



Establishing pastures - Readers' Note

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Pasture species

Annual grass crops

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Sorghum—sweet
Sudan grass

Perennial grasses

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Kikuyu
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Perennial ryegrass – white clover pastures
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Perennial legumes

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Strawberry clover
Subterranean clover
White clover

Other pasture species

Chicory

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Annual grass crops

ANNUAL RYEGRASS—See Ryegrass

MAIZE (*Zea mays*)

High yielding fodder crop producing high quality roughage with a metabolisable energy (ME) > 10 MJ/kg. Can be stored long-term as silage for supplementation when paddock feed is low. Can also be used to increase stocking rates and thus to increase pasture use efficiency.

Strengths: High potential yields—up to 25 t/ha dry matter Useful cleaning crop in a pasture rotation to break disease and insect cycle. Maize silage in storage is usually much cheaper than purchased roughage of similar quality.

Weaknesses: Costly to grow; failure is expensive. A large capital infrastructure is required to plant, harvest, store and feed out the crop. With machinery in place, production is cost-effective. Low in protein; high protein supplementation required. Cannot be grazed.

Seasonality: Can be planted from late October to January, depending on the district and the maturity of the variety sown. Highly susceptible to frosts; choose sowing date and variety combinations to avoid frosts before the crop is ready to harvest.

Persistence: 100–150 days from planting to harvest.

Varieties: Early: 75–95 days Mid season: 110–120 days Late: 120–130 days.

Sowing: Sow into a weed-free, well prepared seedbed. Use precision sowing to ensure a density of 60–90 000 plants per hectare in rows 75–90cm apart.

Feed quality: Silage made from maize harvested when the milk line in the grain is half-way across the kernel will have an



ME content of 9.5–10.5MJ/kg. Protein content, however, is very low: 5%–7%. Use protein feed supplements when maize forms a high proportion of the diet.

Diseases: Leaf diseases and stalk rots. Use resistant varieties.

Pests: Cutworms, black beetle and wireworms can seriously limit yield.

Grazing management: Not suitable for grazing. Feed as green-chop or silage instead.

Companion species: Legumes have been grown with maize to increase total protein content, but the maize yield suffers. Sunflowers have also been grown with maize to increase energy concentration, but these combinations are difficult to manage. The aim should be to get the highest yielding maize crop possible.

Special factors: Weeds can compete with maize crops and substantially reduce yields if not controlled. Use a combination of pre- and post-emergence herbicides.

MILLET

There are two distinct types of millet sown as summer fodder crops—Japanese and pearl.

Strengths: Produces feed during summer and early autumn. Growth is rapid. Dry matter yields can be high. Suitable for hay or silage. Useful because cultivation for establishment cleans up summer-growing weeds.

Weaknesses: Pearl millet can be difficult to establish—needs a clean seedbed. Feed quality declines rapidly with advancing maturity—plants should be grazed when young. Rapid growth rate makes management for best feed quality difficult.

Japanese millet (*Echinochloa utilis*)

Strengths: Germinates under the cooler soil temperatures of spring (14°C) better than other millets and sorghums. Valuable as a short-term rotation crop for spring – early summer grazing, before the ground is prepared for the next crop or pasture. Rapid early growth can fill feed shortfalls in early summer after floods or drought. Good grazing is available 6–7 weeks after sowing. Gives two good grazings in northern NSW and repeated grazings in the cooler southern areas.

Weaknesses: Runs quickly to head under hot and dry conditions.

Varieties: Shirohie.

Sowing: Sow at 15–20 kg/ha into clean seedbed, late September onwards.

Feed quality: Fair if grazed when young—ME 8.5–9.5 MJ/kg. Protein content can decline from 25% to 6% with advancing maturity.

Diseases: None significant.

Pests: None significant.

Grazing management: Grazing before growth becomes too advanced aids recovery and lengthens the grazing life.

Introduce stock when plants are 15–22 cm high.

Companion species: Millets are normally sown without any companion species, as legumes grow too slowly to be useful in combination.

Pearl millet (*Pennisetum glaucum*)

Requires higher soil temperatures (18°C) than Japanese millet for germination. Maximum growth during summer and early autumn.

Strengths: Higher digestibility throughout its growth cycle than forage sorghums.

Weaknesses: Often will not germinate and establish effectively. Extreme care is required in seedbed preparation, sowing depth and avoiding compaction at sowing.

Varieties: Nutrifeed, Feedmill, Supermill, Katherine, Ingrid, Tamworth.

Sowing: Sow at 5–15kg/ha into a clean seedbed, mid November – mid December.

Feed quality: High, but declines quickly with advancing maturity—ME is in the range 8.5–9.5MJ/kg. Protein content can decline from 25% to 6% with advancing maturity.

Grazing management: Introduce stock when plants are 45–90cm high. If left ungrazed, plants can reach 3m, and their rapid growth can cause management problems in maintaining high feed quality.

OATS (*Avena sativa*)

Although largely replaced by annual ryegrass, oats can be a useful winter forage crop.

Strengths: Large seed well suited to oversowing or direct-drilling into existing summer-growing pastures. Can be sown in mixtures with ryegrass to supply extra feed in late autumn – early winter.

Produces vigorous seedlings. Two weeks quicker to first grazing than annual and Italian ryegrass. Produces high quality

feed in late winter – spring. With repeated grazings, oats thin out and are gone by early spring, leaving the ryegrass to continue without competition for another few months into late spring – early summer. N fertiliser can produce significant increases in feed when required. Excess growth can be conserved as medium to high quality hay or silage. Growth rhythm complementary to summer-growing species such as kikuyu.

Weaknesses: Overall, oats do not produce the yield of forage over the extended period that ryegrass does. The forage is also less digestible and lower in feed value. Feed supply will not extend into late spring – early summer. Susceptible to grazing mismanagement: grazing off the growing points at the wrong time can seriously impair regrowth and feed production. The high rates of nitrogen required for high production could pollute streams and ground water.

Varieties: Wide range of varieties including Saia, Enterprise, Yarran, Bimbil, Condamine, Culgoa, Cleanleaf, Blackbutt, Amby, Graza, Panorama, Camellia. Sown in mixtures, Saia is still the preferred cultivar. Enterprise has shown up well in early season production. Others with promise include Yarran, Bimbil, Condamine and Culgoa.

Sowing: Sow early autumn – early winter at 100–130kg/ha. Rates will be lower with smaller-seeded oats such as Saia. Reduce rate when sowing with annual ryegrass. Drill or broadcast into a clean seedbed. Direct-drill early sowings after suppression of summer pasture with herbicides. Later sowings will successfully establish after control of summer pasture by slashing or mulching.

Diseases: Most cultivars are affected by rust and yellow dwarf virus, which reduce yield and crop life.

Pests: None significant.

Grazing management: Graze when plants are 20–30cm high. After grazing, topdressing with nitrogen at 30–60kg N per hectare will promote good regrowth. Up to four grazings are possible before oats thin out. Grazing to a height above the plants' growing point will maintain the density of the crop and prolong its productive life.

PRAIRIE GRASS (*Bromus unioloides*)

Often naturalised in coastal dairy pastures. Produces high-quality feed in early spring. The naturalised strains mature rapidly and seed early, losing their quality. Commercial strains are later maturing and more useful for quality feed production in late spring and summer. Some of the improved strains are more perennial.

Strengths: Produces high-quality feed in early spring and high autumn growth rates.



Weaknesses: Weakly perennial. Can decline rapidly if grazing is not rotationally managed.

Seasonality: Perennial types produce autumn, winter and spring feed. Winter production can be higher than from other grasses. Sow early for best winter growth.

Varieties: Grasslands Matua

Sowing: Large seed; 120000 seeds/kg. Sow 15–30kg/ha alone or 5–8kg/ha with other grasses and clovers. De-awned and fungicide-coated seed (see 2.4) is available and flows more easily through machinery. Sow de-awned seed at half the normal rate. Sow in autumn.

Feed quality: High-quality feed. Highly palatable, making it prone to overgrazing. Feed quality declines near flowering and maturity.

Diseases: Seed must be treated with fungicide before sowing.

Pests: None significant.

Grazing management: Because of its high palatability, prairie grass must be grazed strictly rotationally. Can be used for hay crops, especially when combined with legumes such as red or berseem clover.

Companion species: Perennial ryegrass, white clover, red clover, berseem clover.

RYEGRASS — Annual ryegrass (*Lolium rigidum*, *L. multiflorum*)

Annual ryegrasses have become a major source of winter–spring forage over the last 20 years. They have replaced oats and other forage crops, mainly because of their longer growing season and better feed quality.

Strengths: Large seed well suited to oversowing or direct-drilling into existing summer-growing pastures. Produces vigorous seedlings. Provides forage May–December, around two months later than



oats. Produces high quality feed in late winter – spring. Mixture of annual ryegrasses and oats allows the strengths of one to cover the weaknesses of the other, and gives a more even distribution of forage throughout the season. Nitrogen fertiliser can produce significant increases in feed when feed is required. Excess growth can be conserved as medium to high quality hay or silage. Growth rhythm complementary to summer-growing species such as kikuyu.

Weaknesses: Being annuals, plants will seed down in late spring, but regeneration from seed in the following autumn can often be poor. For best results, sow annual ryegrasses each year. No production in autumn – early winter.

Varieties: Concord, Conquest, Corvette, Eclipse, Midmar, Aristocrat, Surrey, Noble, Tetila. Leading varieties in recent years have been Concord, Tetila, Aristocrat, Eclipse, Midmar, Southern Star and Surrey.

Sowing: For maximum production, sow in early autumn at 10–25 kg/ha. Use the higher rate for early production and the lower rates with clover and perennial ryegrass. Broadcast or drill into clean seedbeds. Direct-drill into clean seedbeds or after suppression of summer pasture growth with herbicides. For later sowings in late autumn – early winter, slashing is often sufficient to both cover the seed and remove competition.

Feed quality: High at the early grazings and then declines with maturity in spring. Late-flowering varieties (for example, Concord) provide better quality forage in spring than early-flowering varieties.

Diseases: Rusts, such as leaf and crown rust, can be a major problem in areas where hay is made from ryegrass in spring. Grazing management and nitrogen topdressing can reduce rust incidence. Most varieties have a rust rating of light to moderate. Eclipse is very light to light and Tetila is moderate to heavy. Host for annual ryegrass toxicity syndrome.

Pests: None significant.

Grazing management: Begin grazing when plants have reached the 3-leaf stage, at 6–8 weeks after sowing. Repeat at 3–4 weeks after each grazing. Annual ryegrasses respond well to nitrogen application after grazing. Apply 30–50 kg N/ha after each grazing; higher rates can be used during winter in colder areas.

Companion species: Besides oats, white and red clover can be sown with annual ryegrass to increase forage yield and quality later in the season.

SORGHUM—Hybrid forage sorghum (*Sorghum bicolor* × *S. sudanense*)

Summer-growing fodder crop. Can be cut or grazed up to 3 times. More suited to hay or silage because of potential to

mature quickly.

Strengths: Rapid growth produces a large bulk of feed quickly in summer – early autumn. Good dry weather performance. Dry matter yields can be high. Can be used to build up depleted feed stocks quickly. Can be conserved as hay or silage for reserve feed. Useful because cultivation for establishment cleans up summer-growing weeds.

Weaknesses: Quality declines rapidly with advancing maturity if not harvested early for forage. Should be grazed when young, but can cause prussic acid (cyanide) poisoning if grazed when very young or stressed. Requires clean seedbed for effective establishment. Rapid growth rate makes management for best feed quality difficult.

Seasonality: Summer-growing fodder crop. Frost-susceptible. Soil temperature dictates sowing time in early summer.

Varieties: Speed Feed, Super Sudax, Cowpow, Jumbo. Late-maturing varieties that require shortening days to stimulate flowering are available; for example, Jumbo. These varieties are easier to manage and do not decline as rapidly in quality as other varieties.

Sowing: Sow into a clean seedbed November–January at 5–10kg/ha under dryland conditions and up to 15kg/ha under high rainfall or irrigation. Minimum soil temperature 18°C.

Feed quality: Best when plants are harvested at 1–1.5m tall. Digestibility at this stage is 65%; ME 9.5MJ/kg. Quality declines rapidly with maturity and can be as low as 50% digestibility and 6.5–7MJ/kg ME. More highly digestible, brown-midrib varieties are now available. Protein content can decline from 25% to 6% with advancing maturity.

Diseases: None significant.

Pests: Armyworms can cause severe

damage to seedlings and to leaves of growing plants. Black beetle.

Grazing management: Probably best to use for hay or silage production. If used for grazing, it is important to start grazing as soon as plants are more than 50cm high and safe from prussic acid poisoning as they will be growing very quickly and declining in quality. Best to strip-graze and back-fence to allow plants to recover quickly.

Companion species: Best in pure stands.

Special factors: Stock require sodium and sulphur supplements with sorghum.

SORGHUM—Sweet sorghum *(Sorghum bicolor)*

Summer-growing forage crop that produces high yields of moderate quality feed. Not grown as extensively in recent years as in the past, when it provided a valuable bridge between summer and winter pastures for late autumn – early winter feed.

Sowing hybrid cultivars in mid spring can often provide two silage cuts during the season, whereas open-pollinated cultivars will generally give only one silage cut and some grazing on the regrowth in autumn.

Strengths: Versatile and cheap source of energy—can be grazed, green-chopped, ensiled or left in the paddock until required. Rapid growth produces a large bulk of feed quickly in summer – early autumn. Dry matter yields can be high. Can be used to build up depleted feed stocks quickly. Can be conserved as hay or silage for reserve feed. Useful because cultivation for establishment cleans up summer-growing weeds.

Weaknesses: The decline in use of sweet sorghum comes largely from the need for quick rotation of crops between summer and winter. Sweet sorghum can lock up productive land for too long in autumn

and delay the sowing of winter pastures and forage crops, thus reducing yield.

Quality declines rapidly with advancing maturity if the sorghum is not harvested early for forage. Should be grazed when young, but can cause prussic acid poisoning if grazed when very young or stressed. Often poor regrowth after grazing. Requires clean seedbed for effective establishment. Rapid growth rate makes management for best feed quality difficult. Highest yield as standalone crop for silage and grazing.

Varieties: Sugargraze, Sugarsweet, Saccaline (open pollinated), FS26. Sugargraze and FS26 are preferred.

Sowing: Sow November–January into a clean seedbed at 10–20kg/ha. Either broadcast or drill into rows 35–55cm apart. Don't sow too late in frost-prone districts.

Feed quality: ME 7.7–8.6MJ/kg, crude protein 5.6%–8.6%, digestibility 51%–57%.

Diseases: In coastal districts, sweet sorghum can suffer damage from leaf blight, rust, root and stalk rot, and seedling blights. Control measures depend largely on good management and crop rotation.

Pests: Cutworms, armyworms, wireworms and black beetle can reduce yields.

Grazing management: If the sorghum is to be used for grazing, avoid stressed plants and young plants below 50cm high, which can contain potentially high amounts of prussic acid. In some instances, sweet sorghum plants may ratoon and grow again in the next year, but plant density declines to about half that of the original population, and it is not usually economic to leave such crops for a second year.

Special factors: Stock require sodium and sulphur supplements with sorghum.

SUDAN GRASS (*Sorghum sudanense*)

Summer-growing fodder crop. Can be cut or grazed up to 3 times or used for hay or silage. Open pollinated and hybrid types available. Sweet sudan grass hybrids have been developed.

Strengths: Rapid growth produces a large bulk of feed quickly in summer – early autumn. Dry matter yields can be high. Thinner stems and higher leaf content allow for higher quality forage than hybrid forage sorghums, but yields are lower. Rapid growth more manageable than hybrid forage sorghums. Lower prussic acid poisoning potential than hybrid forage sorghums. Can be used to build up depleted feed stocks quickly. Can be conserved as hay or silage for reserve feed. Useful because cultivation for establishment cleans up summer-growing weeds.



Weaknesses: Quality declines rapidly with advancing maturity if not harvested early for forage. Should be grazed when young, but can cause prussic acid (cyanide) poisoning if grazed when very young or stressed. Requires clean seedbed for effective establishment.

Seasonality: Summer producer. Can be sown when soil temperature reaches 18°C.

Varieties: Open pollinated: Greenleaf, Piper; Hybrid: Trudan, Superdan, Sweet Sudan.

Sowing: Sow into clean seedbed early November – January. Sow at 3–8kg/ha in 35cm rows rainfed, 8–10kg/ha in 35cm rows irrigated, 10–15kg/ha broadcast.

Feed quality: Declines rapidly with increasing age.

Diseases: None significant.

Pests: Armyworm and cutworm can cause serious damage to seedlings and mature plants.

Grazing management: Graze when plants are taller than 45cm to reduce risk of prussic acid poisoning. Don't delay too long, though, as quality drops quickly. Cut well before maturity to obtain effective regrowth. Suitable for round bale silage because of its thin stems.

Companion species: Best grown alone.

Special factors: Stock require sodium and sulphur supplements with sudan grass. The potential for prussic acid poisoning is retained with haymaking but there have been no reported difficulties with silage.

Perennial grasses

COCKSFOOT (*Dactylis glomerata*)

Strongly tufted, erect perennial. Purplish-green flowering heads in one-sided clusters.

Strengths: Better summer growth and more drought tolerance than perennial ryegrass. Greater tolerance to acidic soils and aluminium than fescue or phalaris. Tolerates poorly fertile soils better than other perennial grasses. Well suited to cattle grazing in more heavily stocked dry-run situations.

Weaknesses: Requires good drainage. Forms tussocks if not grazed heavily enough. Poorest quality of all the perennial grasses.

Seasonality: Two distinct types: European (summer-active and winter-dormant) and Mediterranean (winter-active and summer-dormant). Summer-active types have filled a useful role in the Southern Highlands. Persistence is good on well-drained soils with the right grazing management.

Varieties: Porto, Grasslands Kara, Currie.

Sowing: Sow at 2–4kg/ha into a clean seedbed, no more than 2cm deep. Plant in autumn or spring or mild winter.

Feed quality: 60%–70% digestibility, 9.5–10.5MJ/kg ME, 10%–18% crude protein. Poorer quality than perennial ryegrass.

Diseases: Leaf rust can be a periodic problem.

Pests: Grass grubs and cockchafers—phalaris and fescue are more tolerant.

Grazing management: Persists best when moderately and rotationally grazed. But grazing pressure must be sufficient to prevent the development of tussocks and shading of associated legumes.



Companion species: Often sown in mixtures with other more nutritious grasses such as perennial ryegrass (early maturity types), fescue and phalaris. Sown with white clover or subclover.

FESCUE—See Tall Fescue

KIKUYU (*Pennisetum clandestinum*)

Vigorous, summer-growing perennial grass. Responds well to nitrogen fertiliser. Can produce large quantities of medium-quality feed from late spring to autumn.

Strengths: High production from late spring to autumn. Tolerant of dry conditions. Capable of supporting very high stocking rates. Resilient to grazing. High protein content for summer-growing



grass. Responsive to N fertiliser. Vigorous growth excludes weeds.

Weaknesses: Decline in nutritive value with advancing age. Apparent serious decline in quality in autumn. Susceptible to frosts. Strong seasonality of production—no winter – early spring growth. Vigorous growth excludes establishment of autumn–winter–spring species such as white clover and ryegrass in autumn. Susceptible to kikuyu yellows. Requires high fertility.

Seasonality: Most rapid growth in late summer – early autumn. Nitrogen fertiliser can stimulate earlier spring production. Autumn saving can carry forward medium quality feed to late autumn – early winter. Highly persistent—difficult to eradicate seeding strains.

Varieties: Common (runners only); Whittet, Noonan.

Sowing: Runners, turf or rotary-hoed pieces (1 runner per square metre). Sow seed at 1–4kg/ha in early autumn, or in spring – early summer with irrigation. Drill or broadcast into a clean seedbed. Slow to establish.

Feed quality: Protein content and digestibility decline with age and are higher when N fertiliser is applied. Protein content at 3 and 6 weeks is 17% and 14% without N and 23% and 14% with 130kg N/ha. Digestibility at 3 and 6 weeks is 73% and 65% with 130kg N/ha. Quality is best when stolons are removed by slashing and mulching and when the sward is kept leafy.

Diseases: Kikuyu yellows severely reduces swards north of Taree. Noonan is resistant.

Pests: Armyworms can eat large amounts of kikuyu.

Grazing management: Remove stolons by slashing early in the season. Graze at 3–4 weeks' regrowth. Remove excess material after grazing with followers, by slashing or mulching, or with a combination of both. Kikuyu is a vigorous competitor with high quality pasture species such as perennial ryegrass and white clover and should be controlled to obtain the best from these species.

Companion species: Late autumn – spring production can be improved by

direct-drilling annual ryegrasses or oats. With careful management white clover can be grown in association with kikuyu.

PASPALUM (*Paspalum dilatatum*)

Summer-growing perennial grass. Usually sown with legumes, particularly white clover. Characterised by vigorous summer growth, which is often difficult to control effectively by grazing. Usually has to be slashed or mown during summer to control excess growth and keep available a fresh supply of young, highly digestible feed. Summer-growing pastures based on paspalum have been replaced by kikuyu along the coast, although paspalum with white clover is still used in irrigation areas.

Strengths: Grows quickly and produces well during summer, but requires good grazing management or slashing to restrict seed production and ergot formation. Quality of forage declines rapidly as plants run to head in late summer and autumn. Useful grass in wetlands as it can tolerate waterlogging. Often added to other grasses as it is relatively cheap. Basis for summer-growing pastures in irrigation areas as it combines effectively with white clover. Withstands effects of heavy grazing. Seed heads can be infected with ergot, which can poison livestock.

Weaknesses: Persistence appears to depend on soil fertility. If fertility declines, carpet grass comes in to replace it. As fertility increases, kikuyu often becomes dominant. Only moderately tolerant of frosts. Rapid decline in feed quality with advancing maturity, particularly as it approaches maturity in late summer and autumn. Prone to infection with ergot when allowed to go to head; livestock poisoning is possible.

Varieties: Common.

Sowing: Sow at 4–10kg/ha in spring –



early autumn. Drill or broadcast with companion legumes into a clean seedbed and lightly cover seed.

Feed quality: Feed quality is generally good for young leafy material, but falls drastically when plants run to head. Slashing of the stemmy growth will benefit white clover and improve the feed value of the pasture.

Diseases: Ergot poisoning most commonly affects cattle when early summer rains, which promote rapid growth and maturity of the paspalum, are followed by a relatively dry period.

Pests: Occasional problems for paspalum can arise from attack by black beetles, cutworms, armyworms and scarabs.

Grazing management: To maintain feed quality, keep plants short to prevent them from running to head. Where grazing pressure is insufficient, slash.

Companion species: White clover is the most common companion species sown with paspalum. Its persistence in the sward can be encouraged by heavy grazing in late summer and fertiliser application in autumn.

PERENNIAL RYEGRASS—See Ryegrass

RHODES GRASS (*Chloris gayana*)

Summer-growing perennial. Forms strong bunch-type stools and stolons anchoring at the nodes to give rapid soil coverage.

Strengths: Establishes well on poorer soils and is an ideal species for soil binding and erosion control. Though primarily a summer grower, it shows moderate frost-tolerance and can provide grazing well into late autumn in most areas. Responds well to improved fertility from associated legumes, but can run down where fertility is not maintained. Tolerant to salt, more so than paspalum.

Weaknesses: In dairy situations, its use is confined to northern NSW. Persistence under heavy grazing is inferior to that of kikuyu and other summer grasses.

Varieties: Callide, Katambora, Pioneer. The first two are more productive but are less tolerant to frost than Pioneer.

Sowing: Sow at 1–4kg/ha into a clean seedbed in spring or late summer – early autumn.

Feed quality: As with other tropical grasses, feed value decreases as the plants mature and become rank, stemmy and unpalatable.

Diseases: None significant.



Pests: None significant.

Grazing management: Avoid rank, stemmy growth. Slash or burn over-mature pastures.

Companion species: Difficult to maintain in Rhodes grass pastures because of the stoloniferous habit of the plant. Lucerne, phasey bean, siratro and centro have had some success in coastal south-eastern Queensland.

RYEGRASS—Perennial ryegrass (*Lolium perenne*)

Densely tufted, multi-tillered perennial. Leaves shiny on undersurface; flowering stalks are erect spikes.

Strengths: Highest yield of quality grass in high rainfall areas (>900mm) or under irrigation. Perfectly suited to rotational grazing in dairy systems. Responds well to nitrogen applied as fertiliser or fixed by legumes. Easier to establish than other

perennial grasses. Resistant to frost. Tolerates saline and sodic soils and some waterlogging. Persists best under high fertility conditions.

Weaknesses: Lacks drought-tolerance, especially late-maturing cultivars. Persistence is limited by competition with subtropical grasses, especially north of Taree.

Seasonality: Best growth in autumn and spring. Early maturing cultivars give good winter growth. Late maturing cultivars give good summer growth under irrigation. Infection with high levels of endophyte* fungus aids persistence. Old high-endophyte stands in the Shoalhaven and Bega Valley have persisted for 100 years.

Varieties: Early maturing: Kangaroo Valley, Roper; late maturing: Yatsyn, Dobson, Ellett, Embassy, Verdette, Banks. New varieties are frequently released.

Sowing: Sow at 10–14kg/ha in autumn (dryland) or spring (irrigated and Tablelands). Direct-drill after suppression of existing growth by herbicide. Drill or broadcast following mulching or into a clean seedbed. Susceptible to competition from annual ryegrass. Restrict sowing rate of annual ryegrass to no more than 7kg/ha when sown with perennial ryegrass.

Feed quality: Highest quality grass available. Digestibility 65%–80%; ME 11–12MJ/kg; crude protein 15%–20%. Soluble carbohydrate levels generally lower than in Italian ryegrass varieties. High-endophyte cultivars can reduce milk production by up to 10% compared with low-endophyte cultivars, but persistence of stand is reduced without the endophyte. Very few cases of ryegrass staggers have been observed in NSW perennial ryegrass pastures.

* Endophyte: An intercellular fungus (*Acremonium lolii*) living entirely within the perennial ryegrass plant.



Diseases: Crown and stem rust are serious problems, particularly under irrigation and north of Taree. Rhizoctonia can weaken the root system and allow pulling by stock. Yellow dwarf virus and ryegrass mosaic polyvirus can reduce stand health.

Pests: Susceptible to pasture scarabs, grass grubs, armyworms. Argentine stem weevils have been found in ryegrass pastures in the Bega Valley. High-endophyte cultivars tend to be more

resistant to insect attack than low-endophyte cultivars.

Grazing management: Grazing when the third leaf is as long as the second leaf (third-leaf stage) provides for maximum use of perennial ryegrass pasture and allows the plant to build up higher amounts of carbohydrate.

Companion species: White and red clover.

PERENNIAL RYEGRASS – WHITE CLOVER PASTURES

Perennial ryegrass sown in association with white clover forms the base pasture for most dairy farms in NSW. This base pasture has the potential to produce high quality feed from autumn to early summer. Production is restricted in summer – early autumn and alternative sources of feed have to be sought to supplement the base pasture. The main objective in managing perennial ryegrass – white clover pastures is to ensure that the survival and productivity of both species are preserved. Well understood management strategies are available for this objective; adopting them can significantly increase base pasture productivity.

Strengths: Both species produce highly digestible feed. Increasing clover content can increase the feed quality and milk production potential. Nitrogen fixation by the clover reduces fertiliser costs. High productivity of pasture allows high stocking rates to be sustained in the growing period. High quality conserved feed can be produced from excess spring production.

Weaknesses: Lack of summer–autumn productivity. Difficulty in sustaining grass–clover balance. Potential for invasion by annual and perennial summer-growing grasses. Short-term survival of the pasture (2–5 years). Difficulty in

maintaining ryegrass and clover throughout summer for the next season of growth. Irrigation is essential to ensure survival in subtropical dairying districts.

SETARIA (*Setaria* spp.)

Summer-growing, tufted, perennial grass. Adapted to a wide range of soil types from low to high fertility. Usually sown in association with legumes, particularly white clover. Characterised by vigorous summer growth, which is often difficult to control effectively by grazing. With excellent persistence and greater productivity, setaria should replace carpet grass in the dry-runs of dairy farms along the coast.

Strengths: Grows rapidly during summer and into autumn. High dry matter yields. Extremely persistent once established. Does not crowd out companion legumes such as white clover. Clump-forming habit allows successful regeneration of white clover. Responsive to nitrogen fertiliser. Resistant to dry soil conditions.

Weaknesses: Rapid decline in feed



quality with advancing maturity. Susceptible to frosts. Potential for oxalic acid poisoning. Requires slashing or mowing to control excess ungrazed material.

Varieties: Newer cultivars such as Solander and Narok have generally shown greater frost tolerance and lower oxalate levels than the older cultivars Nandi and Kazungula.

Sowing: Sow at 1–5kg/ha in February–March or in spring – early summer, particularly with irrigation. Sow into clean seedbed. Seed is small, so don't sow too deep when drilling. Broadcasting, covering and rolling can also be used.

Feed quality: Like many tropical grasses, feed quality of setaria falls rapidly with advancing maturity. If kept short by rotational grazing and strategic mowing, young leafy growth can have about 12% crude protein, 9.2MJ/kg ME and 61% digestibility. On rare occasions, cattle can suffer oxalate poisoning from setaria, especially after heavy applications of potassium or nitrogen fertilisers.

Diseases: None significant.

Pests: In coastal areas, armyworms can damage setaria in summer. Grass seed crops have been destroyed by the yellow peach moth grub and the buffel grass seed caterpillar.

Grazing management: Usually has to be slashed or mown during summer to control excess growth and to keep a fresh supply of young, highly digestible feed available. Maintain short leafy growth at about 25–30cm in height. If growth gets away, paddocks may be closed for hay or silage. Use heavy grazing or slashing in early autumn to open up the sward to allow white clover to grow during winter and spring.

Companion species: Companion species have usually been cover crops with an

annual ryegrass, red clover and white clover. The lotus cultivar Goldie has also been used. Cowpeas have been a successful cover crop for summer sowings.

TALL FESCUE (*Festuca arundinacea*)

A perennial, spring- and summer-growing pasture grass. Reasonably persistent. Adapted to waterlogged sites and area where moderate salting occurs.

Strengths: Spring and summer production can complement ryegrass-dominant pastures, which lose quality late in the season when they begin the reproductive growth stage.

Weaknesses: Persistence is often poor owing to inappropriate management. Suffers from competition from vigorous perennials like ryegrass. Slow to establish, but once established can become a productive, persistent pasture. More suited to dry stock than to milkers.

Seasonality: Spring, summer and autumn. Takes 2 years to establish properly. After that it becomes very persistent.



Varieties: Demeter, Au Triumph, Cajun, Dovey.

Sowing: Sow 5–15mm deep at 8–10kg/ha dryland and 10–12kg/ha irrigated. Broadcast and harrow or drill into a clean, firm seedbed.

Feed quality: During late spring – summer, quality is superior to that of ryegrass. Under adequate grazing management, it is good enough for fattening stock or milking purposes.

Diseases: Under adverse conditions some cultivars are affected by rust; this can also indicate that the crop lacks adequate nutrients.

Pests: Treat soil or seed with miticides to reduce the effect of earth mites during establishment.

Grazing management: Do not graze hard during the first 2 years. After this, it will tolerate heavy grazing.

Companion species: Red clover, strawberry clover, chicory.

Annual legumes

Annual legumes grown alone as a forage crop can produce high yields of high-quality feed, particularly in spring and early summer. Best production is obtained from early sowing in late February – early March. These early sowings will produce some late autumn – early winter feed. Sowing rates have to be kept high so that these crops can establish quickly. Late maturing varieties allow production into early summer. These legumes can be useful crops grown after a maize silage crop is harvested.

Advantages: High yields of highly digestible, high protein feed. Can be grazed or conserved as high quality hay or silage. Fit well into autumn–winter–spring production in cropping systems such as maize cropping.

Disadvantages: Bloat, which can and should be controlled. Lack of autumn–winter–spring production if not sown early. Have to be resown annually into a weed-free, cultivated seedbed.

BALANSA CLOVER (*Trifolium balansae*)

Grows predominantly in winter and has an early spring flush. High seeding ability helps in colonising other areas when seed is transferred by livestock. Adapted to areas with at least 500mm of winter - dominant rainfall.

Strengths: Good regeneration in irrigation districts but less so on the coast. Resistance to clover scorch. High seed yield. Can handle mildly acidic soils, waterlogging and mild salinity. Useful for haymaking. Excellent persistence owing to high seed production. Hard seed content is approximately 70%, which allows some seed in reserve for dry times. Useful fodder crop if rainfall is less than 700mm.

Weaknesses: Hollow stems allow inaccurate estimation of hay yield. Growth is slow during autumn. Red-legged earth mites damage plant and cause losses, especially at establishment.

Seasonality: Begins growth at the autumn break but is slow. Has relatively good winter and spring yield. Not summer-active.

Varieties: Paradana.

Sowing: Autumn (dryland) or early autumn (irrigated or with good moisture conditions). Sow into a clean seedbed.

Feed quality: Good, but not as good as Persian clover. Protein content of up to 18%.

Diseases: Highly tolerant of all major diseases.

Pests: The major insect pest is the red-legged earth mite, especially in the establishment year. Other pests include blue-green aphids and heliothis caterpillars.

Grazing management: Do not graze after sowing till the plant starts to tiller, and then only lightly in the first year. After establishment, continuous grazing rather than rotational grazing will promote persistence. Remove stock at flowering time.

Companion species: Subterranean clover, Persian clover, phalaris, cocksfoot, tall fescue, ryegrass.

BERSEEM CLOVER (*Trifolium alexandrinum*)

Used as forage crop because of high yields.

Strengths: Grows in wet conditions. Allows multiple grazings or cuttings. Makes good hay. Slightly less bloating than other legumes. Good winter and spring yields.

Weaknesses: Requires high fertility and adequate moisture for effective

production. Frost-sensitive. Needs 700mm rainfall. Sensitive to low molybdenum. Requires high sowing rate.

Seasonality: Can be sown as early as February. Given a reasonable spread of rain or irrigation through the growing period, can be grazed or cut up to 6 times through to late spring. Will set seed, but the usual method is to resow each year.

Varieties: Multicut (= Carmel), Bigbee.

Sowing: Sow at 6–10kg/ha late February – early March into a clean seedbed. It is usually sown by itself but can be sown with other legumes, oats or winter-growing grasses, such as tetraploid ryegrasses.

Feed quality: Excellent.

Diseases: In wet spring conditions, leaf and stem blight can occur when growth is rank.

Pests: Host to blue-green aphids, but these usually do not cause a great loss. Red-legged earth mites can devastate a crop, especially with late-sown crops. Heliothis caterpillars occasionally damage leaves at the end of spring.

Grazing management: Begin grazing or cutting when plants reach about 25cm in height after planting and after each grazing. Can be left to grow higher for silage or hay.

Companion species: Usually sown as a monoculture but can be sown with other annual species such as annual ryegrass or oats.

Special factors: Responds well to nitrogen, phosphorus, potassium and molybdenum.

COWPEA (*Vigna unguiculata*)

Summer-growing forage legume crop. Valuable source of protein in subtropical and tropical dairying districts. Can be grazed or conserved as hay or silage to

supplement low-quality pastures.

Strengths: Early-sown crops are superior in growth to lablab with early sowings. Digestibility is usually higher than that of lablab. With careful management up to two regrowths are available for grazing. Relatively high yields. Produces high protein feed in summer when summer grasses are deficient in protein.

Weaknesses: Susceptible to stem- and root-rot diseases and to insect attack, particularly from bean fly. Will not grow as late into autumn as lablab. Dry weather performance can be poor. Difficult to graze or harvest for silage in wet summers. The stem portion of the crop becomes more indigestible as the crop ages and will be rejected by stock. Damaged severely by frosts.

Seasonality: Summer producer. Growth is reduced by low night temperatures in autumn.

Varieties: Poona, Caloona, Red Caloona.

Sowing: Best results when sown into well prepared seedbed with ample conserved moisture. Sow seed 4–6cm deep at 10–14kg/ha in dryland districts and at up to 20 kg/ha in high rainfall areas. Can be direct-drilled after controlling competition with herbicides.

Feed quality: Better than that of lablab and soybean.

Diseases: Root and stem rots.

Pests: Bean fly can cause serious losses.

Grazing management: Can be grazed 2–3 times during summer. Should be grazed lightly so that the growing points near the stem are not destroyed. Graze or ensile before first frost.

Companion species: Can be sown with maize or sorghum to increase protein content of the combined crop, but yields are much lower.

LABLAB (*Dolichos lablab*)

Twining, summer forage legume crop. Valuable source of protein in subtropical and tropical dairying districts. Can be grazed or conserved as hay or silage to supplement grazed pastures low in protein.

Strengths: Produces high protein feed in summer when summer grasses are deficient in protein. Suitable for grazing. Will regrow for subsequent grazings with careful management. Relatively disease-resistant. Will continue to grow and retain feed quality into late autumn. Valuable green manure crop. Can be made into silage. Produces up to 4t/ha dry matter .

Weaknesses: Difficult to graze or harvest in wet summers. Stems toughen rapidly, become more indigestible as the crop ages and will be rejected by stock. Damaged severely by frosts.

Seasonality: Susceptible to frost but grows later into the autumn than other summer-growing forage legumes. Without frost will survive and grow into the next summer.

Varieties: Rongai, Highworth.

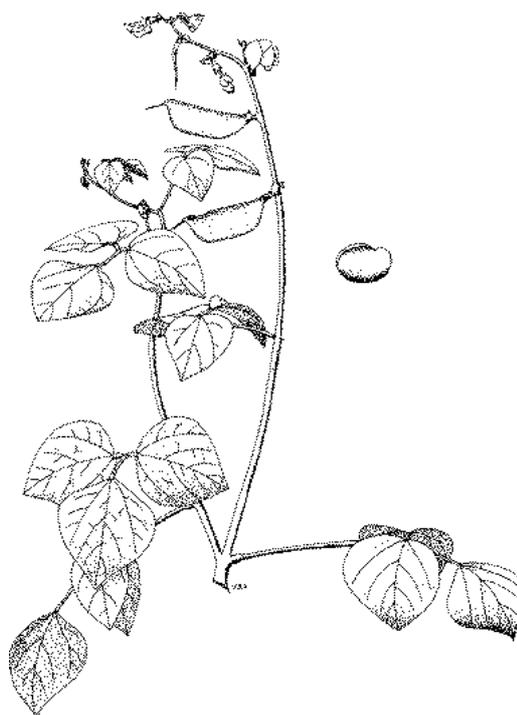
Sowing: Sow into a clean seedbed at 15–20kg/ha dryland and 30 kg/ha in high rainfall districts. Drill in 18–35cm rows 4–6cm deep. Can be direct-drilled after chemical control of existing pasture.

Feed quality: Leaves produce high quality, high protein feed and are selectively grazed. Stems lignify and are low in digestibility. Stems are rejected in hay but are eaten in silage.

Diseases: None significant.

Pests: None significant.

Grazing management: Lenient grazing so that growing points are not damaged. Aim for 2–3 grazings. Do not graze during wet periods. Graze or ensile before first frost.



Companion species: Can be sown with maize or sorghum to increase protein content of combined crop, but yields are much lower.

PERSIAN CLOVER (*Trifolium resupinatum*)

Late-maturing annual clover used as a forage crop. Produces high-quality feed autumn–spring. Used over a wide range of environments. Often used in southern NSW irrigation areas and districts.

Strengths: Non-oestrogenic clover; very palatable and produces high-quality feed. Late maturity extends the growing season later than subclover varieties. Can be grown on for a hay crop after grazing period. Capacity to produce high yields: up to 16t/ha of dry matter .

Weaknesses: Susceptible to rust.

Seasonality: When sown early in irrigation districts (February), can be grazed twice before winter. Later sowings produce little autumn–winter growth because of low temperatures. Matures 2–4 weeks later than subclover.

Varieties: Maral, Kyambro.

Sowing: Sow at 4–5kg/ha dryland and 6–8kg/ha irrigation. Very small seed (800000/kg); sow not more than 1cm deep. Sow on the surface of a prepared seedbed and cover with light harrows or a sheet of weldmesh. Can be direct-drilled but seedlings are not very competitive: control all competition.

Feed quality: Highly digestible. More digestible than lucerne, red clover and pasture hay. Digestibility 63%–78%. High protein content: 16%–21%. Low fibre content increases voluntary intake.

Diseases: Subclover rust (*Uromyces trifolii-repentis*) and clover rot (*Sclerotinia trifoliorum*) can cause serious damage in spring. Effect can be reduced by grazing or mowing to reduce humidity in the sward and reduce inoculum potential. Kyambro more resistant than Maral to rust.

Pests: Red-legged earth mite and lucerne flea can attack seedlings and should be controlled by chemical spray within 1 week of germination when the pests are present. Sitona weevil and heliothis can cause damage but seldom need control; but careful observation is required. Also susceptible to blue-green aphid and pea aphid but resistant to spotted alfalfa aphid.

Grazing management: Can be grazed or taken for hay production after grazing.

Companion species: Can be sown with oats or annual ryegrass to reduce bloat risk and spread production. Oats will provide more early feed and ryegrass will provide more winter and spring feed.

SOYBEAN (*Glycine max*)

Forage crop best used for silage. Valuable source of protein in subtropical and tropical dairying districts. Can be grazed or conserved as hay or silage to supplement low-protein pastures.

Strengths: Produces relatively high yields of high-protein forage. Can be ensiled as either round bale or precision chopped silage. Yields of 6–10t/ha dry matter .

Weaknesses: Difficult to harvest in wet summers. Lignification of stems leads to high rejection by stock when conserved as round bale silage. Damaged severely by frosts.

Seasonality: Summer-growing forage crop. Whole crop is harvested and area is then available for sowing with a follow-up pasture or crop.

Varieties: Wide range of varieties to suit different environments. Plant any of the grain varieties recommended for the district. Use the latest maturing varieties.

Sowing: Sow mid November to December.

Feed quality: Valuable source of protein in subtropical environments where there could be a protein deficiency in other feeds. Yields are highest at the full-sized green bean stage but digestibility of the whole plants at this stage may be only 60%. Lower yields but better whole-plant quality will be obtained with earlier harvests.

Diseases: None significant.

Pests: None significant.

Grazing management: Not suitable for repeated grazing as it doesn't recover well after grazing. Stock select leaves very heavily. When a mature crop is grazed there is serious wastage. The most effective method for using soybean is to harvest the whole crop for hay or silage. Wastage is greater with hay and round-bale silage than with precision-chopped silage.

Companion species: Grown as a monoculture.

HIGH DENSITY LEGUMES

Mixtures of annual and perennial legumes are sown at high sowing rates with the aim of giving a wide seasonal spread of production. Mixtures include Clare subclover, red clover, white clover and Persian clover sown at high rates. Up to 40kg/ha of legume seed is sown. Early (March) sowings are most effective. These sowings are usually managed as an annual crop. Nevertheless, high-density, irrigated clover pastures in subtropical districts can produce effectively throughout summer and into autumn.

Strengths: Sown instead of annual ryegrass pastures, which are heavily fertilised with nitrogen. They give a much higher quality feed for a lower overall cost of production. Productivity is maintained throughout a much longer season. Production extends through to autumn with irrigation.

Weaknesses: Bloat is a serious problem. Slower to establish than ryegrass when planted in April–May. Weed control is more difficult than in an annual ryegrass pasture. Some of the legumes are sensitive to acidic soils and could require lime for effective growth.

Perennial legumes

KENYA WHITE CLOVER (*Trifolium semipilosum*)

Stoloniferous perennial similar in appearance to white clover but leaflets and stems are softly hairy.

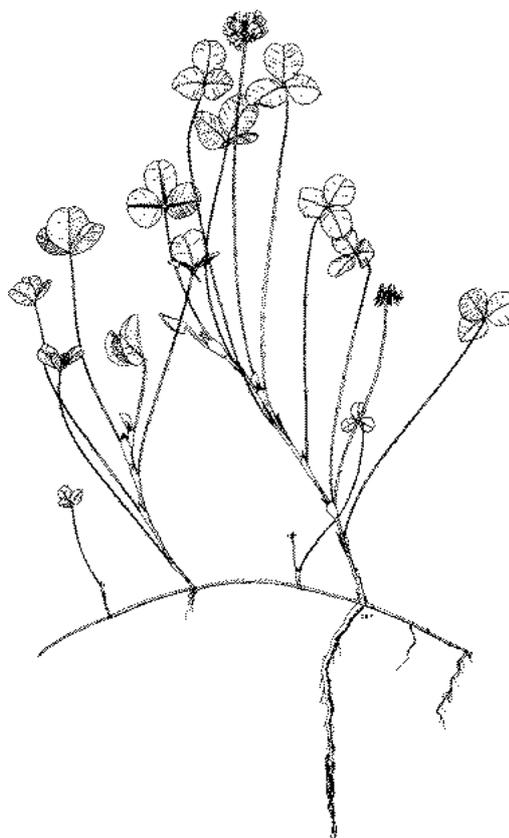
Strengths: Better summer growth and drought survival than white clover north of Taree. Grows well on acidic soils and is more compatible with summer-growing grasses than white clover.

Weaknesses: Difficult to establish. Not as frost-tolerant as white clover.

Seasonality: Spring, summer and autumn growth. Good persistence with correct grazing management.

Varieties: Safari.

Sowing: Sow in autumn at 2–4kg/ha into a clean seedbed. Small seeded—don't plant too deep. Susceptible to waterlogging.



Feed quality: Similar to that of white clover. No oestrogens.

Diseases: Big bud MLO (mycoplasma-like-organism) can cause stunting in cooler environments. Susceptible to a range of viruses.

Pests: Slugs can be a problem at establishment. Amnemus and white-fringed weevil larvae can cause damage.

Grazing management: Lightly graze to remove grass competition in the first year to allow seed set and a seed bank for subsequent germination to develop. Subsequently tolerates heavier grazing than white clover. Grazing should be sufficient to suppress summer grass growth.

Companion species: Kikuyu.

LOTUS (*Lotus pedunculatus*)

Rhizomatous perennial with 5 leaflets per leaf, 2 at the base and 3 more prominent at the end. Yellow flowers give rise to long cylindrical pods borne in clusters resembling an inverted bird's foot.

Strengths: Grows better than other legumes in low fertility, acidic soils. Tolerates high amounts of aluminium. Well suited to acid sulphate soils. Tolerates some salinity and sodicity. Contains condensed tannins, which provide bypass protein and prevent bloat. More drought-tolerant than white clover.

Weaknesses: Requires lenient grazing management for persistence. Will not persist under frequent grazing rotations.

Seasonality: Good growth in spring, summer and autumn. Will tolerate frosts but winter growth is limited. Persistence is limited by summer drought and frequent heavy grazing.

Varieties: Grasslands Maku, Sharnae.

Sowing: Sow at 1–2kg/ha in late winter – early spring or late summer – early



Illustration drawn by María A. Migoya and graciously provided by Ana M. Arambarri, Argentina.

autumn. Sow into clean seedbed and not too deep. Can be oversown into short pasture. Best if a cover crop is also sown when planting in a clean seedbed.

Feed quality: Digestibility 60%–75% (lower than white clover). ME 11–12MJ/kg. Protein 15%–20%. Presence of condensed tannins lowers digestibility but increases the availability of the protein to the animal. Tannin concentrations of less than 1% of dry matter in the diet prevent bloat. On balance, milk production is similar to that from white clover as long as tannin concentrations do not exceed 6%.

Diseases: None significant.

Pests: Old, heavily grazed stands are susceptible to white-fringed weevil larvae.

Grazing management: Graze infrequently in first year after establishment to remove grass competition. Rotational grazing favours lotus persistence. Twenty-year-old stands in the Illawarra and Highlands prove that lotus can persist with the right grazing management. A summer spell will encourage seed production, especially

south of Taree. An autumn spell will encourage rhizome development. Better suited to dry-run areas than to the milking area.

Companion species: Fescue, carpet grass, setaria (as long as grass is grazed well). Perennial ryegrass can improve winter production from lotus stands, but use only low sowing rates (< 15 kg/ha).

Special factors: Responds to phosphorus and potassium fertiliser.

LUCERNE (*Medicago sativa*)

Deep-rooted, semi-erect to erect plant with stems arising from a crown. Highly winter-active and winter-active varieties can produce grazings from autumn to spring. Stands with these varieties tend not to last as long as stands with semi-dormant and dormant varieties.

Strengths: Highest yielding legume for well drained, slightly acidic to alkaline soils in coastal and inland irrigation areas. Valuable crop for rotational grazing and hay or silage production. Growth is rapid in spring–autumn. Winter activity is useful for grazing in autumn–spring but produces only 20% of summer yield. High protein content makes it a valuable protein supplement for the milking herd. Nitrogen fixation capacity of lucerne allows for minimal nitrogen fertiliser use. The growth rhythms of ryegrass–clover pastures and lucerne pastures are complementary. In combination, these pastures can produce a year-round source of high-quality feed. Surplus production can be sold for cash as hay.

Weaknesses: Does not tolerate waterlogging, salinity or acidic soils high in aluminium. Requires careful management for best yields. Weeds, pests and diseases can cause substantial loss in production and should be managed effectively. Bloat can be a serious problem



when the crop is grazed. Risk is highest in winter: spray bloat oil on the pasture. Feed quality declines with advancing maturity. Severe decline in quality at flowering can lead to fall in milk production.

Seasonality: Predominantly a warm-season species; divided into winter-dormant, semi-winter-dormant, winter-active and highly winter-active categories. Winter-dormant types tend to be more persistent: they last 3–8 years depending on drainage and management.

Varieties: Highly winter-active: Aquarius, Pioneer Brand L69, Sceptre, Pioneer Brand 5929; Winter-active: WL516, Aurora, Quadrella, Trifecta, Hunterfield; Semi-dormant: Pioneer Brand L52, Pioneer Brand 581, Nova, WL Southern Special; Dormant: Pioneer Brand 545, Prime, WL320.

Sowing: Sow 1–5kg/ha dryland or 8–15kg/ha irrigated in autumn or spring when the temperature is high enough and there is enough moisture to ensure establishment. Sow into a clean seedbed. Drill or broadcast. Cover effectively and roll.

Feed quality: 65%–75% digestibility, 15%–25% crude protein, 8–11MJ/kg ME. Spray with bloat oil before grazing lucerne-dominant stands. Low in soluble carbohydrate: animals need to be fed carbohydrate supplements. Feeding maize silage while grazing lucerne can often provide a well-balanced ration.

Diseases: The most serious are phytophthora root rot, colletotrichum crown rot and common crown rot. (See Agfact P2.5.25 for more details.)

Pests: Blue-green aphid and spotted alfalfa aphid are the major pests. Full resistance to blue-green aphid is not available. Pea aphid is an occasional problem. Other pests include red-legged earth mite in cooler areas, white-fringed weevil larvae, lucerne-leaf roller, lucerne flea, cutworms, sitona weevil, heliothus and wingless grasshopper.

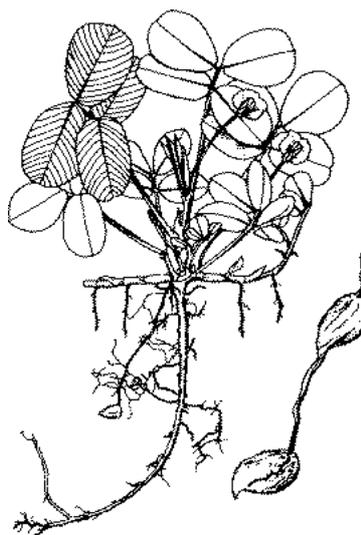
Grazing management: Rotational grazing with back-fencing and cutting at 36–40-day intervals gives the best balance between harvesting quality feed and allowing the lucerne plant to store carbohydrate in the crown for continued persistence.

Companion species: Phalaris, fescue, cocksfoot. Most commonly sown as monoculture on dairies.

PINTO PEANUT (*Arachis pintoi*)

Mat-forming perennial peanut with promise for producing high-quality feed in the tropics and subtropics.

Strengths: Produces high-quality feed from October to May in moist humid



environment. Tolerant of heavy grazing. Tolerant of frosts when established but slow growing in winter. Persistent under a wide range of conditions but prefers moist conditions on well drained soils. Tolerant of shading from tall-growing grasses.

Weaknesses: Requires specific rhizobium for effective nitrogen fixation (*Bradyrhizobium* spp.). Often the plant remains yellow even after inoculation, which suggests poor nitrogen fixation. There is only one seeded variety; others have to be planted from runners or cuttings.

Seasonality: Maximum production in summer under higher temperatures. Will grow for an extended period. Highly persistent. Develops mat of underground rhizomes.

Varieties: Amarillo.

Sowing: Sow between September and March to avoid frost damage to young seedlings. Plant 15–20kg/ha of seeds-in-pods 2–6cm deep, where there is adequate moisture, preferably in a clean seedbed. Never plant on the surface. Must be inoculated with the correct rhizobia. Plant *A. glabrata* from runners.

Feed quality: Higher feed quality than the grasses with which it grows. This can help to increase the protein intake of stock

grazing subtropical grass–legume pastures.

Diseases: None significant.

Pests: None significant.

Grazing management: Tolerant of heavy grazing. Correct timing of grazing is required to allow rhizome development and effective spread and persistence in the pasture.

Companion species: Can be grown with either creeping short grasses or tall grasses because of its shade tolerance.

RED CLOVER (*Trifolium pratense*)

Often used as a pure stand for hay and silage. Suited to well drained, fertile soils, particularly in areas with an annual rainfall of 700mm or where irrigation is available.

Strengths: Abundance of quality feed during spring–summer. Useful component of mixed pasture swards, although not always long lived. Supplies quality forage when most other legumes grow poorly.



Weaknesses: Often short lived in a mixed pasture sward if inappropriate grazing management allows damage to plant crowns. Some cultivars are oestrogenic and can cause fertility problems in stock. Poor winter growth.

Seasonality: Most production in spring–summer.

Varieties: Grasslands Hamua, Grasslands Pawera, Grasslands Colenso, Redquin, Renegade, Astred, Pac 19.

Sowing: Sow in autumn or spring at 2–5kg/ha in mixtures with grasses and white clover for perennial pastures; 5–8kg/ha for hay crops or in mixtures with annual ryegrass. Inoculate seed before sowing.

Feed quality: Crude protein and digestibility are adequate for fattening or milk production.

Diseases: None significant, although can be affected by root and crown rots on poorly drained sites.

Pests: Red-legged earth mite and blue oat mite can have a devastating effect during establishment. Heliothis can also cause damage.

Grazing management: Responds best and persists longer if frequent close grazing or cutting is avoided. The recommended minimum residual grazing or cutting height is 75mm. Can sometimes dominate the pasture during late spring – early summer. Graziers should take adequate bloat precautions.

Companion species: White clover, perennial ryegrass, tall fescue and many other pasture plants such as chicory.

STRAWBERRY CLOVER (*Trifolium fragiferum*)

Spring–summer-growing legume that spreads by runners. Well suited to saline or poorly drained sites.

Strengths: Provides a useful contribution



to pasture quality during spring–summer when other legumes are less active. Will regenerate well from seed following drought. Very persistent. Will withstand frequent close grazing and grows well in situations that are too wet or too dry for other perennial clovers.

Weaknesses: Not as productive as white clover and should not be sown where white clover will grow successfully.

Seasonality: Main production from spring to autumn.

Varieties: Palestine, O'Connor.

Sowing: Sow at 1–4kg/ha in autumn (dryland) or spring (irrigated). Sow into a firm, clean seedbed. Drill less than 1cm or broadcast and cover and roll. Inoculate seed before sowing.

Feed quality: Good. Adequate protein and energy for fattening.

Diseases: None significant.

Pests: Establishment can be affected by red-legged earth mites.

Grazing management: Reasonably tolerant of a wide range in grazing management, although continuous close grazing, particularly by sheep, can lead to a thinning of the sward.

Companion species: Most often mixed with tall fescue, cocksfoot and sometimes tall wheat grass. In wet saline areas it is

most often the only legume sown. Often included at low rates in more general pasture mixes in order to colonise occasionally wet parts of the pasture.

SUBTERRANEAN CLOVER (*Trifolium subterraneum*)

As there is far more to be written about subclover than would fit in this manual, details are not given here. Instead, read the Agfact *Subterranean clover in NSW—identification and use* (P2.5.16), which should be in the back of this manual.

WHITE CLOVER (*Trifolium repens*)

Prostrate stoloniferous perennial legume (can also be a self-regenerating annual). The flower head is large, round and white or light pink.

Strengths: Highest quality legume available for high rainfall (>900mm) and irrigation areas. Responds well to phosphorus and potassium fertiliser. Tolerates acidic soil as long as aluminium concentrations are below 10%. Well suited to frequent rotation grazing on dairies.

Weaknesses: Lacks drought tolerance. Poor stolon survival over summer. High requirement for potassium can disadvantage it when growing in



competition with kikuyu. Does not tolerate waterlogging or salinity.

Seasonality: Grows well in autumn and has a marked spring flush. Tolerates frost. Some winter growth in early-flowering cultivars. Summer growth can occur in Ladino types if moisture is available. Persistence through stolon survival is poor in most districts without irrigation. Will re-establish with correct grass management. Many coastal districts have a large seed-bank of naturalised white clover, which can make a significant contribution in some years.

Varieties: Haifa, Grasslands Huia (NZ white clover), Irrigation, Pitau, Osceola, Grasslands Kopu, Prop, Grasslands Prestige, Aran, Sustain, Grasslands Tahora, Tamar.

Sowing: Sow at 1–4kg/ha on good moisture in early autumn to early winter (dryland) or spring (irrigated and Tablelands). Sow on the surface, cover and roll. Don't sow too deep.

Feed quality: Highest quality legume available. Digestibility 70%–85%; ME 11–12.5MJ/kg; crude protein 18%–25%. Low in soluble carbohydrate; needs to be grown with high-soluble-carbohydrate

grass, or animals need to be fed carbohydrate supplements. Bloat can be a problem: spray white-clover-dominant pastures with bloat oil before grazing.

Diseases: Rugose leaf curl, lucerne mosaic virus, white clover mosaic virus and rusts can cause yield losses. Rhizoctonia and other root and stolon rots can affect white clover.

Pests: Nematodes can affect white clover stands in coastal NSW. Cutworms, white-fringed weevil larvae, aphids and some mites can also cause damage.

Grazing management: When grown with perennial ryegrass, graze when the third ryegrass leaf is as long as the second leaf (third-leaf stage) or when the lower white clover leaves are just beginning to age. When it is grown with subtropical species such as kikuyu, it is important to follow the 'golden rule of management': graze heavily and slash or mulch so that a kikuyu mat does not develop. This approach allows space for white clover seedlings to emerge from an autumn germination.

Companion species: Perennial ryegrass, fescue, phalaris, kikuyu.

Other pasture species

CHICORY (*Cichorium intybus*)

Chicory is a relatively new species for sowing into pastures. There is a wide variation in types and distinguishing features. At present, the only commercial cultivar is Puna. It is a deep-rooted, perennial plant that is active in spring and summer and produces little during winter. Other varieties could vary significantly from this description.

Strengths: Deep-rooted. Puna is drought-tolerant and capable of providing a quality feed base during the hotter months.

Weaknesses: A very demanding grazing management strategy needs to be used to realise the full benefit from the crop.

Seasonality: Main production spring–autumn.

Varieties: Puna.

Sowing: Sow at 0.5–1 kg/ha in mixtures with ryegrass and clover. Best when sown into a clean seedbed.

Feed quality: Protein and energy are adequate for milking or fattening. Able to extract a variety of minerals and trace elements from the soil; this can be beneficial to stock health.

Diseases: None significant in Australia, although sclerotinia, a crown disease, has been noted overseas, particularly where the crop is grazed and trodden on in wet conditions.

Pests: None significant, but take precautions against earth mites at establishment.

Grazing management: Good production and persistence have been obtained from rotation grazing. A rotation involving 3 weeks' grazing followed by 3 weeks' rest is ideal. Under dairying conditions, particularly during summer, the rotation needs to be shorter to keep up with available feed, possibly 14 days. Needs to be grazed down to 15cm for best results. Ideally, chicory should not make up the entire diet for a dairy animal. Stock should have access to chicory for 3–4 hours a day following milking and then be put on ordinary pasture.

Companion species: Chicory will respond to the nitrogen made available by companion legumes such as red and white clover, strawberry clover and possibly lucerne. It can also be included in pasture mixtures, at low rates, with a variety of complementary grasses.