Technical Fact Sheet

Working with competition in pasture mixes

Resilient Pastures

Addressing the perennial questions:

1. *Are monocultures more productive than mixtures?*
2. *How to make competition and complementarity work with your pasture species choices?*

Key Messages

- Pasture mixtures can improve productivity and resilience over monocultures when species complementarity is maximised.
- Understanding which species are dominant (most productive) in your pasture is key to optimising productivity:
- Companion species that complement the dominant species can increase total pasture productivity.
- When productivity of dominant species is constrained by companion species, total productivity is often reduced.
- More species adds complexity for management.
- Simple mixtures containing 2-4 species is generally optimal. Managing for your dominant species is priority for maximising production and pasture resilience.
- Knowing the adaptive traits of the species you are sowing is important to come up with the right mix.

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Choosing pasture species

Sowing new pastures can be expensive. The aim is to spend that money well; on productive species that will persist rather than on species that may not persist and will compete for resources with the desirable, dominant species.

Pastures should produce quality biomass (i.e. are palatable in that livestock want to eat them and highly digestible in that stock can extract high energy from eating them) and be both productive and persistent. Particularly, desirable species are those with capacity to survive a dry decile 2 year, but with productive potential to produce quality biomass in a wet decile 9 year.

Pastures are a dynamic system, constantly responding to varying seasonal conditions, to fertiliser and grazing management, to pests and disease incursions and to competition with neighbouring plants and the soil organisms. Understanding ecological interactions between species, and species adaptation to your environment, can lead to better species choice, less wastage of seed and resources and a potential increase in stocking rates.

Do mixtures out-yield pure stands?

There is much research globally that has attempted to answer this question. For example, a study from North America assessed the results of 54 published experiments and found that in 38 instances, mixtures out-yielded pure stands. Averaged across all studies, the yield benefit was 12% (Jolliffe 1997). It is noted that not all mixtures out-yielded monocultures and results varied greatly.

The key message is that planting a mixture is no guarantee of increasing yields as it will depend on the circumstance; the soil environment, the species sown, management and the length of the pasture phase as productive differences can take years to emerge.

The theory

Species complementarity explained.

Species complementarity can result in an improved performance of mixtures relative to monocultures due to:

1. **Biotic feedback** — when, for example, the transfer of N from one plant to another
2. **Resource partitioning** — when plants have differing root depths or seasonal growth patterns that enables them to avoid competition with each other
3. **Abiotic facilitation** — when species interactions benefit at least one of the participants and cause harm to neither, for example mineralisation of nutrients or hydraulic lift of soil water.

Note: Species complementarity takes time to develop. Benefits are less likely in a short-term pasture.

Why we really sow pasture mixes

We sow mixtures for other practical reasons as well as to increase pasture biomass. These include:

- To manage animal health issues from grazing on a pure sward (disorders arising from mineral imbalances, toxicity, bloat etc.)
- To manage the nitrogen economy of the pasture. Legumes are an important source of biologically fixed atmospheric nitrogen for driving pasture production. Similarly, productive non-legumes are important for utilising nitrogen as it becomes available to mitigate risk of environmental degradation associated with excess N.
- Reasons can also be context-specific, such as to increase groundcover in a lucerne stand, or to better manage within-paddock variability.

Reasons for not over-complicating pasture mixes

There are many reasons that pasture mixtures should not be over-complicated:

In general, there are very few viable pasture options available to farmers for a given environment. Poorly adapted species should not be sown as they will likely not persist and can compete as the pasture is establishing. Ultimately reducing the density of the more persistent species and leaving gaps for weeds.

- **Challenges at establishment** — Different species may require different sowing times or different sowing depths, which can be difficult to manage in mixtures.
- **Seedling compatibility** — Differences in seedling vigour can lead to establishment failure of some species due to early competition.
- **Management** — The more species in a mixture, the less herbicide options are available to manage weeds.

Grazing and fertiliser management also becomes more difficult, inevitably creating biases towards or against certain species.

Understanding key adaptation features

Predicting the level of complementarity between species is difficult because their competitive advantage will change from paddock to paddock, or farm to farm. A better approach to formulating pasture mixtures is to understand the important adaptive traits of each candidate species, and then only short-list species that are likely to thrive in your paddock and under your intended management approach.

Adaptive traits of the most important pasture species in southern NSW are briefly described:

Lucerne — A deep-rooted, spring/summer growing, perennial legume. Lucerne requires a deep soil and a high level of soil fertility but can fix its own N, provided seed is inoculated with rhizobia prior to sowing. Lucerne is sensitive to soil acidity and to waterlogging and requires rotational grazing for persistence, including a rest from grazing in autumn.

Phalaris — A deep-rooted, winter-spring growing, perennial grass. Phalaris requires a moderate-deep soil, and moderate-high soil fertility, including ongoing inputs of N. Seedling phalaris is sensitive to soil acidity. Phalaris persistence benefits from rotational grazing and care should be taken to avoid allowing rank herbage to dominate the sward.

Cocksfoot — A shallow-rooted, winter-spring growing, perennial grass. Cocksfoot is tolerant to shallow soils and moderately tolerant to low soil fertility and acidity. Cocksfoot persistence benefits from rotational grazing and care should be taken to avoid allowing rank herbage to dominate the sward.

Chicory — A deep-rooted, spring-summer growing, perennial herb. Chicory requires a deep soil and a high level of soil fertility, including ongoing inputs of N. Chicory should be grazed heavily in spring to utilise available biomass and delay heading by plants, but should be rested from grazing in autumn and winter. Chicory stands are not expected to last longer than 3-4 years in most environments.

Sub clover — A self-regenerating, winter-spring growing, annual legume. Sub clover requires a moderate-high level of soil fertility but can fix its own N, provided seed is inoculated with rhizobia prior to sowing. Sub clover is tolerant of set stocking as it buries its seed and benefits from close grazing as it is sensitive to shading.

White clover — A shallow-rooted, short-lived perennial with a year-round growth habit. White clover requires a moderate-high level of soil fertility but can fix its own N, provided seed is inoculated with rhizobia prior to sowing. White clover is sensitive to moisture stress and inevitably requires seedling regeneration to persist. White clover benefits from rotational grazing. Grazing management should promote maximum seed production in spring and reduce the overburden of biomass in summer/early autumn.

Serradella — A self-regenerating, winter-spring growing, annual legume. Serradella tolerates low-moderate soil fertility and can fix its own N, provided seed is inoculated with rhizobia prior to sowing. Serradella is an aerial-seeded legume that benefits from rotational grazing and allowing the pasture to rest during spring to maximise seed production whilst also reducing shading in autumn. Cultivars with appropriate maturity and seed characteristics for reliable regeneration may not be available for all environments.

Understanding dominance hierarchies in pastures

The productivity of short-term pastures is driven largely by the dominant species. Therefore, if increased species diversity comes at the expense of the productivity of the dominant species, total biomass production of the pasture may decline.

Stated differently, increasing the productivity of minor components of the sward will generally have minimal benefit to total sward production.

The inclusion of subordinate or transient species in a pasture mixture should be to add value to the dominant species, rather than as a substitute for them. Some volunteer subordinate species or weeds such as silver grass (*Vulpia* spp.) can have a negative effect on pasture performance through the production of allelopathic compounds that can limit the growth of neighbouring species.

The theory

About dominance hierarchies.

Pasture communities are generally made up of species that take on different roles in that community:

Dominant species — The most abundant and productive species within the pasture sward (e.g. Phalaris or lucerne)

Subordinate species — Smaller in stature, occupy microhabitats (e.g. Strawberry clover)

Transient species — Often exist primarily as juveniles reliant upon seedling regeneration (e.g Sub clover)

Mass ratio theory states "Ecosystem functioning... is largely controlled by the dominant species..." (Grime 1998)

Example: Phalaris/sub clover

Phalaris is the dominant species; sub clover is transient. Sub clover fixes N to increase Phalaris biomass. Sub clover is also a high-quality forage, helping livestock better utilise the bulk of Phalaris dry matter.

Management to improve sub clover production, such as increased soil P fertility, will not constrain Phalaris growth and is encouraged.

Other management, such as excluding Phalaris from some drill rows to give the clover more space, is not encouraged as it often leads to lower overall pasture production.

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