final report

FEEDBASE AND PASTURES

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Prepared by: Dr Jim Virgona

EH Graham Centre &

School of Agricultural and Veterinary Sciences

Charles Sturt University

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Getting More by Sowing Less

Abstract

A paddock survey was conducted to determine the consequences of sowing diverse pasture mixes in terms of species persistence and pasture composition. The survey covered 61 paddocks on 34 farms in rainfall environments from 550 to 950 mm per annum in the permanent pasture country of the south-west slopes of NSW. The median number of species sown was 5 and the median number found (at appreciable levels) was only 2. The two most persistent species were phalaris and sub clover. Further analysis demonstrated that including other perennial grass species in the mix with phalaris had a negative influence on the contribution of phalaris to feed on offer. Hence, farmers who adopt a more simple approach to sowing pasture mixes will reap rewards through lower up-front pasture establishment costs (on average $26.60/ha) and a more resilient phalaris component in their pasture. The industry must work to ensure that advice on the sowing of pasture species is evidence-based. In addition, if species are to be sown in mixes, then perhaps they should also be evaluated under those conditions.

Executive Summary

Farmers routinely sow many species when establishing a new permanent (> 15 years?) pasture. There is little published evidence that underpins this practice. Moreover, there is considerable anecdotal evidence that most of the species sown do not persist over the long-term. A survey was carried out in southern NSW to determine whether this practice has any merit. These complex, or “shotgun”, mixes may also have a detrimental effect on pasture composition. Those species that do not persist may compete with those that do, leading to a poorer outcome if they had never been sown at all. It is in this sense that we ask whether farmers can get more by sowing less.

The survey covered 61 paddocks on 34 farms in the south-west slopes of NSW. Most farmers were contacted after having their names published as having sold stock in local newspapers. Farmers were asked to nominate two paddocks – one sown in the last 5 years and another in the last 5-15 years for which they had reliable records. In spring (October – early December) each paddock was visited. Firstly the farmer was interviewed to obtain management data and then the paddock was analysed. Both frequency of sown species and overall botanical composition were measured in each of the paddocks. In addition, soil was collected from the paddock for analysis of phosphate and pH.

The survey sowed that most commonly paddocks were sown to 5 species but only two could be found at levels where they did (or potentially could) appreciably contribute to paddock productivity. The two most persistent species were phalaris and sub clover. Other species such as cocksfoot, perennial ryegrass and white clover were not present at appreciable levels in over 70% of paddocks in which they had been sown. The conclusion from this section of the survey was that farmers are wasting their money sowing species that do not persist. On average this amounted to $26.60/ha extra over the amount that would be spent if only the two most reliable species were sown. Farmers can directly benefit from these results by adopting a more cautious approach when establishing new permanent pastures and sowing only those species that have proven persistence.

The extent to which sowing a “shotgun” mix affected the contribution made by the phalaris component was also investigated. Phalaris was the most common perennial grass species sown and the life of a pasture is more or less determined by how long the phalaris component persists. Therefore, the entire range of recorded establishment, management and locality factors recorded were analysed to se what effect they had on the contribution to feed on offer made by phalaris. Three factors were identified. Soil phosphate had a positive influence on phalaris and paddock size had a negative influence. Of more relevance, the weight of phalaris seed sown as a proportion of the total perennial grass seed sown was positively related to the percent phalaris found in the pasture. This means that if other perennial grasses were included in the sed mix, they had a negative influence on the productivity of the most persistent perennial grass species, phalaris. Hence, farmers not only waste money up-front by sowing “shotgun” mixes but this also had detrimental effects on the highly persistent species.

Producers will be the main beneficiaries of this research as they seek to contain costs of pasture establishment and reduce the payback period for their pasture dollar. However two

caveats should be applied. Firstly, the results reflect conditions in the south-west slopes only and may not be relevant in other environments (eg. Northern tablelands, coast). Secondly, the results are based on cultivars that have been released over the last 5-50 years and may not apply to some more recently developed types (particularly cocksfoot and tall fescue).

Contents

1 Background

Managers in the higher rainfall zone of south-eastern Australia are routinely advised to sow complex mixtures of pasture species (up to 10). Anecdotal evidence suggests that only a few of these species survive the first two years. The inclusion of non-persistent species represents a significant proportion of the cost of pasture establishment. Moreover, it is likely that competition (from the non-persistent species) early in the life of the pasture may reduce the potential of the most persistent species to dominate the sward over the life of the pasture. In other words, the non-persistent species leave gaps which the persistent ones do not completely fill. This is particularly the case with reliable species like phalaris which has virtually no capacity to regenerate from seed in a pasture. Hence, the consequences of the initial management of a newly-sown pasture may have long-term consequences on the productivity of livestock systems.

In terms of cost and sustainable production these complex mixes may well be detrimental to the efforts being made to establish perennial pastures in the higher rainfall zone. Encouraging farmers to sow these pastures in an effort to reduce dryland salinity needs to be made on the basis of objective information on species persistence on-farm.

2 Project Objectives

The original objectives of this project were:

1. to determine the consequences (in terms of botanical composition) of sowing diverse pasture mixes by July 2006.
2. using survey and experimental approaches to provide information on the role of niche in determining pasture composition.

However, it was decided to put more emphasis on the survey component and not to enter into an experimental program as this would not yield results in the short-term life of the project

3 Methodology

Previous experience with random selection of paddocks had proved to be costly and extremely time consuming. While sample selection based on random generation of map coordinates is the least biased approach to take, the difficulty in identifying and then contacting landholders based on this information proved too expensive. Instead, selection of landholders was performed by utilising published lists of stock sales in local papers. Landholders who lived within the target area (> 550 mm annual average rainfall, south west slopes, NSW) were randomly selected from these lists and approached to cooperate with the survey, few declined. One pre-requisite of involvement in the survey was that the landholder had to have reliable records of pasture establishment. If this could not be guaranteed then the landholder was rejected as a participant (politely!). Overall, 34 landholders were successfully contacted in this manner and 2 extra landholders that were involved in other projects run by the chief investigator were also included. Between these 34 farms, 61 paddocks were selected. Selection was unbiased in that landholders were asked to nominate paddocks that they had sown to improved pastures in either the last 1-5 years of 5-15 years. Most could only nominate1 or 2 in either category which were then randomly selected by the survey team. In this way all paddocks were surveyed in the spring (starting in October) of 2005.

Having nominated potential paddocks for the survey, the landholder was then interviewed regarding establishment and management practices of the paddock. The interview sheet can be found in Appendix 1. The establishment factors considered were:

- Pre-establishment history
- Species and cultivars sown, and their rate
- Paddock preparation – cultivation, herbicide
- Fertiliser, lime at sowing or prior
- Sowing technique – direct drill, conventional, cover crop etc.

Management and site factors considered were:

- Fertiliser use since sowing
- Grazing management
- Stocking rate
- Herbicide, insecticide
- Rainfall

Once in the paddock the botanical survey took place. A draft version of the methodology was presented in the Milestone 1 report (Appendix2). However, there were significant variations to the methodology which will be explained here. Points were sampled along two perpendicular transects in each paddock. One was located to cover the maximum range of landscape variation in the paddock, the other was placed perpendicular to the first approximately halfway through the paddock. Along each of the transects (avoiding unsown areas, under trees, among rocks), 50 equally-spaced samples (quadrats) were assessed for botanical composition (using the dry-weight rank method), feed on offer (visual score), frequency of sown species, landscape class, and GPS coordinates. In addition, soil samples were taken at (usually)16 of the sample points and bulked for chemical analyses (pH, phosphorus). Care was taken to avoid unsown areas within the paddocks (rocky outcrops, under trees etc.) as these would bias the results.

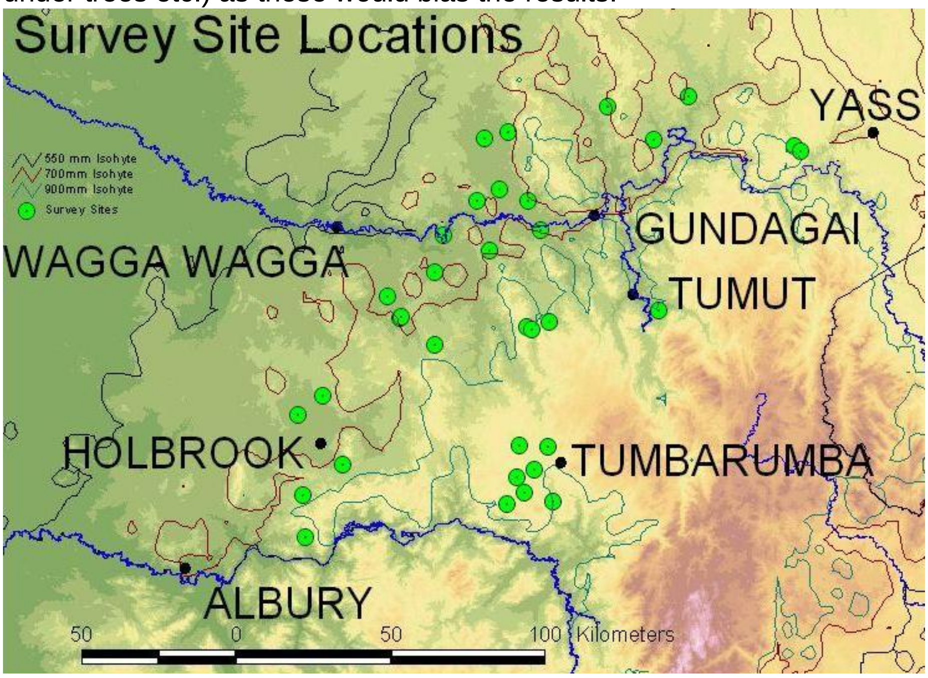

Figure 1. Site locations. Green dots represent the location of farms in the survey.

4 Results and Discussion

4.1 General

Overall, 34 farmers were contacted and 61 paddocks surveyed. The locality of each of the surveyed paddocks is shown in Figure 1 (page before). For the most part, the paddocks surveyed covered as much variation in rainfall, altitude and locality as time would allow. To get a general impression of the range of most of the non-botanical variables recorded, a frequency distribution of all the surveyed paddocks is presented in Table 1. In summary this data combined with some simple overall statistics, indicates that:

- 46 of the 61 paddocks had been **sown** since 1990. Of those sown before this date the oldest was sown in 1967.
- While there was a range in **paddock sizes** (from 9 to 99 Ha), most paddocks were between 15-45 Ha with a median size of 25 Ha
- The distribution of estimated (from the farmer) **annual rainfall** shows that most paddocks were located in the 600-800 mm zone
- Taking an acceptable level of **phosphate** (Olson) to be 16 mg/kg, the majority of paddocks (39) had values lower than this. However, the median Olson P was 13.7 mg/kg, indicating that paddocks were regularly fertilised.
- **pH** was low across the paddocks with only 5 paddocks having values greater than 5. The soil sampled for pH was taken from the top 10 cm and while surface pH may have been low this does not reflect the levels deeper in the soil profile.
- Regarding **sowing method**, most paddocks had been direct-drilled, few conventionally sown (cultivation followed by seeding) while, surprisingly, 16 paddocks had been cover-cropped (pasture sown beneath (in all cases) a cereal crop.
- Most farmers relied on **advice** on pasture establishment from sources that were “off farm” particularly private consultant agronomists and resellers.
- The number of **species sown** in each paddock varied from 2 to 8. The median number was 5 (more on this below).
- **Grazing management** was evenly split between paddocks that were continuously grazed or set stocked (30) and those that had been grazed with some form of regular/irregular rest (29). Grazing management was not recorded for two of the paddocks
- **Carrying capacity** was estimated by farmers for the life of the pasture. Median carrying capacity was 10-15 DSE/ha but this varied widely depending on location and landscape.

4.2 Species and Cultivars Sown

The paddocks surveyed covered a broad range in terms of species and cultivars sown. The number of paddocks sown to species and cultivars is presented in Table 2. The two most widely sown species were subterranean clover and phalaris both of which were sown in over 50 paddocks. Many paddocks were also sown to cocksfoot (42), perennial ryegrass (30) and white clover (41). Beyond these species others were sown but in comparatively few paddocks. It is interesting to note that phalaris pastures were mostly sown to cultivars *Australian* and *Holdfast.* The former cultivar has been available for many decades. In contrast, farmers have mostly opted for more recent cultivars of sub clover as three of the most commonly sown cultivars (Goulburn, Leura and Riverina) have been released since 1992.

Table 1 Frequency distribution of all the paddocks for a range of recorded management and paddock factors. The frequency (F) occurs in the right hand column of each section. Note: *Rain* is an estimate of the annual average rainfall from the farmer; number of paddocks may not always sum to 61 as the variable may not have been available for all paddocks

Year Sown	F	Paddock Size (Ha)	F	Annual Rainfall (mm)	F	Olsen P (mg/kg)	F	pH ($CaCl_2$)	F
<1985	2	< 15	13	< 600	7	< 8	9	< 4.1	5
1985-90	0	15 - 30	22	600 - 700	25	8 - 12	11	4.1 - 4.4	20
1990-95	13	30 - 45	15	700 - 800	13	12 - 16	19	4.4 - 4.7	18
1995-00	32	45 - 60	3	800-900	9	16 - 20	10	4.7 – 5.0	13
2000-05	14	> 60	8	> 900	7	>20	12	> 5.0	5

Sowing Method	F	Source of advice	F	No. species sown	F	Grazing Management	F	Stocking Rate (DSE/Ha)	F
Direct Drill	38	Consultant	35	2	5	Set Stocked	11	< 5	5
Conventional	7	DPI	2	3	11	Continuous	19	5 - 10	11
Cover Crop	16	Retailer	10	4	14	Intermittent	5	10 - 15	25
		Self	14	5	19	Strategic	11	15 - 20	14
				6	9	Rotational	13	> 20	4
				> 6	3				

Table 2 Number of paddocks sown to each species and cultivars. In some cases farmers were not certain of the cultivar sown and these are recorded as *NA* (not available).

Species		*Cultivar*		**Species**		*Cultivar*	
Phalaris	**53**	*Australian*	33	**Cocksfoot**	**42**	*Porto*	33
		Holdfast	26			*Currie*	10
		Sirosa	13			*Uncertain*	4
		Uneta	6			*Tekapo*	1
		Sirolan	2			*Warrior*	1
		Australian II	2			*Wana*	1
		Maru	1			*Condor*	1
Perennial Ryegrass	**30**	*Victorian*	10	**Tall Fescue**	**12**	*Triumph*	3
		K. Valley	10			*Quantum*	3
		Lincoln	6			*Demeter*	3
		Fitzroy	2			*Flecha*	2
		Extreme	2			*Resolute*	1
		Superior	1			*NA*	2
		Ellet	1				
Sub clover	**56**	*Goulburn*	25	**Sub clover**	**56**	*Karridale*	4
		Leura	13			*Mt Barker*	2
		Riverina	11			*Woogenellup*	2
		Gosse	11			*Larisa*	1
		Junee	9			*Esperence*	1
		Denmark	7			*Seaton Park*	1
		Trikkala	7			*Not recorded*	4
White clover	**41**	*Haifa*	33	**Strawberry clover**	**16**	*Upward*	4
		Tahora	14			*NA*	12
		Demand	1				
		Prefect	1	**Balansa**	**10**	*Bolta*	4
		Bounty	1			*NA*	6
		Tamar	1				
		NA	1	**Red Clover**	**1**	*Hamua*	1
Lucerne	**5**	*Aurora*	5	**Arrow leaf**	**2**	*Zulu*	2
Chicory	**2**	*Puna*	2	**Puccinellia**	**1**	*NA*	1
Tall Wheat Grass	**1**	*NA*		**Other Ryegrass**	**3**	*Concord*	2
						Tetila	1

4.3 Measuring Persistence

Before considering which of the species persisted, it is worth considering how persistence can be measured. Two measurements were taken in the current study. Firstly, quadrats were placed in the paddock 100 times. Each time any of the sown species (these were already known, as farmers had provided this information before the measurements were taken) were found in the quadrate, it was recorded. The measurement is then expressed as a percentage and will be referred to as the **frequency**. Simply, it is a measure of how often that species is encountered across the paddock and does not tell us how abundant (in terms of dry matter or % feed on offer) a species is. Hence, the second measurement was **botanical composition**. This was measured using the dry-weight rank method which simply relies on a ranking of the first 3 species as estimated by the observer in order of standing dry matter. This is then calculated using a standard formula and expressed here as % feed on offer. Therefore it is possible for a species to be present (have a frequency score above 0) but not contribute to the biomass (ie never rank in the top 3 species in any quadrat).

So a key question to address is, what measure should we use to determine persistence? This can best be addressed by considering the relationship between frequency and botanical composition for a set of species (Figure 2). Regardless of species, it is clear that the percent contribution to feed on offer varies widely only at relatively high frequencies. For example, at a frequency of 80% the contribution of phalaris to dry matter appears to range from 10% to 70%. In other words a species may be frequently found but not be contributing much to the feed on offer. Reasons for this could include both seasonal conditions and management factors (eg. fertiliser, weed control, grazing). If conditions change then it is possible that a frequent species contributing little to feed on offer may increase substantially. On the other hand, species with low frequency (say 10%) make little contribution to feed on offer in any circumstance. Considering this and other data, it appears that above a frequency of about 30% that there is a distinct rise in the range of % feed on offer that can be found.

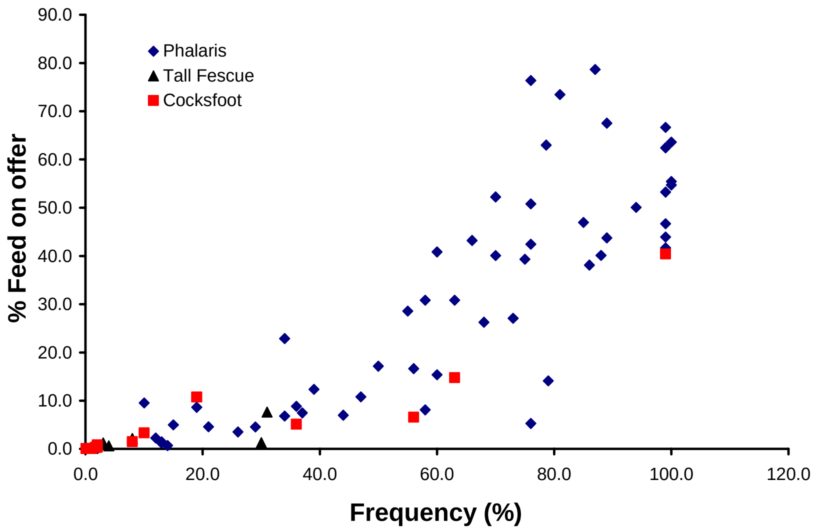

Figure 2 Relationship between botanical composition (as a % of feed on offer) and frequency found in the survey. Points represent individual quadrats.

In summary rather than rely on botanical composition alone, as it may be a function of seasonal and paddock factors that change, frequency is also used to determine whether a species has the potential to still contribute to feed on offer in a particular paddock should circumstances change. Therefore, three key measurements of persistence for each species are presented:

- *Found* - whether a species was found at all in the paddock – this may be as low as in only one out of one hundred quadrats!
- *30% frequency* – present at greater or equal to this frequency
- *5% feed on offer* – this is an arbitrary figure but below which no frequently found perennial grass occurred at. Put another way, it is difficult to imagine species providing much value to the pasture at below 5%!

4.4 Persistence

4.4.1 Number of species found

The median number of species sown was 5 whereas the median number found (at all, i.e. above a frequency of 0%) in the paddock was 3 (Fig. 3 a). While 5 species were sown in 20 out of 61 paddocks, all 5 species could only be found in only four of the paddocks. Considering the level of 30% to be adequate for current of potential contribution to paddock productivity, the median number of sown species to reach this level was 2 (see Fig. 3b). If, on the other hand, a benchmark of 5% feed on offer is set based on the spring 2005 results, then the median number of sown species that exceeded this level was one. However, Figure 3c reveals that there were many paddocks where two of the species reached this level.

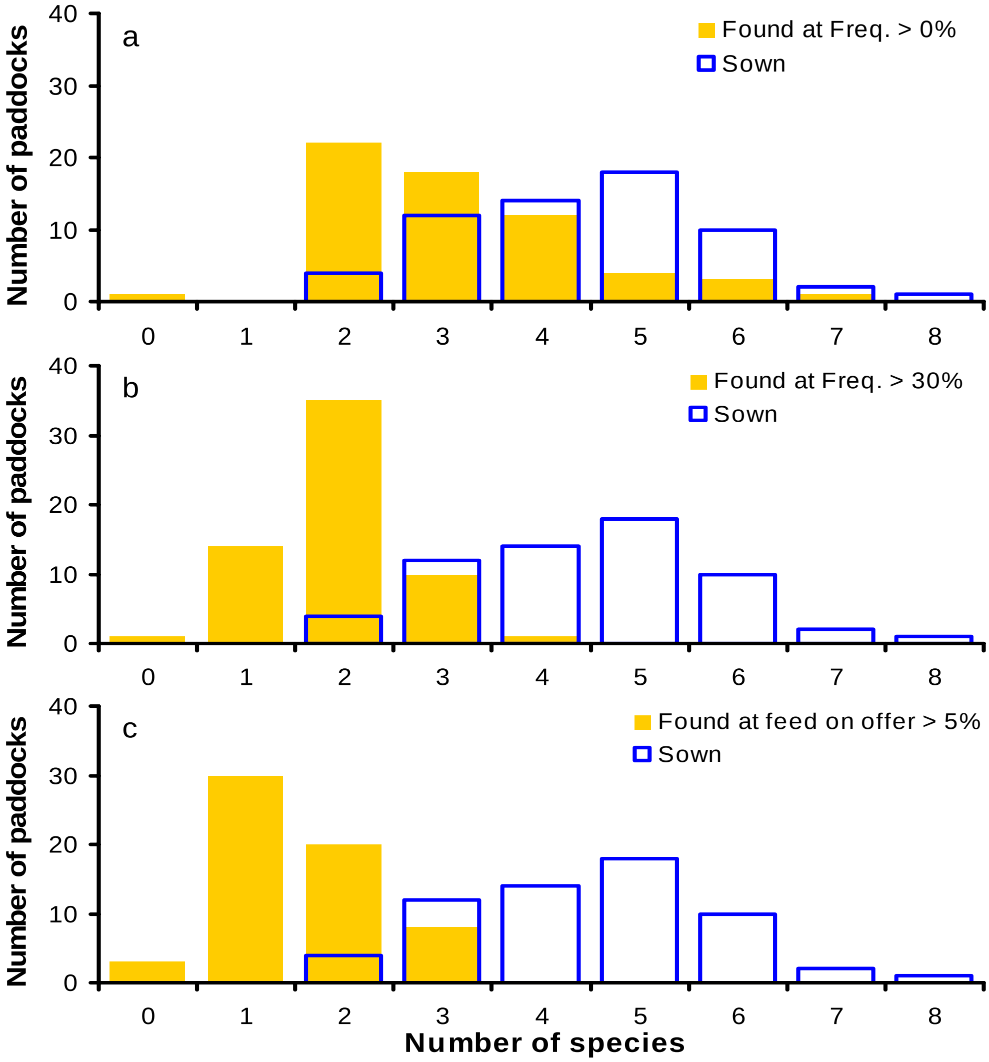

Figure 3 Frequency distribution of the paddocks sown to the range of species sown and (a) number of paddocks where the sown species were found at all (frequency > 0); (b) number of paddocks where the sown species were found at a frequency of > 30%; and (c) number of paddocks where the sown species contribute to feed on offer at a level > 5%.

4.4.2 Species

When expressed as a percentage of the paddocks sown to each of the species, the results indicate that two species, phalaris and sub clover were by far the most frequent species found in the paddocks in which they had been sown (Fig. 4). While other species were sown (Table 2) only those sown in 10 or more paddocks are presented in Figure 4. It is interesting to note that in a significant percentage of paddocks, a sown species may not have even been found (frequency > 0%). This was particularly the case for white clover, perennial ryegrass and tall fescue.

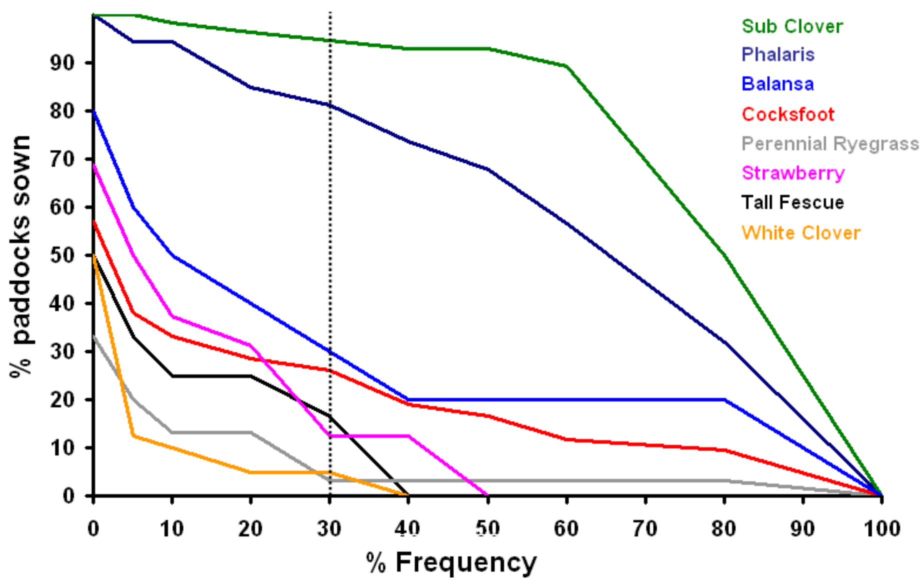

Figure 4 The percentage of paddocks sown to a particular species at various frequency levels for that species. The dotted line represents 30% frequency (see text).

The results can also be presented in terms of botanical composition instead of frequency. Similar conclusions can be reached as with frequency at 30% (Figures 4 and 5). Only phalaris and sub clover reach a level of 5% feed on offer in over 50% of paddocks sown. Interestingly, sub clover is frequently found but contributes little to feed on offer. This explains why the median number of species found at feed on offer > 5% was only one, usually phalaris. This may have been due to seasonal/management conditions in particular as it is widely accepted that abundance of sub clover may significantly vary between years. For all other species none contribute more than 5% to feed on offer in over 30% of the paddocks sown to that species.

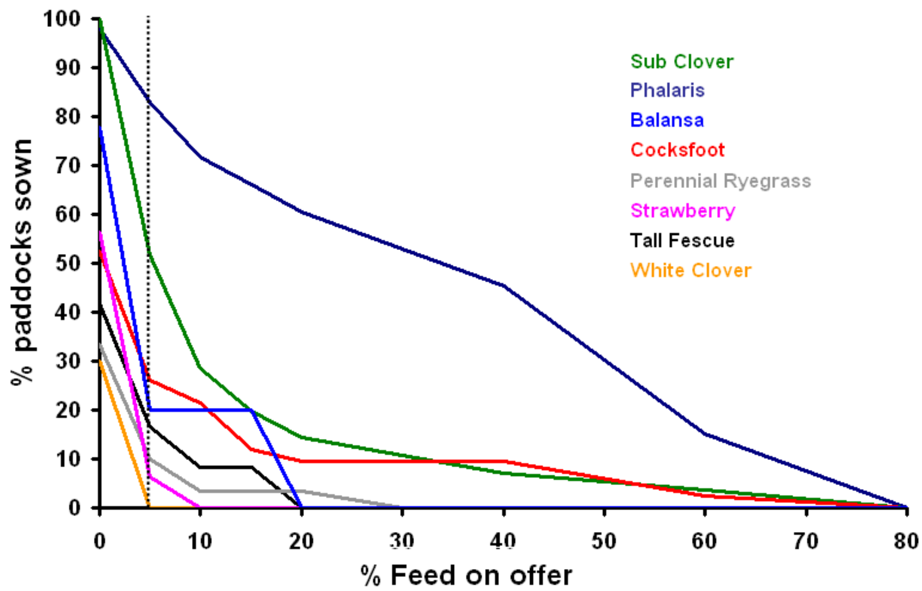

Figure 5. The percentage of paddocks sown to a particular species at various levels of the % feed on offer for that species. The dotted line represents 5%

It is convenient to tabulate the data for the key persistence criteria (Table 3). For completeness all species are shown but not much can be concluded about the bottom set of infrequently sown species. It is striking that cocksfoot, perennial ryegrass and tall fescue could not be found in a substantial proportion of the paddocks where they were sown (43%, 67% and 50%, respectively). Likewise, white clover was sown in 41 of the 61 paddocks but contributed to over 5% feed on offer in none.

Table 3 Species persistence in sown pastures

Species	Number Paddocks sown	Paddocks sown (%) with: Frequency > 0%	Frequency > 30%	Feed on offer > 5%
Phalaris	53	100	81	83
Cocksfoot	42	57	26	26
Perennial Ryegrass	30	33	3	10
Tall Fescue	12	50	17	17
Sub clover	56	100	95	52
White clover	41	50	5	0
Strawberry clover	16	69	13	6
Balansa clover	10	78	20	20
Lucerne	5	20	20	20
Arrow leaf	2	0	0	0
Chicory	2	50	0	0
Red Clover	1	100	0	0
Tall wheatgrass	1	100	0	100
Puccinellia	1	100	0	0

4.5 Establishment, Management and Pasture Composition.

As presented above, phalaris and subterranean clover were the two most frequently found of the species sown. One objective of this study was to determine whether sowing a number of species that do not persist harmed the composition of the pasture. It is possible that "gaps" left in the pasture may be colonised by undesirable species and lead to lower long-term productivity. Given that phalaris was the dominant perennial grass, the most relevant approach is to examine what possible influence any of the management and establishment practices had on contribution (%) to feed on offer made by this species.

Only paddocks sown to phalaris could be included in this analysis. In addition 4 paddocks about which the information was not complete have been excluded. The approach taken was to use multiple regressions to isolate those variables that had an influence on the amount of phalaris in the pasture. The range of variables included all the establishment, management, location and paddock factors that had been recorded, these included:

- annual rainfall (mm)
- paddock size (ha)
- year sown

- number of species sown
- pasture sowing rate (total, kg/ha)
- phalaris as a proportion of total pasture sown (by weight)
- phalaris as a proportion of total perennial grasses sown (by weight)
- number of species to have been lost from the pasture
- sowing method (cover crop versus no cover crop)
- soil phosphate (mg/kg, Olson)
- soil pH (in $CaCl_2$)
- grazing management (continuous versus some form of rest)
- stocking rate (DSE/ha, six classes from < 5 DSE/ha to >20 DSE/ha)

Three of these variables were found to significantly ($P < 0.001$) influence the proportion of phalaris found in the pasture. These were, paddock size (SIZE), soil phosphorus (SOIL-P) and phalaris as a proportion of the perennial grasses sown in the seed mix ($Phal/PG_{sown}$). The model that explained 27% of the variation in the proportion of phalaris in feed (%PHALARIS) on offer was:

$$\%PHALARIS = 7.5 + 1.19 * SOIL\text{-}P + 31.9 * Phal/PG_{sown} - 0.297 * SIZE$$

with the exception of the constant, each of the three parameters (SOIL-P, SIZE and $Phal/PG_{sown}$) was significant at $P < 0.05$). Care must be taken in the interpretation of this relationship as it relates specifically to the 51 paddocks from which it was derived. Nonetheless, while it only explains 27% of the total variation in %PHALARIS, this was still highly significant. The extent to which the parameters (as estimated in the multiple regression) apply outside this data set is questionable. Hence, it is most useful to take a mainly qualitative approach to interpreting the data. The direction of the parameters (positive for SOIL-P and Phal/PG and negative for SIZE) are important. That soil phosphate level was related to the contribution made by phalaris to feed on offer is not surprising. Phalaris is known to respond to phosphate supply and little needs to be added here. Paddock size was negatively related to phalaris composition. There is no simple biological explanation for why such a relationship could exist. It is possible, however, that the influence of paddock size reflects other management factors to do with paddock landscape and management that may have favoured phalaris more in smaller paddocks. Some of these factors could have been – weed control, grazing management, control of stocking rate, soil factors (larger paddock may have included more rocky or hilly areas).

The positive relationship between the amount of phalaris in the sowing mix as a proportion of all perennial grasses sown (Phal/PG) and the contribution of phalaris to feed on offer is a key result of the survey. This clearly points to the potential negative consequences of including other perennial grasses (which in most cases did not persist) in the seed mix.

4.6 General Discussion and Recommendations

4.6.1 Caveats

Before considering the meaning of these results it is worthwhile to consider two main issues. Firstly, the results reflect the characteristics of those species *and* cultivars that were sown in the paddocks surveyed. A recurring theme in the foregoing discussion will be the lack of fitness of many of the sown species. How much persistence is related to edaphic factors (eg. Soil pH) or climatic factors is unknown. However, many of the species (particularly white clover and perennial ryegrass) have been sown in areas that are well outside what NSW DPI currently recommends. For instance white clover is recommended to be sown in areas with "750 mm with summer incidence" (Betts and Ayres 2004) and perennial ryegrass at "700 mm (southern NSW)" (Lowien, Kemp and Launders 2004). Applying these recommendations to the data set, 21 out of 41 paddocks sown to white clover do not on average receive the recommended amount of rainfall and similarly for 15 out of the 30 paddocks sown to perennial ryegrass. These recommendations are general ones made for the species as a whole. However, within some species there is sizeable variation in important fitness characteristics such as summer dormancy. This is particularly the case with tall fescue and cocksfoot. Both species have cultivars that have recently (0-8 years) been commercially released. These cultivars were not encountered in many paddocks. Therefore, the first major caveat is that new cultivars and species that have been recently released and have greater fitness than older cultivars (eg. the summer dormant fescues versus the non-dormant, Demeter/Triumph types) may still be of use in permanent pastures. Remembering that the key determinant of "usefulness", in this sense, is demonstrated long-term persistence.

The regional nature of the research means that extending the results to regions with different soils/climate is hazardous. The climate of the south-west slopes of NSW is best described as summer-dry/winter-wet. Although in many locations rainfall is nearly evenly distributed throughout the year, the higher temperature and large vapour pressure deficits over the summer months means that soil moisture is often limiting. In other environments that receive greater amounts of summer rainfall with lower temperatures (eg. Northern tablelands of NSW), then it is possible that a larger number of species could persist. Hence, the second caveat is that it would be unwise to extend the results of this study into other climatically distinct regions.

4.6.2 Cheaper Establishment

The results presented in figures 3b and 3c make it clear that while farmers may sow many species, only two will meaningfully contribute to the pasture. By obtaining seed prices for most of the cultivars sown (and approximating the cost of those for which a price could not be found – using the closest type of cultivar), the total cost of seed sown in each paddock has been estimated for all but 4 paddocks (for which growers were unable to supply the sowing rates). It is not possible to relate cost of sowing to number of species sown. This would make sense if all species were sown at the recommended rate but this was not the case (eg. Cocksfoot as high as 14 kg/ha!). One way to come to analyse the extent to which farmers are wasting their money sowing species that do not persist is to compare the cost of sowing their pasture versus a simple mix of 2 phalaris cultivars and three sub clover cultivars. This was done assuming that the phalaris cultivars Australian and Holdfast (1.5 kg/ha each) and the sub clover cultivars were Goulburn, Seaton park and Riverina (1.5 k/ha each). On average a saving of $26.60/ha could have been made per ha if the simple mix had been sown. Some farmers actually sowed less seed than the simple mix described above. Hence, the "saving" ranges from -$33.28/ha up to $105.81. A frequency distribution of this potential saving ($/ha) is presented in Figure 6.

Taking into account the size of each of the surveyed paddocks, the total extra cost of seed over that found in the simple mix can be calculated (Figure 7). On average the saving that could have been made if phalaris and sub clover only had been sown was $840 (range - $831 - $2919). This reflects the saving across the area sown and puts into perspective just how much farmers may be apparently wasting by sowing complex mixtures.

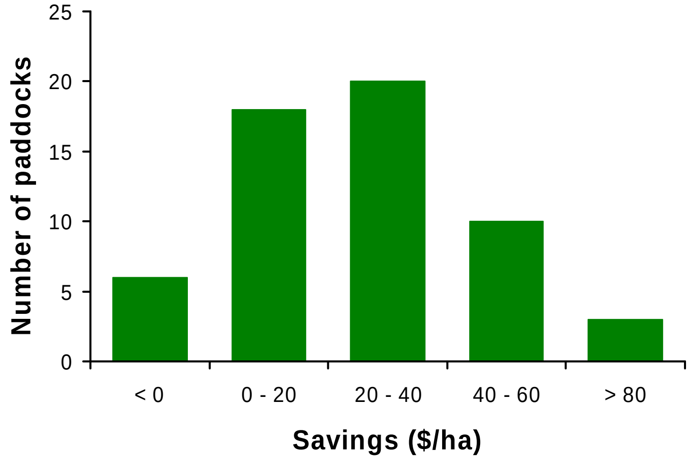

Figure 6. Frequency distribution of the potential savings in seed costs applied to 57 of the surveyed paddocks. Savings ($/ha) was calculated by subtracting the cost of a phalaris-sub clover seed mix from the cost (in current $) of the seed sown.

Figure 7. Frequency distribution of potential saving in seed costs on a per paddock basis. See caption Fig. 5.

Estimates of the costs of pasture establishment vary considerably. NSW DPI estimates are comparatively low at $157/ha (Anon. 2006) because they properly amortise the lime cost over 10 years rather than as a single up-front cost. Another reason why they may seem low is because the loss of production from the paddock is not taken into account. Higher estimates have been used in recent times (Scott et al. 2000) and will vary according to input prices and length of time that the paddock is out of production. If the non-seed cost of establishment is calculated from the DPI budget (Anon 2006), the cost of direct drilling a standard pasture is $113.85. The savings from sowing a simple mix can then be expressed as a percentage of total paddock costs (calculated by adding $113.85 to the cost of seed sown in each paddock). On average a saving on establishment costs of 12.8%. Once again the frequency distribution is instructive (Fig. 8) as it reveals that in 13 paddocks savings of over 20% of establishment costs could have been made.

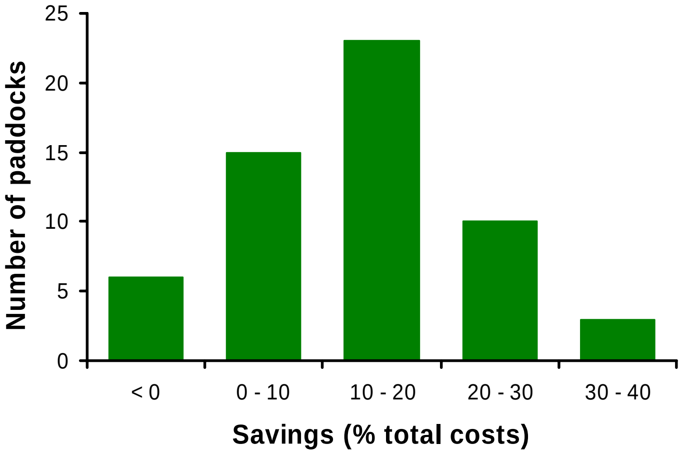

Figure 8. Frequency distribution of potential savings of sowing a simple mix as a percentage of total establishment costs.

In summary, many farmers were wasting their money either sowing too much seed per ha and/or sowing too many species. Payback times for pasture establishment vary (Scott et al. 2000) and can, depending on circumstances, be well over 5 years. Any initial cost that does not benefit the long-term productivity of the paddock represents an extension to the payback time. As such, the sowing of non-persistent species/cultivars is an expense that pasture managers could well do without.

4.6.3 Getting more by sowing less

The results demonstrate that when species are sown that do not persist, this can reduce the contribution of phalaris to the pasture. As phalaris is the most persistent of the sown perennial grasses and the mainstay of the permanent pasture production system in the south-west slopes, any management factor that reduces its competitiveness (unless over dominant) should be discouraged. Of the three factors that were related to the contribution of phalaris to feed on offer, both paddock size (potentially a surrogate for intensity of paddock management) and soil phosphate, do not require further discussion as they are not directly related to establishment. The fact that there was a positive relationship between the proportion of phalaris to all perennial grass seed sown (by weight) is critical. Although this is one of three factors in a relationship that only explained 27% of the variance of %phalaris, it clearly signals that some damage to phalaris is done by sowing additional perennial grasses. It is not possible to reliably calculate the decrease in productivity of the pasture due to the negative impact of other sown grasses on phalaris. This means that the costs of sowing extra, ono-persistent, species (see previous section) should be regarded as the *minimum* financial impost.

In the sense that phalaris does better over the long term if it is sown with fewer (or no) other perennial grass species means that this project has lived up to its title, ie. it is possible to get more *phalaris* by sowing less (perennial grasses).

5 Success in Achieving Objectives

Each of the objectives will be dealt with separately:

1) *to determine the consequences (in terms of botanical composition) of sowing diverse pasture mixes by July 2006*.

This project has successfully met its objectives and demonstrated that establishment costs would have been cheaper and the contribution of phalaris greater if the surveyed paddocks had been sown to a simple mix of phalaris and sub clover. The consequences in terms of cost of establishment and implications for the main perennial species, phalaris, have been clearly identified.

2) *using survey and experimental approaches to provide information on the role of niche in determining pasture composition*

This component of the project has not yet been completed. As mentioned above any ambition to commence an experimental program (originally the idea was to sow some side by side replicated plots of complex versus simple mixtures in farmers' paddocks) was abandoned (see earlier operational plan). There is some analyses that remains to be done and the relationship between species presence and niche is one of these. However, this will be mainly of academic interest and will not alter the central messages that have been presented above.

6 Impact on Meat and Livestock Industry – now & in five years time

The main impact of this work will be to focus farmers, consultants, retailers and pasture specialists on pasture establishment strategies. The results of the survey will be publicised in Prograzier magazine (near future), through local media (District agronomist column), with local consultants (eg. Holmes and Sackett 's "On-farm"). They will also be presented at the Australian Society of Agronomists conference in Perth next September. Farmers who adopt the recommendation of sowing simple mixes will realise reduced pasture establishment costs (quicker returns on pasture establishment) and better phalaris production. In addition dollars saved on establishment should be able to be invested in other more productive activities on-farm.

However, predicting the uptake of this message is difficult. It is likely that there will be considerable resistance to change particularly from agricultural consultants many of whom seemed to have developed "signature" pasture mixes. Recommending a much simpler (evidence-based) mix will reduce their ability to distinguish their product (advice) in the market place. Nonetheless, the results of this survey should signal the start of a concerted push for evidence-based recommendations of pasture species and cultivars. The practice of sowing diverse (or “shotgun”) mixes has been unequivocally demonstrated to be of no long-term use and, in many cases, harmful. As a new perennial grass cultivar is developed and released, key questions need to be addressed before it can be widely recommended:

1) How well does it persist?
2) How does its production compare with phalaris?
3) How does phalaris perform if sown with it?

The practice of recommending species in mixes that have not been evaluated in mixes (particularly the long-lived perennial species, is a particularly dubious one.

It is one thing to recommend a sowing mix on speculation that it may do well, it is another to recommend in spite of the low likelihood of success. As half the paddocks sown to white clover and perennial ryegrass did not occur with in the recommended rainfall boundary, it must be concluded that there are a number of farmers, consultants, retailers etc. who are just getting it wrong. The data for white clover and ryegrass can be presented to illustrate this point (Table 4). For both species consultants were the main source of advice for sowings that took place under the recommended amount of rainfall. This illustrates that for this message to be taken up, consultants will have to be a target audience. Hence, in five years time it is to be hoped that consultants and others will not be wasting their clients money by recommending sowing practices that are costly and of no apparent benefit.

Table 4. Sources of advice for paddocks sown to perennial ryegrass and white clover below recommended (DPI) rainfall boundary

Source of advice	Number who wrongly* recommended sowing:	
	Perennial ryegrass	White clover
Consultant	10	13
Retailer	2	4
Self	3	4
Total	15	21

*”wrongly” taken to mean recommended below minimum rainfall declared by NSW DPI.

Finally, in a more optimistic tone, these results may shed light on the professionalism of those involved in pasture advice. If specialised complex mixtures are not a key ingredient to paddock productivity, what is? Clearly fertility management remains a central component of all productive pasture systems but this is not all. If composition cannot be controlled by sowing complex mixtures, how can it? Over the past 10 or so years, MLA and other bodies have invested large sums to determine how botanical composition (persistence of perennials, legume content, weeds, etc.) can be manipulated (Kemp et al. 2000). A concerted effort needs to be made to convince farmers and all those giving advice on pasture management of the need to apply some of this research rather than rely on the mystique of “signature” mixes alone. It is through such an approach that sustained benefits can accrue for the meat and livestock industry within and beyond the next 5 years.

7 Conclusions and Recommendations - Section

The recommendations from this research are:

1) That complex seed mixes offer little in terms of improved composition and can be a substantial burden on the pasture manager. Therefore, until provided with evidence to the contrary, farmers in the south-west slopes of NSW should sow mixtures of phalaris and sub clover only.
2) As new grass species/cultivars are developed or released, they must be *demonstrated* to be either superior to phalaris in terms of persistence and productivity *or*, if recommended in a mix, should be able to persist with phalaris. If the species is not clearly superior to phalaris then one would question why it would be recommended at all unless it is superior in a particular niche (eg. very low pH, salinity).
3) Botanical composition is not influenced by sowing complex mixtures. Therefore, it is important that farmers and those who advise them become skilled at applying other methods to influence composition (grazing, fertiliser…etc.) rather than relying on “shotgun” mixes.

8 Bibliography

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9 Appendices

9.1 Appendix 1 – Recording Sheets

CHARLES STURT UNIVERSITY

mla MEAT & LIVESTOCK AUSTRALIA

Getting more by sowing less

Paddock Survey Details. Please fill in as much information as possible for one paddock that you have sown in the last 5 years and another that you have sown in the last 6-15 years. Please note that this information needs to be reasonably accurate so if you are not sure or do not have accurate written records, it is better not to guess.

Name:____
Property Name:___________________________________
Address:____
Phone Number:_________________ **Fax Number:**________________
Internet Address:_________________________________

Paddock sown 2000-2004		**Paddock sown 1991-1999**	
Paddock name:		**Paddock name :**	
Date of sowing:		**Date of sowing:**	
Species sown	**Rate of sowing**	**Species sown**	**Rate of sowing**

How many other paddocks do you have this information for that have been sown over the two periods?:

2000-2004 [ ] **1991-1999** [ ]

Thank you very much for your time and cooperation. Please return this form in the envelope supplied. Alternately you can fax the form to Shane Hildebrand on (02) 69332812.

9.2 Appendix 2 - Original Operational Plan

Draft survey design

The survey of farmers paddock will be undertaken in spring of 2005. This plan has three important components: the selection of paddocks, recording paddock history *and* the details of the physical survey.

Paddock Selection

In conducting a recent survey of undeveloped pastures in the Murray, Murrumbidgee and Lachlan catchments we have learnt that it is extremely difficult to obtain the information necessary to conduct a totally random survey of paddocks. Just to locate sixty properties at random and obtain the names of the owners as well as permission to survey the paddock was extremely labour intensive. Nonetheless for that survey it was deemed necessary, for this one, given that farmer commonly and regularly sow improved pastures, a different approach will be taken. We will be contacting district agronomists in the Yass, Wagga, Tumut and Albury district of NSW. Initially, we will rely on them to provide the names (in as unbiased a fashion as possible) of 10 farmers. This does not mean that we will be solely surveying “client” of these public agronomists as we will be selecting from as unbiased a source as possible. There is a need to avoid client lists of re-sellers and consultants as establishment practices may be closely related to these sources.

We will then contact these growers and survey two of their paddocks – varying in either in date of sowing and/or number/type of species and/or establishment method. The key selection criteria for the farmers will be that they have reliable records of the date and species mix (sowing rates) for the paddock in question. Farmers who cannot supply this will not be included. Once a farm has been selected, two paddocks that have been sown within the last 10 years, for which adequate records exist, will be randomly selected for survey.

Paddock History

We will need to know as much about paddock history as possible. Factors that will be important are:

- Pre-sowing history – did the pasture replace a previously-sown pasture or natives etc.
- Liming and fertiliser history – pre-sowing
- Date of establishment
- Sowing techniques, direct drill, cover crop, conventional etc.
- use of fertiliser at sowing
- Weed control prior to sowing
- Species sown and sowing rates
- Post sowing management in general terms:
    - grazing management and estimated stocking rate
    - fertiliser regime
    - use of weed control
    - fodder conservation
- Other relevant observations

Physical survey.

This will be similar to the native grass survey in that we will use a simple process to select 7-9 sites within the paddock that cover all landclass types and make frequency and botanical composition measurements. In addition some soil chemical factors (pH and phosphorus) will be measured. The protocol will be as follows with minor modifications:- sample sites will be located along two transects one that will be in the general direction of the prevailing slope in the paddock and the other which will be normal to the first. In the trial paddock this coincided pretty closely to N-S and E-W transects but that will not always be the case. The sampling frequency will be 7-9 sites per paddock. These are to be evenly spaced according to the dimensions of the two transects (ie the size and shape of the paddock). You will need to go to the centre of the paddock (estimate) and establish that as site one – then travel toward a fence along one of the transects – move in from the fence to a distance that will not include any edge of paddock effects and establish site 2. Then move back toward site one and find mid-way (site 3) using the GPS, repeat for each of the other directions along the transect. Only sample a site if it there is evidence that it has been sown down in the past, otherwise move to the nearest position along the transect (away from a previously sampled site) leaving at least 10 m from the edge of the area that is unacceptable.

The figure below represents an ideal 25 ha paddock. The arrows in the top section represent 9 sampling sites in the paddock that are evenly spaced. They occur along two transects, one in the direction of the prevailing slope, the other normal to it. The lower part of the figure represents the sampling strategy at each site. Normal to the direction of the main transect a 40 m sub-transect will be set up along which botanal and occurrence observations will be made.

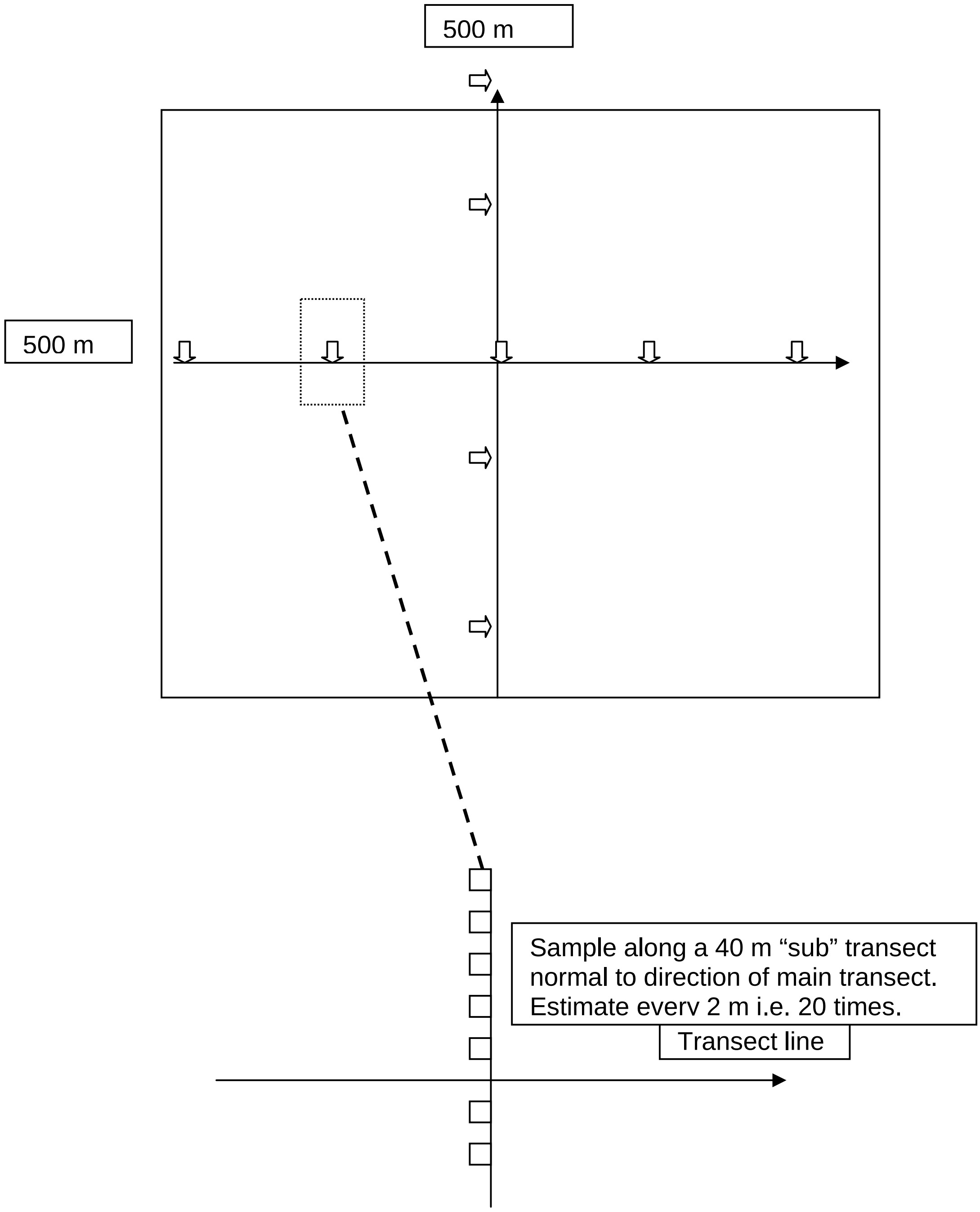
On arriving at each sampling site, the following actions will take place

- **Position**. Use a GPS to record position (use decimal degrees, set to GDA94 by preference) and altitude for each sampling site (to be recorded along the transect)
- **Slope and Slope Morphology:** Record approximate slope at each sampling site (use NSW land capability classes slope classes (Class 1, Class 2; Class 3; Class 4; Class 5) –there is an Appendix for details and landscape slope-morphology (Crest; Rocky outcrop, Upper slope; Mid-slope, Lower slope; Flat; Depression, Shoulder).
- **Aspect:** Record approximate aspect at the mid-point of each sleeper/monorail (eg north, south-east etc).
- Set up a 40 m sub-transect normal to the direction of the main transect. A measuring tape or 40 m rope will do or it is OK just to approximately step out each 2 m until you have 10 samples either side of the centre.
- Place a 0.5 x 0.5 m quad down every 2 m along the sub-transect (if using the rope notches can be made every 2 m).

COMPOSITION and DRY MATTER

- Each time the quadrat is placed down make a dry weight rank estimate of the first 3 species (ie botanal technique *and* record the occurrence of any of the species that were sown.

- For annual grasses you will have to aggregate bromes, vulpia, annual ryegrass and barley grass and wild oats into one classification. Likewise broadleaved species can be a species level for the common ones, and then ranked as “other broadleaves” for the uncommon ones.



  - Record a dry matter estimate for each quadrat. Each group should calibrate their dry matter estimates at least once per operator – absolute accuracy is not critical as these estimates used are primarily used to weight differences between samples within sites and to give an idea of variation in biomass between sites.

- **Soil** – take 3 0-10 cm cores at each site (along sub transect) bulk these for each site. A decision will be made later as to the (financial necessity) of bulking across a paddock.

- **Data** – finally all data is to be entered into a spreadsheet in preparation for analysis.

Timeframe
The survey will commence at the lower altitude part of the region in late September and progress to higher altitude sites through to November. The reason for this is that the survey can be carried out more efficiently when plant are at or near flowering to speed identification. This should see us able to complete the survey by the date (25th November) nominated in the schedule.

Abstract

A paddock survey was conducted to determine the consequences of sowing diverse pasture mixes in terms of species persistence and pasture composition. The survey covered 61 paddocks on 34 farms in rainfall environments from 550 to 950 mm per annum in the permanent pasture country of the south-west slopes of NSW. The median number of species sown was 5 and the median number found (at appreciable levels) was only 2. The two most persistent species were phalaris and sub clover. Further analysis demonstrated that including other perennial grass species in the mix with phalaris had a negative influence on the contribution of phalaris to feed on offer. Hence, farmers who adopt a more simple approach to sowing pasture mixes will reap rewards through lower up-front pasture establishment costs (on average $26.60/ha) and a more resilient phalaris component in their pasture. The industry must work to ensure that advice on the sowing of pasture species is evidence-based. In addition, if species are to be sown in mixes, then perhaps they should also be evaluated under those conditions.

Executive Summary

Farmers routinely sow many species when establishing a new permanent (> 15 years?) pasture. There is little published evidence that underpins this practice. Moreover, there is considerable anecdotal evidence that most of the species sown do not persist over the long-term. A survey was carried out in southern NSW to determine whether this practice has any merit. These complex, or "shotgun", mixes may also have a detrimental effect on pasture composition. Those species that do not persist may compete with those that do, leading to a poorer outcome if they had never been sown at all. It is in this sense that we ask whether farmers can get more by sowing less.

The survey covered 61 paddocks on 34 farms in the south-west slopes of NSW. Most farmers were contacted after having their names published as having sold stock in local newspapers. Farmers were asked to nominate two paddocks – one sown in the last 5 years and another in the last 5-15 years for which they had reliable records. In spring (October – early December) each paddock was visited. Firstly the farmer was interviewed to obtain management data and then the paddock was analysed. Both frequency of sown species and overall botanical composition were measured in each of the paddocks. In addition, soil was collected from the paddock for analysis of phosphate and pH.

The survey sowed that most commonly paddocks were sown to 5 species but only two could be found at levels where they did (or potentially could) appreciably contribute to paddock productivity. The two most persistent species were phalaris and sub clover. Other species such as cocksfoot, perennial ryegrass and white clover were not present at appreciable levels in over 70% of paddocks in which they had been sown. The conclusion from this section of the survey was that farmers are wasting their money sowing species that do not persist. On average this amounted to $26.60/ha extra over the amount that would be spent if only the two most reliable species were sown. Farmers can directly benefit from these results by adopting a more cautious approach when establishing new permanent pastures and sowing only those species that have proven persistence.

The extent to which sowing a "shotgun" mix affected the contribution made by the phalaris component was also investigated. Phalaris was the most common perennial grass species sown and the life of a pasture is more or less determined by how long the phalaris component persists. Therefore, the entire range of recorded establishment, management and locality factors recorded were analysed to se what effect they had on the contribution to feed on offer made by phalaris. Three factors were identified. Soil phosphate had a positive influence on phalaris and paddock size had a negative influence. Of more relevance, the weight of phalaris seed sown as a proportion of the total perennial grass seed sown was positively related to the percent phalaris found in the pasture. This means that if other perennial grasses were included in the sed mix, they had a negative influence on the productivity of the most persistent perennial grass species, phalaris. Hence, farmers not only waste money up-front by sowing "shotgun" mixes but this also had detrimental effects on the highly persistent species.

Producers will be the main beneficiaries of this research as they seek to contain costs of pasture establishment and reduce the payback period for their pasture dollar. However two

caveats should be applied. Firstly, the results reflect conditions in the south-west slopes only and may not be relevant in other environments (eg. Northern tablelands, coast). Secondly, the results are based on cultivars that have been released over the last 5-50 years and may not apply to some more recently developed types (particularly cocksfoot and tall fescue).

Contents

1 Background

Managers in the higher rainfall zone of south-eastern Australia are routinely advised to sow complex mixtures of pasture species (up to 10). Anecdotal evidence suggests that only a few of these species survive the first two years. The inclusion of non-persistent species represents a significant proportion of the cost of pasture establishment. Moreover, it is likely that competition (from the non-persistent species) early in the life of the pasture may reduce the potential of the most persistent species to dominate the sward over the life of the pasture. In other words, the non-persistent species leave gaps which the persistent ones do not completely fill. This is particularly the case with reliable species like phalaris which has virtually no capacity to regenerate from seed in a pasture. Hence, the consequences of the initial management of a newly-sown pasture may have long-term consequences on the productivity of livestock systems.

In terms of cost and sustainable production these complex mixes may well be detrimental to the efforts being made to establish perennial pastures in the higher rainfall zone. Encouraging farmers to sow these pastures in an effort to reduce dryland salinity needs to be made on the basis of objective information on species persistence on-farm.

2 Project Objectives

The original objectives of this project were:

1. to determine the consequences (in terms of botanical composition) of sowing diverse pasture mixes by July 2006.
2. using survey and experimental approaches to provide information on the role of niche in determining pasture composition.

However, it was decided to put more emphasis on the survey component and not to enter into an experimental program as this would not yield results in the short-term life of the project

3 Methodology

Previous experience with random selection of paddocks had proved to be costly and extremely time consuming. While sample selection based on random generation of map coordinates is the least biased approach to take, the difficulty in identifying and then contacting landholders based on this information proved too expensive. Instead, selection of landholders was performed by utilising published lists of stock sales in local papers. Landholders who lived within the target area (> 550 mm annual average rainfall, south west slopes, NSW) were randomly selected from these lists and approached to cooperate with the survey, few declined. One pre-requisite of involvement in the survey was that the landholder had to have reliable records of pasture establishment. If this could not be guaranteed then the landholder was rejected as a participant (politely!). Overall, 34 landholders were successfully contacted in this manner and 2 extra landholders that were involved in other projects run by the chief investigator were also included. Between these 34 farms, 61 paddocks were selected. Selection was unbiased in that landholders were asked to nominate paddocks that they had sown to improved pastures in either the last 1-5 years of 5-15 years. Most could only nominate1 or 2 in either category which were then randomly selected by the survey team. In this way all paddocks were surveyed in the spring (starting in October) of 2005.

Having nominated potential paddocks for the survey, the landholder was then interviewed regarding establishment and management practices of the paddock. The interview sheet can be found in Appendix 1. The establishment factors considered were:

- Pre-establishment history
- Species and cultivars sown, and their rate
- Paddock preparation – cultivation, herbicide
- Fertiliser, lime at sowing or prior
- Sowing technique – direct drill, conventional, cover crop etc.

Management and site factors considered were:

- Fertiliser use since sowing
- Grazing management
- Stocking rate
- Herbicide, insecticide
- Rainfall

Once in the paddock the botanical survey took place. A draft version of the methodology was presented in the Milestone 1 report (Appendix2). However, there were significant variations to the methodology which will be explained here. Points were sampled along two perpendicular transects in each paddock. One was located to cover the maximum range of landscape variation in the paddock, the other was placed perpendicular to the first approximately halfway through the paddock. Along each of the transects (avoiding unsown areas, under trees, among rocks), 50 equally-spaced samples (quadrats) were assessed for botanical composition (using the dry-weight rank method), feed on offer (visual score), frequency of sown species, landscape class, and GPS coordinates. In addition, soil samples were taken at (usually)16 of the sample points and bulked for chemical analyses (pH, phosphorus). Care was taken to avoid unsown areas within the paddocks (rocky outcrops, under trees etc.) as these would bias the results.

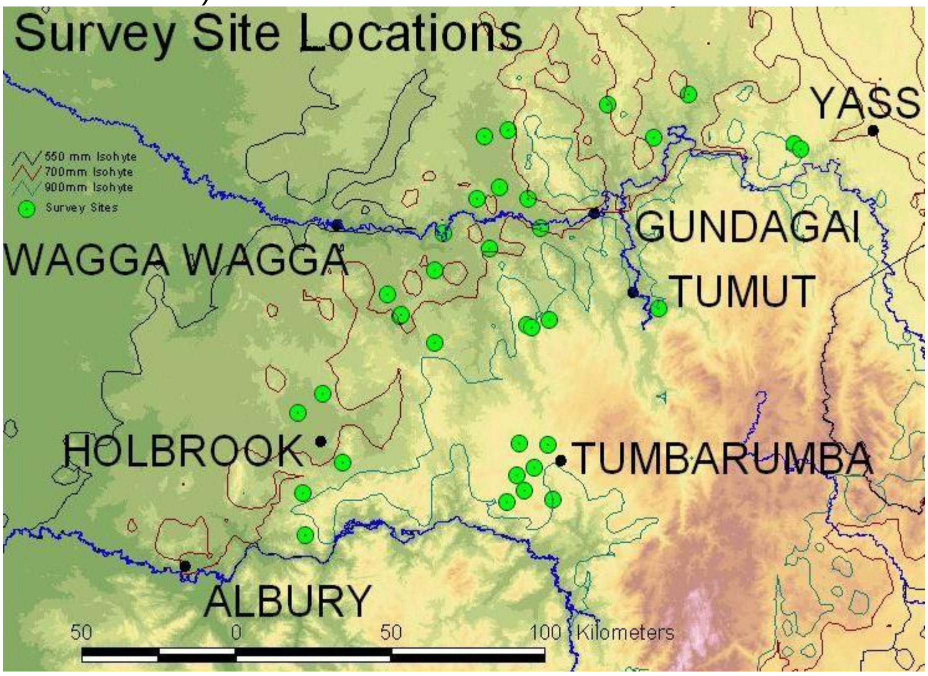


Figure 1. Site locations. Green dots represent the location of farms in the survey.

4 Results and Discussion

4.1 General

Overall, 34 farmers were contacted and 61 paddocks surveyed. The locality of each of the surveyed paddocks is shown in Figure 1 (page before). For the most part, the paddocks surveyed covered as much variation in rainfall, altitude and locality as time would allow. To get a general impression of the range of most of the non-botanical variables recorded, a frequency distribution of all the surveyed paddocks is presented in Table 1. In summary this data combined with some simple overall statistics, indicates that:

- 46 of the 61 paddocks had been **sown** since 1990. Of those sown before this date the oldest was sown in 1967.
- While there was a range in **paddock sizes** (from 9 to 99 Ha), most paddocks were between 15-45 Ha with a median size of 25 Ha
- The distribution of estimated (from the farmer) **annual rainfall** shows that most paddocks were located in the 600-800 mm zone
- Taking an acceptable level of **phosphate** (Olson) to be 16 mg/kg, the majority of paddocks (39) had values lower than this. However, the median Olson P was 13.7 mg/kg, indicating that paddocks were regularly fertilised.
- **pH** was low across the paddocks with only 5 paddocks having values greater than 5. The soil sampled for pH was taken from the top 10 cm and while surface pH may have been low this does not reflect the levels deeper in the soil profile.
- Regarding **sowing method**, most paddocks had been direct-drilled, few conventionally sown (cultivation followed by seeding) while, surprisingly, 16 paddocks had been cover-cropped (pasture sown beneath (in all cases) a cereal crop.
- Most farmers relied on **advice** on pasture establishment from sources that were “off farm” particularly private consultant agronomists and resellers.
- The number of **species sown** in each paddock varied from 2 to 8. The median number was 5 (more on this below).
- **Grazing management** was evenly split between paddocks that were continuously grazed or set stocked (30) and those that had been grazed with some form of regular/irregular rest (29). Grazing management was not recorded for two of the paddocks
- **Carrying capacity** was estimated by farmers for the life of the pasture. Median carrying capacity was 10-15 DSE/ha but this varied widely depending on location and landscape.

4.2 Species and Cultivars Sown

The paddocks surveyed covered a broad range in terms of species and cultivars sown. The number of paddocks sown to species and cultivars is presented in Table 2. The two most widely sown species were subterranean clover and phalaris both of which were sown in over 50 paddocks. Many paddocks were also sown to cocksfoot (42), perennial ryegrass (30) and white clover (41). Beyond these species others were sown but in comparatively few paddocks. It is interesting to note that phalaris pastures were mostly sown to cultivars *Australian* and *Holdfast.* The former cultivar has been available for many decades. In contrast, farmers have mostly opted for more recent cultivars of sub clover as three of the most commonly sown cultivars (Goulburn, Leura and Riverina) have been released since 1992.

Table 1 Frequency distribution of all the paddocks for a range of recorded management and paddock factors. The frequency (F) occurs in the right hand column of each section. Note: *Rain* is an estimate of the annual average rainfall from the farmer; number of paddocks may not always sum to 61 as the variable may not have been available for all paddocks

Year Sown	F	Paddock Size (Ha)	F	Annual Rainfall (mm)	F	Olsen P (mg/kg)	F	pH ($CaCl_2$)	F
<1985	2	< 15	13	< 600	7	< 8	9	< 4.1	5
1985-90	0	15 - 30	22	600 - 700	25	8 - 12	11	4.1 - 4.4	20
1990-95	13	30 - 45	15	700 - 800	13	12 - 16	19	4.4 - 4.7	18
1995-00	32	45 - 60	3	800-900	9	16 - 20	10	4.7 – 5.0	13
2000-05	14	> 60	8	> 900	7	>20	12	> 5.0	5

Sowing Method	F	Source of advice	F	No. species sown	F	Grazing Management	F	Stocking Rate (DSE/Ha)	F
Direct Drill	38	Consultant	35	2	5	Set Stocked	11	< 5	5
Conventional	7	DPI	2	3	11	Continuous	19	5 - 10	11
Cover Crop	16	Retailer	10	4	14	Intermittent	5	10 - 15	25
		Self	14	5	19	Strategic	11	15 - 20	14
				6	9	Rotational	13	> 20	4
				> 6	3				

Table 2 Number of paddocks sown to each species and cultivars. In some cases farmers were not certain of the cultivar sown and these are recorded as *NA* (not available).

Species		*Cultivar*		**Species**		*Cultivar*	
Phalaris	**53**	*Australian*	33	**Cocksfoot**	**42**	*Porto*	33
		Holdfast	26			*Currie*	10
		Sirosa	13			*Uncertain*	4
		Uneta	6			*Tekapo*	1
		Sirolan	2			*Warrior*	1
		Australian II	2			*Wana*	1
		Maru	1			*Condor*	1
Perennial Ryegrass	**30**	*Victorian*	10	**Tall Fescue**	**12**	*Triumph*	3
		K. Valley	10			*Quantum*	3
		Lincoln	6			*Demeter*	3
		Fitzroy	2			*Flecha*	2
		Extreme	2			*Resolute*	1
		Superior	1			*NA*	2
		Ellet	1				
Sub clover	**56**	*Goulburn*	25	**Sub clover**	**56**	*Karridale*	4
		Leura	13			*Mt Barker*	2
		Riverina	11			*Woogenellup*	2
		Gosse	11			*Larisa*	1
		Junee	9			*Esperence*	1
		Denmark	7			*Seaton Park*	1
		Trikkala	7			*Not recorded*	4
White clover	**41**	*Haifa*	33	**Strawberry clover**	**16**	*Upward*	4
		Tahora	14			*NA*	12
		Demand	1				
		Prefect	1	**Balansa**	**10**	*Bolta*	4
		Bounty	1			*NA*	6
		Tamar	1				
		NA	1	**Red Clover**	**1**	*Hamua*	1
Lucerne	**5**	*Aurora*	5	**Arrow leaf**	**2**	*Zulu*	2
Chicory	**2**	*Puna*	2	**Puccinellia**	**1**	*NA*	1
Tall Wheat Grass	**1**	*NA*		**Other Ryegrass**	**3**	*Concord*	2
						Tetila	1

4.3 Measuring Persistence

Before considering which of the species persisted, it is worth considering how persistence can be measured. Two measurements were taken in the current study. Firstly, quadrats were placed in the paddock 100 times. Each time any of the sown species (these were already known, as farmers had provided this information before the measurements were taken) were found in the quadrate, it was recorded. The measurement is then expressed as a percentage and will be referred to as the **frequency**. Simply, it is a measure of how often that species is encountered across the paddock and does not tell us how abundant (in terms of dry matter or % feed on offer) a species is. Hence, the second measurement was **botanical composition**. This was measured using the dry-weight rank method which simply relies on a ranking of the first 3 species as estimated by the observer in order of standing dry matter. This is then calculated using a standard formula and expressed here as % feed on offer. Therefore it is possible for a species to be present (have a frequency score above 0) but not contribute to the biomass (ie never rank in the top 3 species in any quadrat).

So a key question to address is, what measure should we use to determine persistence? This can best be addressed by considering the relationship between frequency and botanical composition for a set of species (Figure 2). Regardless of species, it is clear that the percent contribution to feed on offer varies widely only at relatively high frequencies. For example, at a frequency of 80% the contribution of phalaris to dry matter appears to range from 10% to 70%. In other words a species may be frequently found but not be contributing much to the feed on offer. Reasons for this could include both seasonal conditions and management factors (eg. fertiliser, weed control, grazing). If conditions change then it is possible that a frequent species contributing little to feed on offer may increase substantially. On the other hand, species with low frequency (say 10%) make little contribution to feed on offer in any circumstance. Considering this and other data, it appears that above a frequency of about 30% that there is a distinct rise in the range of % feed on offer that can be found.

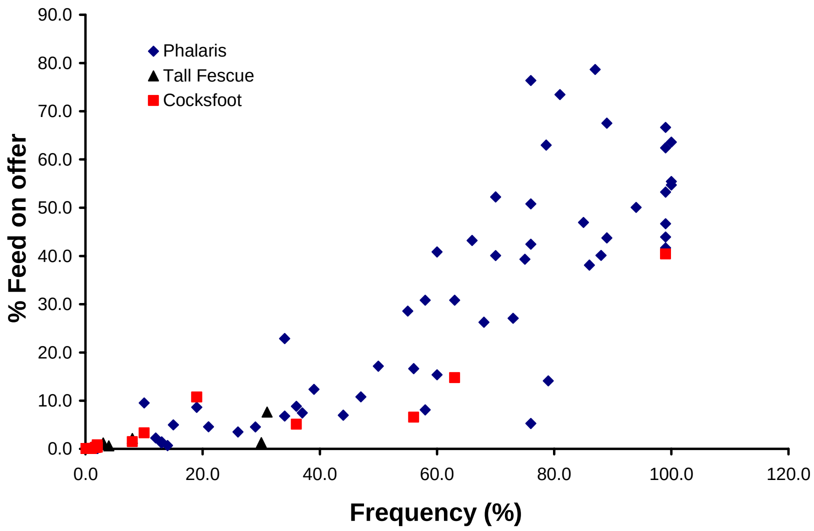


Figure 2 Relationship between botanical composition (as a % of feed on offer) and frequency found in the survey. Points represent individual quadrats.

In summary rather than rely on botanical composition alone, as it may be a function of seasonal and paddock factors that change, frequency is also used to determine whether a species has the potential to still contribute to feed on offer in a particular paddock should circumstances change. Therefore, three key measurements of persistence for each species are presented:

- *Found* - whether a species was found at all in the paddock – this may be as low as in only one out of one hundred quadrats!
- *30% frequency* – present at greater or equal to this frequency
- *5% feed on offer* – this is an arbitrary figure but below which no frequently found perennial grass occurred at. Put another way, it is difficult to imagine species providing much value to the pasture at below 5%!

4.4 Persistence

4.4.1 Number of species found

The median number of species sown was 5 whereas the median number found (at all, i.e. above a frequency of 0%) in the paddock was 3 (Fig. 3 a). While 5 species were sown in 20 out of 61 paddocks, all 5 species could only be found in only four of the paddocks. Considering the level of 30% to be adequate for current of potential contribution to paddock productivity, the median number of sown species to reach this level was 2 (see Fig. 3b). If, on the other hand, a benchmark of 5% feed on offer is set based on the spring 2005 results, then the median number of sown species that exceeded this level was one. However, Figure 3c reveals that there were many paddocks where two of the species reached this level.

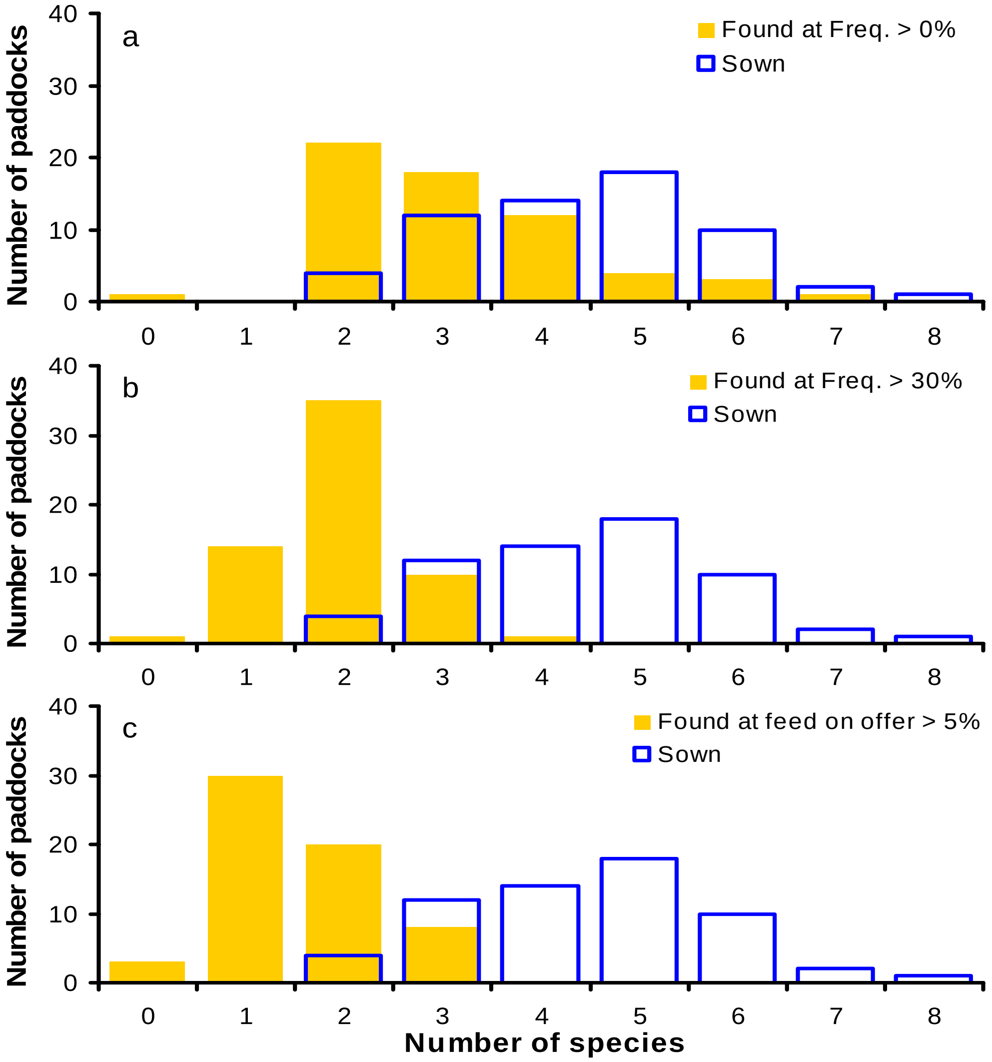


Figure 3 Frequency distribution of the paddocks sown to the range of species sown and (a) number of paddocks where the sown species were found at all (frequency > 0); (b) number of paddocks where the sown species were found at a frequency of > 30%; and (c) number of paddocks where the sown species contribute to feed on offer at a level > 5%.

4.4.2 Species

When expressed as a percentage of the paddocks sown to each of the species, the results indicate that two species, phalaris and sub clover were by far the most frequent species found in the paddocks in which they had been sown (Fig. 4). While other species were sown (Table 2) only those sown in 10 or more paddocks are presented in Figure 4. It is interesting to note that in a significant percentage of paddocks, a sown species may not have even been found (frequency > 0%). This was particularly the case for white clover, perennial ryegrass and tall fescue.

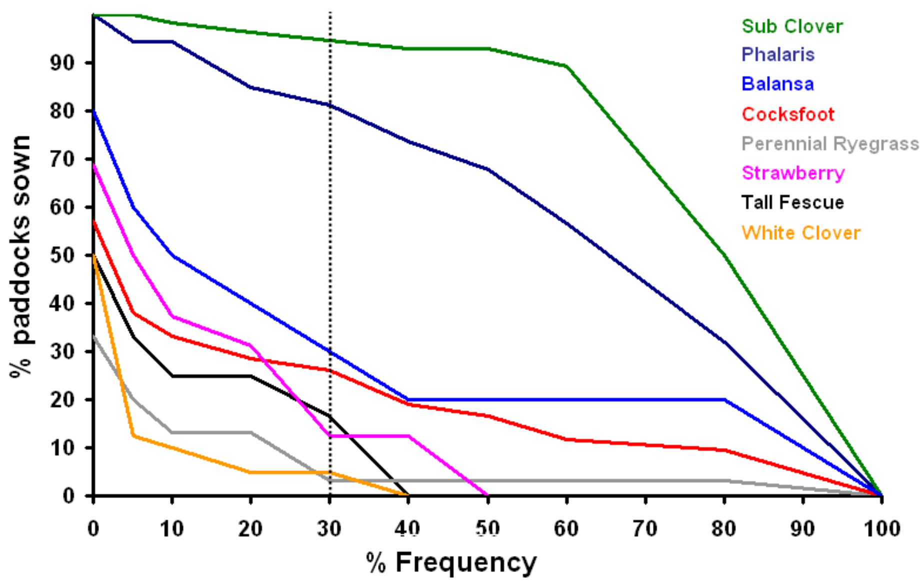


Figure 4 The percentage of paddocks sown to a particular species at various frequency levels for that species. The dotted line represents 30% frequency (see text).

The results can also be presented in terms of botanical composition instead of frequency. Similar conclusions can be reached as with frequency at 30% (Figures 4 and 5). Only phalaris and sub clover reach a level of 5% feed on offer in over 50% of paddocks sown. Interestingly, sub clover is frequently found but contributes little to feed on offer. This explains why the median number of species found at feed on offer > 5% was only one, usually phalaris. This may have been due to seasonal/management conditions in particular as it is widely accepted that abundance of sub clover may significantly vary between years. For all other species none contribute more than 5% to feed on offer in over 30% of the paddocks sown to that species.

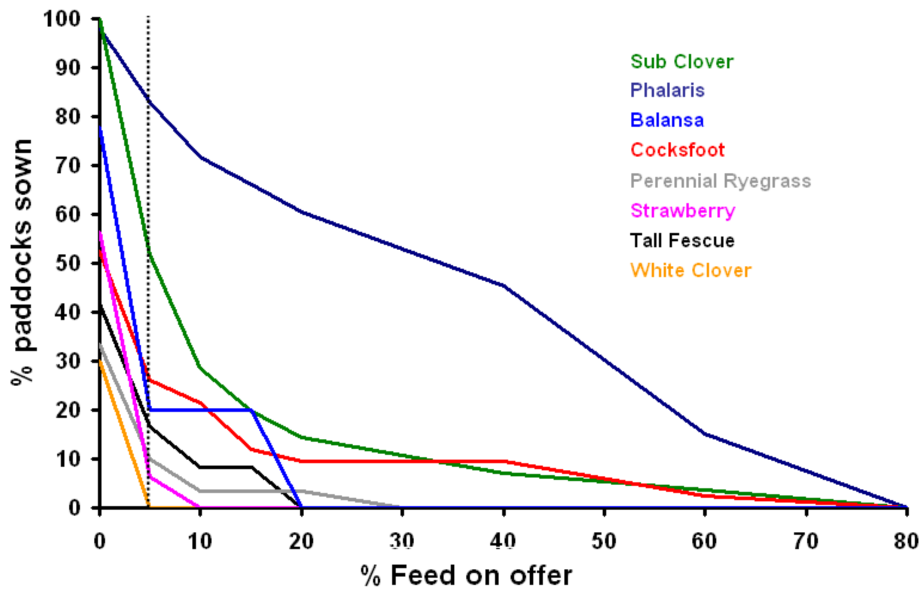


Figure 5. The percentage of paddocks sown to a particular species at various levels of the % feed on offer for that species. The dotted line represents 5%

It is convenient to tabulate the data for the key persistence criteria (Table 3). For completeness all species are shown but not much can be concluded about the bottom set of infrequently sown species. It is striking that cocksfoot, perennial ryegrass and tall fescue could not be found in a substantial proportion of the paddocks where they were sown (43%, 67% and 50%, respectively). Likewise, white clover was sown in 41 of the 61 paddocks but contributed to over 5% feed on offer in none.

Table 3 Species persistence in sown pastures

Species	Number Paddocks sown	Paddocks sown (%) with: Frequency > 0%	Frequency > 30%	Feed on offer > 5%
Phalaris	53	100	81	83
Cocksfoot	42	57	26	26
Perennial Ryegrass	30	33	3	10
Tall Fescue	12	50	17	17
Sub clover	56	100	95	52
White clover	41	50	5	0
Strawberry clover	16	69	13	6
Balansa clover	10	78	20	20
Lucerne	5	20	20	20
Arrow leaf	2	0	0	0
Chicory	2	50	0	0
Red Clover	1	100	0	0
Tall wheatgrass	1	100	0	100
Puccinellia	1	100	0	0

4.5 Establishment, Management and Pasture Composition.

As presented above, phalaris and subterranean clover were the two most frequently found of the species sown. One objective of this study was to determine whether sowing a number of species that do not persist harmed the composition of the pasture. It is possible that “gaps” left in the pasture may be colonised by undesirable species and lead to lower long-term productivity. Given that phalaris was the dominant perennial grass, the most relevant approach is to examine what possible influence any of the management and establishment practices had on contribution (%) to feed on offer made by this species.

Only paddocks sown to phalaris could be included in this analysis. In addition 4 paddocks about which the information was not complete have been excluded. The approach taken was to use multiple regressions to isolate those variables that had an influence on the amount of phalaris in the pasture. The range of variables included all the establishment, management, location and paddock factors that had been recorded, these included:

- annual rainfall (mm)
- paddock size (ha)
- year sown

- number of species sown
- pasture sowing rate (total, kg/ha)
- phalaris as a proportion of total pasture sown (by weight)
- phalaris as a proportion of total perennial grasses sown (by weight)
- number of species to have been lost from the pasture
- sowing method (cover crop versus no cover crop)
- soil phosphate (mg/kg, Olson)
- soil pH (in $CaCl_2$)
- grazing management (continuous versus some form of rest)
- stocking rate (DSE/ha, six classes from < 5 DSE/ha to >20 DSE/ha)

Three of these variables were found to significantly ($P < 0.001$) influence the proportion of phalaris found in the pasture. These were, paddock size (SIZE), soil phosphorus (SOIL-P) and phalaris as a proportion of the perennial grasses sown in the seed mix ($Phal/PG_{sown}$). The model that explained 27% of the variation in the proportion of phalaris in feed (%PHALARIS) on offer was:

$$\%PHALARIS = 7.5 + 1.19 * SOIL\text{-}P + 31.9 * Phal/PG_{sown} - 0.297 * SIZE$$

with the exception of the constant, each of the three parameters (SOIL-P, SIZE and $Phal/PG_{sown}$) was significant at $P < 0.05$). Care must be taken in the interpretation of this relationship as it relates specifically to the 51 paddocks from which it was derived. Nonetheless, while it only explains 27% of the total variation in %PHALARIS, this was still highly significant. The extent to which the parameters (as estimated in the multiple regression) apply outside this data set is questionable. Hence, it is most useful to take a mainly qualitative approach to interpreting the data. The direction of the parameters (positive for SOIL-P and Phal/PG and negative for SIZE) are important. That soil phosphate level was related to the contribution made by phalaris to feed on offer is not surprising. Phalaris is known to respond to phosphate supply and little needs to be added here. Paddock size was negatively related to phalaris composition. There is no simple biological explanation for why such a relationship could exist. It is possible, however, that the influence of paddock size reflects other management factors to do with paddock landscape and management that may have favoured phalaris more in smaller paddocks. Some of these factors could have been – weed control, grazing management, control of stocking rate, soil factors (larger paddock may have included more rocky or hilly areas).

The positive relationship between the amount of phalaris in the sowing mix as a proportion of all perennial grasses sown (Phal/PG) and the contribution of phalaris to feed on offer is a key result of the survey. This clearly points to the potential negative consequences of including other perennial grasses (which in most cases did not persist) in the seed mix.

4.6 General Discussion and Recommendations

4.6.1 Caveats

Before considering the meaning of these results it is worthwhile to consider two main issues. Firstly, the results reflect the characteristics of those species *and* cultivars that were sown in the paddocks surveyed. A recurring theme in the foregoing discussion will be the lack of fitness of many of the sown species. How much persistence is related to edaphic factors (eg. Soil pH) or climatic factors is unknown. However, many of the species (particularly white clover and perennial ryegrass) have been sown in areas that are well outside what NSW DPI currently recommends. For instance white clover is recommended to be sown in areas with "750 mm with summer incidence" (Betts and Ayres 2004) and perennial ryegrass at "700 mm (southern NSW)" (Lowien, Kemp and Launders 2004). Applying these recommendations to the data set, 21 out of 41 paddocks sown to white clover do not on average receive the recommended amount of rainfall and similarly for 15 out of the 30 paddocks sown to perennial ryegrass. These recommendations are general ones made for the species as a whole. However, within some species there is sizeable variation in important fitness characteristics such as summer dormancy. This is particularly the case with tall fescue and cocksfoot. Both species have cultivars that have recently (0-8 years) been commercially released. These cultivars were not encountered in many paddocks. Therefore, the first major caveat is that new cultivars and species that have been recently released and have greater fitness than older cultivars (eg. the summer dormant fescues versus the non-dormant, Demeter/Triumph types) may still be of use in permanent pastures. Remembering that the key determinant of "usefulness", in this sense, is demonstrated long-term persistence.

The regional nature of the research means that extending the results to regions with different soils/climate is hazardous. The climate of the south-west slopes of NSW is best described as summer-dry/winter-wet. Although in many locations rainfall is nearly evenly distributed throughout the year, the higher temperature and large vapour pressure deficits over the summer months means that soil moisture is often limiting. In other environments that receive greater amounts of summer rainfall with lower temperatures (eg. Northern tablelands of NSW), then it is possible that a larger number of species could persist. Hence, the second caveat is that it would be unwise to extend the results of this study into other climatically distinct regions.

4.6.2 Cheaper Establishment

The results presented in figures 3b and 3c make it clear that while farmers may sow many species, only two will meaningfully contribute to the pasture. By obtaining seed prices for most of the cultivars sown (and approximating the cost of those for which a price could not be found – using the closest type of cultivar), the total cost of seed sown in each paddock has been estimated for all but 4 paddocks (for which growers were unable to supply the sowing rates). It is not possible to relate cost of sowing to number of species sown. This would make sense if all species were sown at the recommended rate but this was not the case (eg. Cocksfoot as high as 14 kg/ha!). One way to come to analyse the extent to which farmers are wasting their money sowing species that do not persist is to compare the cost of sowing their pasture versus a simple mix of 2 phalaris cultivars and three sub clover cultivars. This was done assuming that the phalaris cultivars Australian and Holdfast (1.5 kg/ha each) and the sub clover cultivars were Goulburn, Seaton park and Riverina (1.5 k/ha each). On average a saving of $26.60/ha could have been made per ha if the simple mix had been sown. Some farmers actually sowed less seed than the simple mix described above. Hence, the "saving" ranges from -$33.28/ha up to $105.81. A frequency distribution of this potential saving ($/ha) is presented in Figure 6.

Taking into account the size of each of the surveyed paddocks, the total extra cost of seed over that found in the simple mix can be calculated (Figure 7). On average the saving that could have been made if phalaris and sub clover only had been sown was $840 (range - $831 - $2919). This reflects the saving across the area sown and puts into perspective just how much farmers may be apparently wasting by sowing complex mixtures.

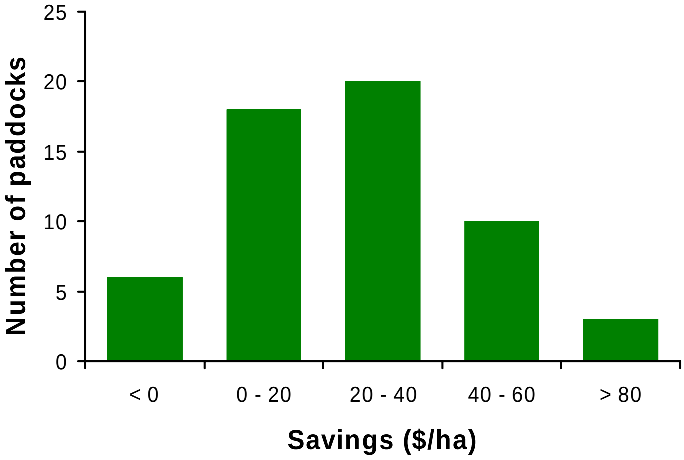


Figure 6. Frequency distribution of the potential savings in seed costs applied to 57 of the surveyed paddocks. Savings ($/ha) was calculated by subtracting the cost of a phalaris-sub clover seed mix from the cost (in current $) of the seed sown.

Figure 7. Frequency distribution of potential saving in seed costs on a per paddock basis. See caption Fig. 5.

Estimates of the costs of pasture establishment vary considerably. NSW DPI estimates are comparatively low at $157/ha (Anon. 2006) because they properly amortise the lime cost over 10 years rather than as a single up-front cost. Another reason why they may seem low is because the loss of production from the paddock is not taken into account. Higher estimates have been used in recent times (Scott et al. 2000) and will vary according to input prices and length of time that the paddock is out of production. If the non-seed cost of establishment is calculated from the DPI budget (Anon 2006), the cost of direct drilling a standard pasture is $113.85. The savings from sowing a simple mix can then be expressed as a percentage of total paddock costs (calculated by adding $113.85 to the cost of seed sown in each paddock). On average a saving on establishment costs of 12.8%. Once again the frequency distribution is instructive (Fig. 8) as it reveals that in 13 paddocks savings of over 20% of establishment costs could have been made.

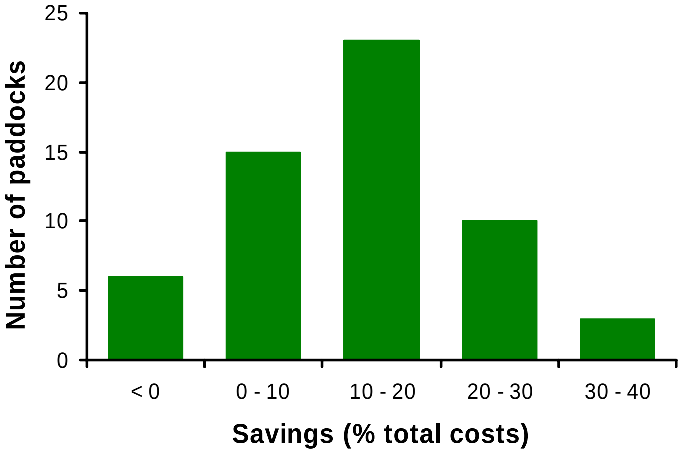


Figure 8. Frequency distribution of potential savings of sowing a simple mix as a percentage of total establishment costs.

In summary, many farmers were wasting their money either sowing too much seed per ha and/or sowing too many species. Payback times for pasture establishment vary (Scott et al. 2000) and can, depending on circumstances, be well over 5 years. Any initial cost that does not benefit the long-term productivity of the paddock represents an extension to the payback time. As such, the sowing of non-persistent species/cultivars is an expense that pasture managers could well do without.

4.6.3 Getting more by sowing less

The results demonstrate that when species are sown that do not persist, this can reduce the contribution of phalaris to the pasture. As phalaris is the most persistent of the sown perennial grasses and the mainstay of the permanent pasture production system in the south-west slopes, any management factor that reduces its competitiveness (unless over dominant) should be discouraged. Of the three factors that were related to the contribution of phalaris to feed on offer, both paddock size (potentially a surrogate for intensity of paddock management) and soil phosphate, do not require further discussion as they are not directly related to establishment. The fact that there was a positive relationship between the proportion of phalaris to all perennial grass seed sown (by weight) is critical. Although this is one of three factors in a relationship that only explained 27% of the variance of %phalaris, it clearly signals that some damage to phalaris is done by sowing additional perennial grasses. It is not possible to reliably calculate the decrease in productivity of the pasture due to the negative impact of other sown grasses on phalaris. This means that the costs of sowing

extra, ono-persistent, species (see previous section) should be regarded as the *minimum* financial impost.
In the sense that phalaris does better over the long term if it is sown with fewer (or no) other perennial grass species means that this project has lived up to its title, ie. it is possible to get more *phalaris* by sowing less (perennial grasses).

5 Success in Achieving Objectives

Each of the objectives will be dealt with separately:

1) *to determine the consequences (in terms of botanical composition) of sowing diverse pasture mixes by July 2006*.

This project has successfully met its objectives and demonstrated that establishment costs would have been cheaper and the contribution of phalaris greater if the surveyed paddocks had been sown to a simple mix of phalaris and sub clover. The consequences in terms of cost of establishment and implications for the main perennial species, phalaris, have been clearly identified.

2) using survey and experimental approaches to provide information on the role of niche in determining pasture composition

This component of the project has not yet been completed. As mentioned above any ambition to commence an experimental program (originally the idea was to sow some side by side replicated plots of complex versus simple mixtures in farmers' paddocks) was abandoned (see earlier operational plan). There is some analyses that remains to be done and the relationship between species presence and niche is one of these. However, this will be mainly of academic interest and will not alter the central messages that have been presented above.

6 Impact on Meat and Livestock Industry – now & in five years time

The main impact of this work will be to focus farmers, consultants, retailers and pasture specialists on pasture establishment strategies. The results of the survey will be publicised in Prograzier magazine (near future), through local media (District agronomist column), with local consultants (eg. Holmes and Sackett 's "On-farm"). They will also be presented at the Australian Society of Agronomists conference in Perth next September. Farmers who adopt the recommendation of sowing simple mixes will realise reduced pasture establishment costs (quicker returns on pasture establishment) and better phalaris production. In addition dollars saved on establishment should be able to be invested in other more productive activities on-farm.

However, predicting the uptake of this message is difficult. It is likely that there will be considerable resistance to change particularly from agricultural consultants many of whom seemed to have developed "signature" pasture mixes. Recommending a much simpler (evidence-based) mix will reduce their ability to distinguish their product (advice) in the market place. Nonetheless, the results of this survey should signal the start of a concerted push for evidence-based recommendations of pasture species and cultivars. The practice of sowing diverse (or “shotgun”) mixes has been unequivocally demonstrated to be of no long-term use and, in many cases, harmful. As a new perennial grass cultivar is developed and released, key questions need to be addressed before it can be widely recommended:

1) How well does it persist?
2) How does its production compare with phalaris?
3) How does phalaris perform if sown with it?

The practice of recommending species in mixes that have not been evaluated in mixes (particularly the long-lived perennial species, is a particularly dubious one.

It is one thing to recommend a sowing mix on speculation that it may do well, it is another to recommend in spite of the low likelihood of success. As half the paddocks sown to white clover and perennial ryegrass did not occur with in the recommended rainfall boundary, it must be concluded that there are a number of farmers, consultants, retailers etc. who are just getting it wrong. The data for white clover and ryegrass can be presented to illustrate this point (Table 4). For both species consultants were the main source of advice for sowings that took place under the recommended amount of rainfall. This illustrates that for this message to be taken up, consultants will have to be a target audience. Hence, in five years time it is to be hoped that consultants and others will not be wasting their clients money by recommending sowing practices that are costly and of no apparent benefit.

Table 4. Sources of advice for paddocks sown to perennial ryegrass and white clover below recommended (DPI) rainfall boundary

Source of advice	Number who wrongly* recommended sowing:	
	Perennial ryegrass	White clover
Consultant	10	13
Retailer	2	4
Self	3	4
Total	15	21

*”wrongly” taken to mean recommended below minimum rainfall declared by NSW DPI.

Finally, in a more optimistic tone, these results may shed light on the professionalism of those involved in pasture advice. If specialised complex mixtures are not a key ingredient to paddock productivity, what is? Clearly fertility management remains a central component of all productive pasture systems but this is not all. If composition cannot be controlled by sowing complex mixtures, how can it? Over the past 10 or so years, MLA and other bodies have invested large sums to determine how botanical composition (persistence of perennials, legume content, weeds, etc.) can be manipulated (Kemp et al. 2000). A concerted effort needs to be made to convince farmers and all those giving advice on pasture management of the need to apply some of this research rather than rely on the mystique of “signature” mixes alone. It is through such an approach that sustained benefits can accrue for the meat and livestock industry within and beyond the next 5 years.

7 Conclusions and Recommendations - Section

The recommendations from this research are:

1) That complex seed mixes offer little in terms of improved composition and can be a substantial burden on the pasture manager. Therefore, until provided with evidence to the contrary, farmers in the south-west slopes of NSW should sow mixtures of phalaris and sub clover only.
2) As new grass species/cultivars are developed or released, they must be *demonstrated* to be either superior to phalaris in terms of persistence and productivity *or*, if recommended in a mix, should be able to persist with phalaris. If the species is not clearly superior to phalaris then one would question why it would be recommended at all unless it is superior in a particular niche (eg. very low pH, salinity).
3) Botanical composition is not influenced by sowing complex mixtures. Therefore, it is important that farmers and those who advise them become skilled at applying other methods to influence composition (grazing, fertiliser…etc.) rather than relying on “shotgun” mixes.

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9 Appendices

9.1 Appendix 1 – Recording Sheets

CHARLES STURT UNIVERSITY

mla MEAT & LIVESTOCK AUSTRALIA

Getting more by sowing less

Paddock Survey Details. Please fill in as much information as possible for one paddock that you have sown in the last 5 years and another that you have sown in the last 6-15 years. Please note that this information needs to be reasonably accurate so if you are not sure or do not have accurate written records, it is better not to guess.

Name:______________________________
Property Name:______________________________
Address:______________________________
Phone Number:______________ **Fax Number:**______________
Internet Address:______________________________

Paddock sown 2000-2004		**Paddock sown 1991-1999**	
Paddock name:		**Paddock name :**	
Date of sowing:		**Date of sowing:**	
Species sown	**Rate of sowing**	**Species sown**	**Rate of sowing**

How many other paddocks do you have this information for that have been sown over the two periods?:

2000-2004 ☐ **1991-1999** ☐

Thank you very much for your time and cooperation. Please return this form in the envelope supplied. Alternately you can fax the form to Shane Hildebrand on (02) 69332812.

9.2 Appendix 2 - Original Operational Plan

Draft survey design

The survey of farmers paddock will be undertaken in spring of 2005. This plan has three important components: the selection of paddocks, recording paddock history *and* the details of the physical survey.

Paddock Selection

In conducting a recent survey of undeveloped pastures in the Murray, Murrumbidgee and Lachlan catchments we have learnt that it is extremely difficult to obtain the information necessary to conduct a totally random survey of paddocks. Just to locate sixty properties at random and obtain the names of the owners as well as permission to survey the paddock was extremely labour intensive. Nonetheless for that survey it was deemed necessary, for this one, given that farmer commonly and regularly sow improved pastures, a different approach will be taken. We will be contacting district agronomists in the Yass, Wagga, Tumut and Albury district of NSW. Initially, we will rely on them to provide the names (in as unbiased a fashion as possible) of 10 farmers. This does not mean that we will be solely surveying “client” of these public agronomists as we will be selecting from as unbiased a source as possible. There is a need to avoid client lists of re-sellers and consultants as establishment practices may be closely related to these sources.

We will then contact these growers and survey two of their paddocks – varying in either in date of sowing and/or number/type of species and/or establishment method. The key selection criteria for the farmers will be that they have reliable records of the date and species mix (sowing rates) for the paddock in question. Farmers who cannot supply this will not be included. Once a farm has been selected, two paddocks that have been sown within the last 10 years, for which adequate records exist, will be randomly selected for survey.

Paddock History

We will need to know as much about paddock history as possible. Factors that will be important are:

- Pre-sowing history – did the pasture replace a previously-sown pasture or natives etc.
- Liming and fertiliser history – pre-sowing
- Date of establishment
- Sowing techniques, direct drill, cover crop, conventional etc.
- use of fertiliser at sowing
- Weed control prior to sowing
- Species sown and sowing rates
- Post sowing management in general terms:
    - grazing management and estimated stocking rate
    - fertiliser regime
    - use of weed control
    - fodder conservation
- Other relevant observations

Physical survey.

This will be similar to the native grass survey in that we will use a simple process to select 7-9 sites within the paddock that cover all landclass types and make frequency and botanical composition measurements. In addition some soil chemical factors (pH and phosphorus) will be measured. The protocol will be as follows with minor modifications:- sample sites will be located along two transects one that will be in the general direction of the prevailing slope in the paddock and the other which will be normal to the first. In the trial paddock this coincided pretty closely to N-S and E-W transects but that will not always be the case. The sampling frequency will be 7-9 sites per paddock. These are to be evenly spaced according to the dimensions of the two transects (ie the size and shape of the paddock). You will need to go to the centre of the paddock (estimate) and establish that as site one – then travel toward a fence along one of the transects – move in from the fence to a distance that will not include any edge of paddock effects and establish site 2. Then move back toward site one and find mid-way (site 3) using the GPS, repeat for each of the other directions along the transect. Only sample a site if it there is evidence that it has been sown down in the past, otherwise move to the nearest position along the transect (away from a previously sampled site) leaving at least 10 m from the edge of the area that is unacceptable.

The figure below represents an ideal 25 ha paddock. The arrows in the top section represent 9 sampling sites in the paddock that are evenly spaced. They occur along two transects, one in the direction of the prevailing slope, the other normal to it. The lower part of the figure represents the sampling strategy at each site. Normal to the direction of the main transect a 40 m sub-transect will be set up along which botanal and occurrence observations will be made.

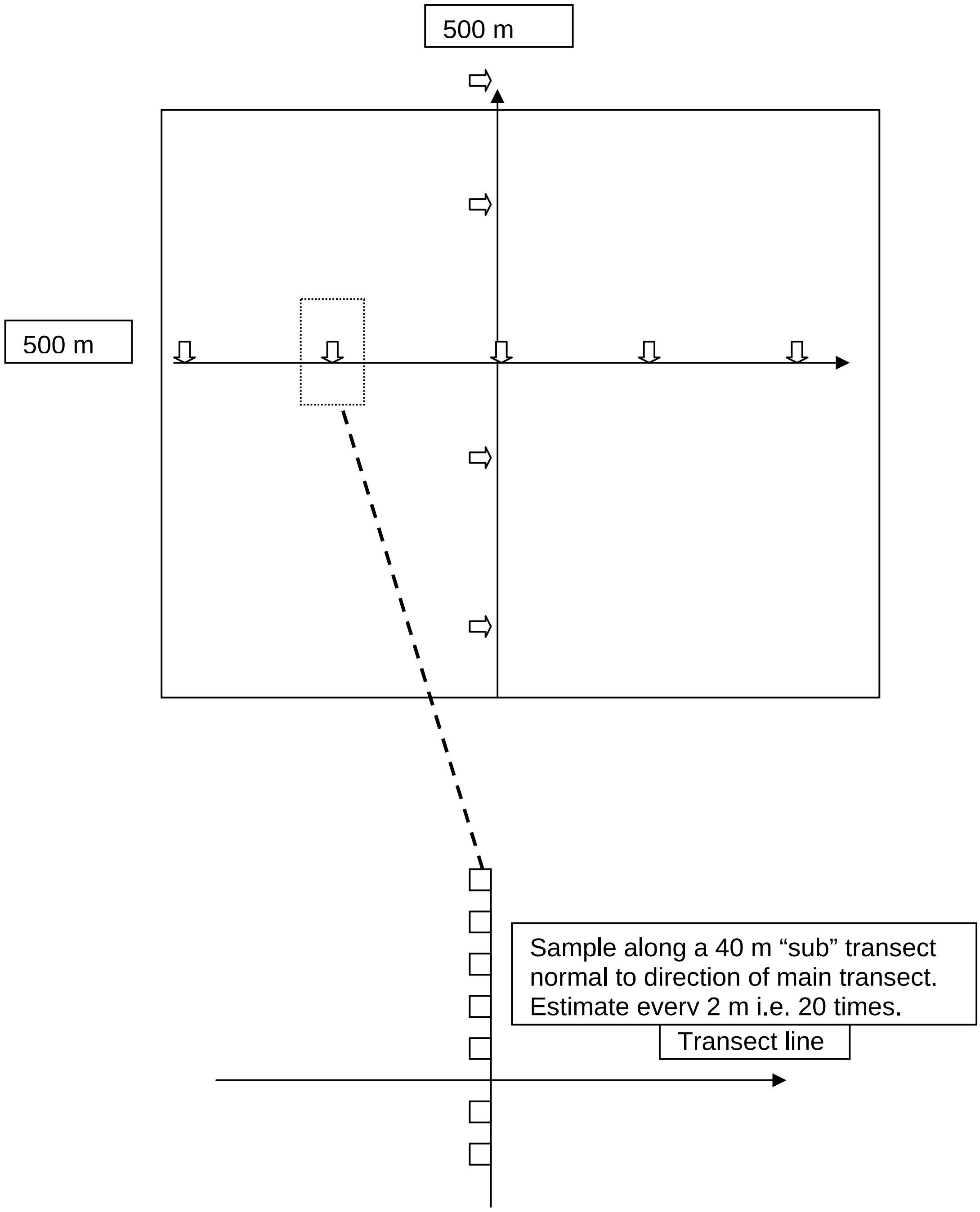
On arriving at each sampling site, the following actions will take place

- **Position**. Use a GPS to record position (use decimal degrees, set to GDA94 by preference) and altitude for each sampling site (to be recorded along the transect)
- **Slope and Slope Morphology:** Record approximate slope at each sampling site (use NSW land capability classes slope classes (Class 1, Class 2; Class 3; Class 4; Class 5) –there is an Appendix for details and landscape slope-morphology (Crest; Rocky outcrop, Upper slope; Mid-slope, Lower slope; Flat; Depression, Shoulder).
- **Aspect:** Record approximate aspect at the mid-point of each sleeper/monorail (eg north, south-east etc).
- Set up a 40 m sub-transect normal to the direction of the main transect. A measuring tape or 40 m rope will do or it is OK just to approximately step out each 2 m until you have 10 samples either side of the centre.
- Place a 0.5 x 0.5 m quad down every 2 m along the sub-transect (if using the rope notches can be made every 2 m).

COMPOSITION and DRY MATTER

- Each time the quadrat is placed down make a dry weight rank estimate of the first 3 species (ie botanal technique *and* record the occurrence of any of the species that were sown.

- For annual grasses you will have to aggregate bromes, vulpia, annual ryegrass and barley grass and wild oats into one classification. Likewise broadleaved species can be a species level for the common ones, and then ranked as “other broadleaves” for the uncommon ones.



- Record a dry matter estimate for each quadrat. Each group should calibrate their dry matter estimates at least once per operator – absolute accuracy is not critical as these estimates used are primarily used to weight differences between samples within sites and to give an idea of variation in biomass between sites.

- **Soil** – take 3 0-10 cm cores at each site (along sub transect) bulk these for each site. A decision will be made later as to the (financial necessity) of bulking across a paddock.

- **Data** – finally all data is to be entered into a spreadsheet in preparation for analysis.

Timeframe
The survey will commence at the lower altitude part of the region in late September and progress to higher altitude sites through to November. The reason for this is that the survey can be carried out more efficiently when plant are at or near flowering to speed identification. This should see us able to complete the survey by the date (25th November) nominated in the schedule.