deeper (5-7 cm). It is important to inoculate the seed with the correct inoculum for the species being sown.

Yields of 5 sub-tropical legumes at Moree are shown in Figure 1.

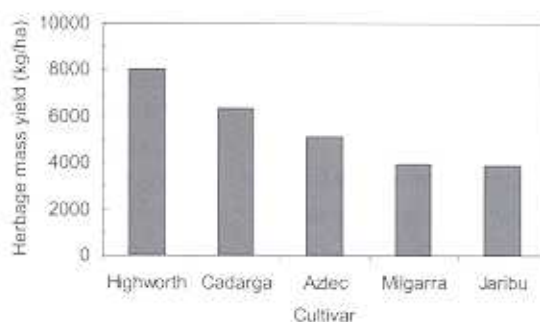


Figure 1. Sub-tropical legume yields (kg DM/ha) on a black earth soil at Moree in May 1998.

Lablab (*Lablab purpureus*) is a large seeded annual with upright growth habit and large leaves capable of rapid growth rate. It should be sown at 15-20 kg/ha and can be sown 5-7 cm deep using conventional machinery or direct drilled with press wheels. Koala is a white seeded variety that can be used for human consumption as well as grazing or green manuring. Highworth is a later maturing variety that rarely sets seed in NSW due to frosts, but produces more dry matter and is good as forage, hay or as a green manure crop. Endurance, a perennial lablab, was released in 2000 and offers greater and earlier second year growth, while in the first year producing about 80% of the dry matter of Highworth.

Burgundy bean (*Macroptilium bracteatum*) is a new semi-erect, perennial species showing great potential. It has consistently been one of the highest yielding species over several seasons from central NSW to Central Queensland. It is deep rooted, drought tolerant, has high seed yields and regenerates well. This species is non-bloating and palatable with 2 cultivars commercially available. Cadarga is more upright and has higher vegetative and seed production than Juanita which has better persistence and disease resistance. It takes its name from the burgundy coloured flowers although Juanita has lighter coloured flowers. Burgundy bean can be used for grazing or crop rotations.

Butterfly pea (*Clitoria ternatea*). Variety Milgarra is a semi-twining perennial with large blue flowers. It is heavily grazed in Central Queensland where it grows very well on the heavier soil types. It does not perform as well south of the Queensland border. It has relatively large seed and is sown at 8-10 kg/ha. It can be used for grazing or as a rotational legume.

Desmanthus (*Desmanthus virgatus*) variety Jaribu is a tall, spreading, fern-like perennial with a deep tap root

giving drought tolerance. It is readily accepted by stock, not known to cause bloat and can be grazed more heavily than the vine type legumes. It seeds well and being small seeded can be sown at 1-2 kg/ha, but no deeper than 2 cm. It is well adapted to clay soils, but does not tolerate water-logging. The plant has fairly thick stems which makes it satisfactory for grazing but not suitable for use in crop rotations.

Atro (*Macroptilium atropurpureum*) was first commercialised in Australia as the cultivar Siratro over 40 years ago. It is a twining perennial that gives good ground cover and high quality, palatable, non bloating pasture. It is deep rooted and shows good drought tolerance and like all sub-tropicals is sensitive to frost. It comes away early in spring and will flower in early summer and autumn setting seed to increase stand density. The latest cultivar released is Aztec which is resistant to rust.

Nutrition

While it is important to have the best species for your soils and climate it is even more important to ensure that you correct any soil nutrient deficiencies. An old saying states that animal performance is influenced 10% by genetics, 15% by animal management and 75% by what they eat (Peart 1992). So while having legume in the pasture is essential for best animal production, pasture production is greatly dependent on adequate nutrition (Crocker 1989).

Conclusion

Pasture legumes play a pivotal role in driving pasture systems by supplying N to grass-legume pastures and building N fertility in cropping rotations (Crocker 2002c). While Australia has very few native legumes, programs have been operating to find suitable legumes for our environment from overseas locations. These programs involve identifying new legumes and adapting and modifying these lines through breeding for production, persistence, better animal performance, or increased disease and insect resistance. This paper gives some information on new and promising legumes, which are or soon will be available commercially.

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References

- Crocker GJ (1989) Increasing production with phosphorus and sulphur – northern slopes. In 'Proceedings of the 4th Annual Conference of the Grasslands Society of NSW, Tamworth.'
- Crocker GJ (2002a) Lucerne allows cropping sustainability in Tamworth rotation trials. The Grasslands Society of NSW Inc newsletter 17, (4) 7-11.
- Crocker GJ (2002b) Lucerne allows cropping sustainability in Tamworth rotation trials 2. Sorghum evaluation. The Grasslands Society of NSW Inc newsletter 17, (4) 18-20.
- Crocker GJ (2002c) Lucerne allows cropping sustainability in Tamworth rotation trials 3. A comparison of lucerne, sub clover, snail medic, chickpea, long fallow and continuous wheat. The Grasslands Society of NSW Inc newsletter 17, (4) 20-24.
- Peart G (1992) Pastures, livestock and the bottom-line. In 'Proceedings of the 7th Annual Conference of the Grasslands Society of NSW, Tamworth'.
- McDonald W (2003) Pasture grasses, legumes and herbs used in NSW 2004-2005. Department of Primary Industries and Grasslands Society of NSW Inc booklet.
- McDonald W (2004) Characteristics of commercially available lucerne varieties. NSW Agriculture Agnote