Dealing with sown pasture run-down

Increasing nitrogen inputs

When a paddock is first developed and a new pasture is sown, the amount of plant-available nitrogen (N) in the soil is typically higher than the pasture requires. This high level of N enables newly established grass pasture to grow a large bulk of highly nutritious forage. However, over time the amount of plant-available N decreases as it becomes tied up in plant organic matter. Therefore, N needs to be added in a plant-available (mineral) form to overcome this deficiency and boost grass production. The two options for increasing N inputs in sown pastures are:

- **applying N fertiliser**
- **adding a legume.**

Research in southern and central Queensland, where annual average rainfall is between 550 mm and 700 mm, shows that adding N to a run-down pasture will typically provide between 20 kg and 50 kg of extra grass per hectare, per kilogram of N applied per hectare.

The response depends on the amount of rainfall, how run-down the pasture is and other limiting soil nutrients. This response occurs up to a rate of 120 kg/ha of N, after which the grass continues to grow better but the response rate starts to decline.

The amount of N that can be added to the soil by legumes is directly related to how well the legumes grow. The better they grow the more N they supply. How well a legume grows depends on soil fertility, rainfall, legume variety, rhizobia and grazing management. Therefore, more N is supplied in environments capable of growing highly productive pastures (e.g. more fertile soils and higher rainfall) and by high-producing legume varieties.

The amount of N that can potentially be added to different production environments, compared to one annual fertiliser application, is shown in Table 1. Large populations of well-grown legumes are needed to contribute the levels indicated in the table, and the legume must be effectively nodulated with the right rhizobium (otherwise it will fix little to no N).

Table 1: Amount of N that can be added through the use of legumes compared with annual N fertiliser applications

Legume production	Legume growth (dry matter/ha)	Average amount of N supplied per hectare per year	Potential amount of extra grass grown per hectare per year	Value of N supplied (based on $1.30/kg N)
Low	1300 kg	20 kg	600 kg/ha	$26
Medium	2300 kg	35 kg	1000 kg/ha	$46
High	4400 kg	67 kg	2000 kg/ha	$87
N fertiliser	N/A	100 kg	3000 kg/ha	Cost: $130/ha + application

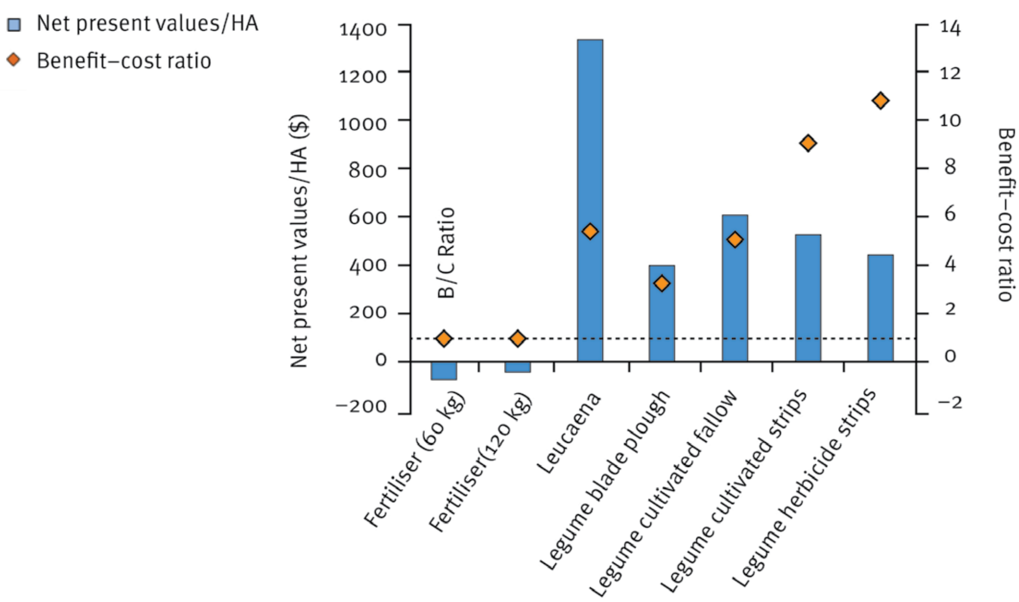

Figure 1: Economic analysis of N-cycling management options—the dotted line represents the break-even point for the benefit–cost ratio

Despite legumes being unable to match the N needs of grass to the degree that fertiliser can, the benefit they provide still makes it worthwhile including them in a pasture. Legumes biologically fix N each year, as opposed to fertiliser, which must be purchased and re-applied periodically. Legumes also provide higher quality forage for more of the year than grasses, leading to higher stock growth rates.

Economic comparisons of different run-down mitigation options over a 30-year period indicate that, despite lower N inputs and hence lower grass responses, legumes still provide better economic outcomes compared to low (60 kg/ha) or high (120 kg/ha) rates of N fertiliser if application is required each year (Figure 1).

The amount of N a legume contributes is directly related to how much dry matter it produces.

Figure 2: Response to N fertiliser on run-down buffel grass—in this case, the fertiliser used was Green Urea, broadcast on the surface

Fertiliser application

N fertilisers provide additional N to the pasture and increase plant-available soil N levels. Responses in dry matter production and protein are dramatic following N fertiliser application (Figure 2), but are also generally short-lived, with significant benefits only lasting 1–2 years. However, if high rates of fertiliser are applied over longer periods, the overall soil N pool increases, leading to increased N cycling.

The key benefit of using fertiliser is the ability to control the supply the required amount of N in a timely and targeted manner.

The largest drawback of using fertiliser is cost. Fertiliser is expensive and may only be economical for higher rainfall districts or irrigated pastures, or for special purposes such as finishing stock earlier for market premiums or for hay and grass seed production.

Adding a legume

Currently available legumes, with good agronomy and management, can potentially reclaim 30–50% of grass production lost through pasture run-down, while also providing additional nutritional benefits to livestock.

Poor commercial results from legumes are often due to poor establishment as low-cost and low-reliability techniques are typically used. The main exception is leucaena, where sound crop agronomy principles are now routinely applied in order to effectively establish this legume. Legumes must be established in sufficient numbers across the paddock to ensure a good population (≥ four plants per square metre for most legumes) with adequate soil nutrients (particularly phosphorus) and the right rhizobium so they can boost N supply and enhance grass growth and quality.

For the best results, N fertiliser needs to be incorporated into the ground, either through rainfall very soon after broadcasting or by drilling it into the soil.

Benefits of legumes

The amount of N fixed by a legume pasture is directly related to its dry matter production. An average well-grown legume pasture will fix 25 kg of N per tonne of dry matter per year, with about 10–15 kg of that cycling back for the grass to utilise. This extra N leads to more grass dry matter production and improved livestock-carrying capacities. Legumes also provide high-quality feed, which improves live-weight gains.

Increasing N levels by adding legumes is the best long-term option for economically increasing the productivity of run-down pastures. Once established, legumes can provide moderate amounts of N year after year.

Establishing legumes

The success of leucaena establishment across Queensland has identified the importance of good agronomic practices before, during and after planting. These incude:

- seedbed preparation and soil moisture storage
- reducing competition by controlling grass, weeds and trees before and after sowing
- planting at the right time of year when there is a high chance of follow-up rainfall
- grazing only once plants have grown a root mass strong enough to withstand grazing without being pulled out of the ground and have set seed (self-regenerating legumes, not leucaena).

Establishing pasture legumes is costly, so aim to do it properly the first time. You can increase your chances of success significantly by using good agronomic practices—however, failure to establish can still occur due to issues beyond your control. Pasture and live-weight gain improvements will be achieved sooner if legumes are given the best chance to establish and thrive.

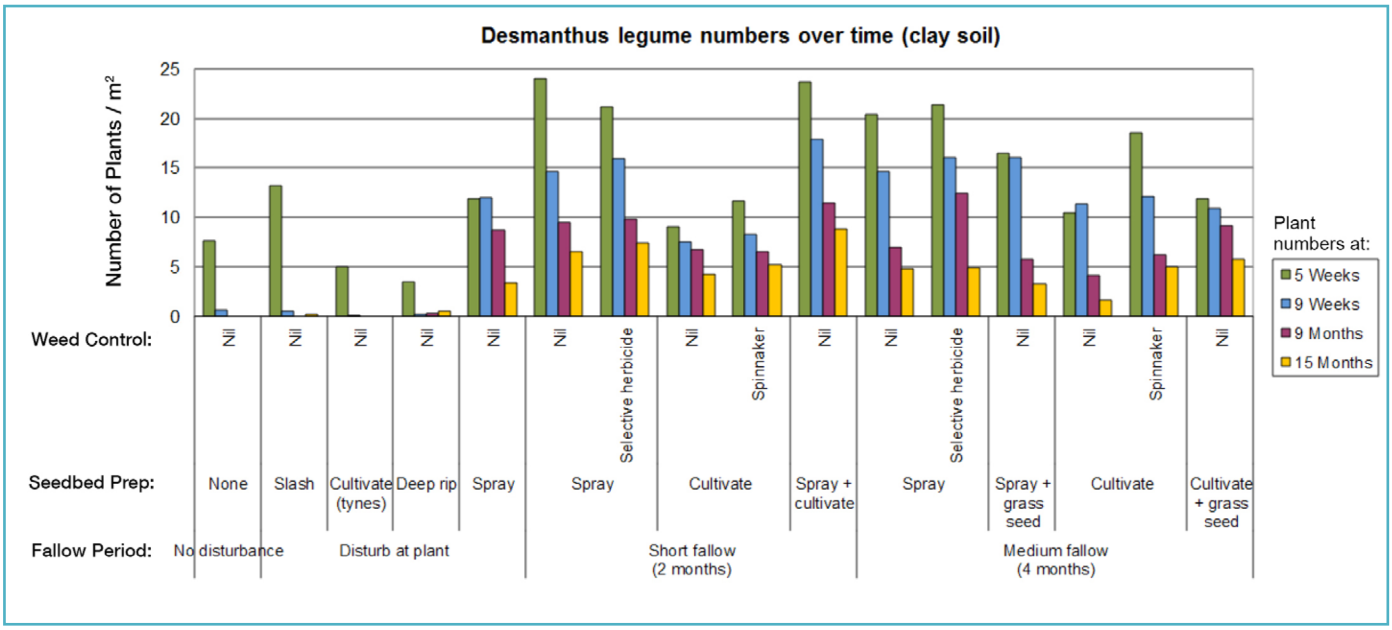

Figure 3: Benefits of removing competiton (grass and weeds) and preparing a seedbed when establishing legumes in an existing grass pasture—the longer the fallow and the more grass removed, the better the establishment

Key guidelines for establishing legumes in existing grass pastures

1. Plan ahead

Fallow the area or paddock to be planted to reduce competition, store moisture and kill grass and weeds. An entire paddock can be fallowed, or fallow strips of 4 m or greater throughout the paddock. Select correct varieties and ensure the planted area can be spelled after sowing.

2. Check soil nutrition is adequate

Some legumes have high phosphorous and sulphur requirements. If soil nutrient levels are low, plants will be stunted and grow poorly, reducing the amount of N they supply. Phosphorus fertiliser may need to be applied prior to or at planting.

3. Choose correct legume varieties for your situation

When choosing legumes, seek expert advice to determine the best species for your situation. Factors to consider are soil type and nutrition, frost tolerance, rainfall, life span (perennial or annual), long-term persistence, time of maturity and grazing management.

4. Use quality seed at recommended planting rates

Make sure the seed has been mechanically scarified and tested for germination. A germination percentage of 30–60% for small-seeded legumes provides high amounts of seed to germinate with the first rains, with some hard seed that may germinate later. If sowing into prepared seedbeds with good moisture, high levels of soft seed are needed so a higher percentage germinate with the first rain (instead of just weeds germinating).

Aim to sow at least 1 kg/ha of pure live seed, which accounts for germination and purity assessments. If using coated seed, seeding rates per hectare must increase—potentially three to five times based on the coat to seed ratio. Inoculate seed with the correct rhizobium strain for that particular legume just prior to planting.

5. Prepare a suitable seedbed

Aim to maximise seed–soil contact and reduce competition. Seedbeds can be prepared in strips throughout the paddock if the existing grass is productive. Research has shown that strips need to be a minimum of 4 m wide to reduce competition from grass outside the strip.

If the number of better grasses in the paddock are low, the whole paddock should be prepared. Hard-setting soils should be lightly cultivated or 'roughened up' to promote water infiltration and allow seed to be planted on top or just under the soil surface. Avoid very rough seedbeds with large clods, as seeds can be planted too deep (Figure4).

Figure 4: Poor seedbed (photo courtesy of Sid Cook, Queensland Murray-Darling Committee)

Soils that self-mulch (e.g. cracking clays in brigalow, open downs or alluvial landscapes) can naturally provide a seedbed and require minimal preparation. Seedbeds where the soil is fine but firm often have the best germinations.

Aim to plant small-seeded legumes on top or just under the surface (e.g. stylos), or no more than 10–20 mm deep (e.g. desmanthus). However, larger seeded legumes (e.g. leucaena, butterfly pea) can be sown deeper, down to 40 mm.

In situations where a cultivated seedbed is not achievable, spray existing pastures before planting legumes to reduce competition (preferably a couple of times) and assist with moisture storage (Figure 5).

Figure 5: Sprayed-out strips

6. Plant at the right time

Always aim to plant with good subsoil moisture, and time plantings to maximise follow-up rainfall opportunities soon after establishment.

7. Post-sowing management

The success of legumes persisting in grass pasture depends on good grazing management in the first year. Legumes should not be grazed until the seedlings have developed a strong root system. Grazing should be managed to allow legumes to set large amounts of seed. Leucaena is the exception to this rule and can be grazed once the seedlings have reached around 1.5 m in height.

More information

This fact sheet is the second in a series of three fact sheets about sown pasture run-down. For more information on other management options, refer to:

fact sheet 1—*Dealing with sown pasture run-down: symptoms, causes and management*

fact sheet 3—*Dealing with sown pasture run-down: increasing nitrogen cycling*

For more information, visit www.futurebeef.com.au or call 13 25 23.

CS4288 10/15