Abstract: The risks of sowing a new pasture has little impact on the profitability of sowing a permanent pasture across a range of stocking rates. Sowing perennial pastures does increase gross margins and reduce risk, as long as stocking rates don't increase too much and the sown pastures species persist. The sequence of years, in terms of gross margins achieved, following the establishment of a pasture influences profit and the optimal replacement time for the sown pasture. High stocking rates on new sown pastures increases short term profits, but also decreases pasture persistence and increases economic risk. The net result is reduced long term profit, more risk and less persistent pastures. Due to the need for rapid differentiation between Farmlets A (sown species & high soil fertility) and B (some sown species & moderate soil fertility), Farmlet A has been operating inefficiently. To optimise Farmlet A's management and profitability in the future, the previously sown pastures must be managed for persistence.
Optimisation of pasture improvement
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Summary

- The risks of sowing a new pasture has little impact on the profitability of sowing a permanent pasture across a range of stocking rates.
- Sowing perennial pastures does increase gross margins and reduce risk, as long as stocking rates don't increase too much and the sown pastures species persist.
- The sequence of years, in terms of gross margins achieved, following the establishment of a pasture influences profit and the optimal replacement time for the sown pasture.
- High stocking rates on new sown pastures increases short term profits, but also decreases pasture persistence and increases economic risk. The net result is reduced long term profit, more risk and less persistent pastures.
- Due to the need for rapid differentiation between Farmlets A (sown species & high soil fertility) and B (some sown species & moderate soil fertility), Farmlet A has been operating inefficiently.
- To optimise Farmlet A's management and profitability in the future, the previously sown pastures must be managed for persistence.

Sowing success - its impact on profit

Based on GrassGro modelling calibrated by the data from the Cicerone Project Farmlets A and B, in 90% of seasons the possible risks of sowing a new pasture has little impact on the profitability of sowing a permanent pasture. Average gross margins are used in Table 1 at different stocking rates to show the impact of sowing success (time to first grazing) on the profitability (or Net Present Value) of sowing a pasture.

<table>
<thead>
<tr>
<th>Time to first grazing</th>
<th>Post-establishment Stocking Rate (Merino Ewes/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.8</td>
</tr>
<tr>
<td>64 weeks</td>
<td>$364</td>
</tr>
<tr>
<td>Average - 22 Weeks</td>
<td>$505</td>
</tr>
<tr>
<td>20 weeks</td>
<td>$510</td>
</tr>
</tbody>
</table>

Sown pastures: making them earn their keep

The successful sowing of a pasture is only part of the story. How hard pastures are made to work once established interacts strongly with their persistence, their potential for generating dollar returns and the associated production and financial risk.

Figure 1 indicates that there is an expected increase in gross margin per hectare with increasing post-estabishment stocking rates. There is also increasing risk (or variations in the returns) from the higher stocking rates. The results from this suggests Farmlet B will on average (a combination of 3.8 merino ewes/ha on both unimproved and sown pastures) be less profitable than Farmlet A, but with similar levels of risk.
Table 2 shows how climate risk over the life of the sown pasture, through its influence on sowing success and gross margins, determines the profitability (Net Present Value) of establishing an improved pasture at various post establishment stocking rates.

This represents the maximum profit that can be reached over an infinite planning period, which means that pastures are only replaced when long term profit over successive pasture sowing-degradation cycles is maximised. The optimum post-establishment stocking rate is in the vicinity of 6 merino ewes per hectare (11.9 DSE/ha), but this will also depend on the level of risk a producer is willing to accept.

Table 2 also shows the average proportion of sown species still remaining in the established pasture at the optimal replacement time. Although there is little difference between the higher stocking rates, it indicates that if the profits from increasing post-establishment stocking rates are high enough, it may be more profitable to replace degrading pastures more frequently and at much higher proportions of sown species than is usually done in practice.

This requires considerably more in-depth research as the generalised rates of pasture degradation used in this study do not adequately describe the sometimes dramatic influence climate and grazing management have on the persistence and production of sown species.

Table 2: Influence of post-establishment stocking rate on maximum average profit (NPV) from sowing pastures and the average proportion of sown species in the pasture at the optimal replacement time.

<table>
<thead>
<tr>
<th>Post Establishment Stocking Rate (Merino Ewes/ha)</th>
<th>Average Profit (Net Present Value - $/ha)</th>
<th>Risk (Standard Deviation - $/ha)</th>
<th>Average Proportion of sown species</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.8</td>
<td>$552</td>
<td>$69</td>
<td>30%</td>
</tr>
<tr>
<td>6</td>
<td>$847</td>
<td>$136</td>
<td>50%</td>
</tr>
<tr>
<td>8</td>
<td>$695</td>
<td>$260</td>
<td>47%</td>
</tr>
<tr>
<td>10</td>
<td>$186</td>
<td>$366</td>
<td>45%</td>
</tr>
</tbody>
</table>

Is there too much of a good thing when it comes to pasture improvement?

Farmlet A has undergone high rates of pasture improvement over the last 6 years. In the vicinity of 20% of the farmlet has been sown to improved species per annum from 2000 to 2004. Figure 2 demonstrates the trade-offs between profit and risk for different combinations of management strategies, that is, a 'post-establishment stocking rate' (SR) and 'pasture improvement rate' (PIR) combination.

The frontier, shown graphically by a solid line, defines the combinations of risk (standard deviation of NPV) and profits (NPV) under different choices of SR and PIR where management is efficient. Management combinations that are not on the frontier have higher levels of risk and lower profit (i.e. are stochastically inefficient). Figure 2 shows that if Farmlet A reduced its PIR from 20% per annum to around 4% per annum it would operate on the risk-efficient frontier. This would then allow a fair comparison between the farmlets at a similar level of stochastic efficiency. The Cicerone Board's decision to quickly modify the pasture composition on Farmlet A over an unusually and perhaps un-realistic short period has meant that Farmlet A has suffered financially relative to Farmlet B. Thus economic comparisons between the two systems should be made with care.

Figure 2: Risk-efficient frontier for a self replacing Merino ewe flock specified in terms of post-establishment stocking rate and pasture improvement rate (SR, PIR%). Average Profit represents expected NPV with Risk being the standard deviation of the NPV.

Future Research work to provide more conclusions:
- Describe the relationship between pasture persistence and climate, soil fertility and grazing management more accurately.
- Develop a method that defines the optimal development path for a grazing business when technologies interact and risk is taken into account.