final report

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Overcoming constraints to adoption of new annual legumes

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Abstract

Research in central and southern NSW found the inclusion of the new hardseeded annual pasture legumes, biserrula, French serradella and bladder clover, can potentially significantly increase feed availability for livestock, particularly in lower than average rainfall years. These legumes offer potential to improve crop-pasture rotation flexibility due to their high hard seed levels and ability to utilise novel establishment techniques such as twin sowing. Such systems allow farmers to more readily alter crop to pasture ratios of their farms and therefore the crop to livestock ratio, than in traditional phase pasture systems. Additionally, feed quality characteristics are equivalent to or better than subterranean clover and when coupled with generally herbage production mean higher potential animal production. Modelled beef production (using Grazfeed) shows that these new legumes potentially increase liveweight gain per day at a time when animals would be losing weight if being fed traditional pasture types.

Evaluation of feedback from workshop and field day participants shows a marked increase in the use and adoption of these new legumes. While this has been a substantial step forward, there is still a great need to move these famers further along the knowledge pathway to a point where they have sound knowledge of how to grow and manage the new species.

Executive summary

Over the last 20 years a wide range of new annual pasture legumes have been developed for use in Australian agriculture. These new legumes have been developed with improved characteristics in the areas of hard seed levels, deeper root systems, increased herbage production and/or increased pest and disease tolerance. The Pastures Australia funded project 'Agronomy and management of new annual legumes' identified through farmer and advisor surveys (n=300 and n=35 respectively), that new annual legumes were being used by less than 2% of farmers. Key to lack of adoption was lack of technical information on new species performance and lack of general information on how to grow and manage the new species.

Through the Pastures Australia funded project and the current MLA funded project a series of on-farm research and development sites were established to examine ways of incorporating new annual legumes into farming systems. Additionally, co-operating farmers we provided with seed of the new legume for the purpose of growing a small area (2-5 ha) on which they could conduct their own experiments. Through the two projects, more than 2600 farmers and advisors have attended field days and seminars associated with the projects. In this time (2007 to 2011), the use of new annual legumes has increased to just in excess of 15%, based on the result of 300 surveys at project field days in 2011.

The key area of both projects focussed on the investigating the use of new hardseeded annual pasture legumes for their fit in NSW farming systems. The initial farmer surveys undertaken in the Pastures Australia survey in 2007 identified utilisation of new legumes in crop-pasture rotations as the number one priority for research. From prior research, biserrula and French serradella (hardseeded varieties) were known to be widely adapted to, and highly productive in variable climatic conditions in NSW. Although not widely evaluated at that stage, bladder clover had undergone selection as part of the National Annual Pasture Legume Improvement Program (NAPLIP) in southern NSW and its hard seed characteristics indicated it was suitable for use in novel crop-pasture rotation systems.

Pastures are integral to livestock and crop production systems in NSW. Traditionally, subterranean clover has been the most widely utilised pasture legume. However, subterranean clover is shallow rooted and therefore prone to production losses and perhaps more importantly seed production losses in dry and drought seasons. Further, germination of sub clover and subsequent seedling mortality can be high when summer rainfall events occur. The newly developed annual legumes included in these projects have either higher hard seed content and/or deeper root systems which confer protection in false break conditions and/or improve ability to survive dry periods through increased ability to access moisture.

Key to the success of any annual legume-based pasture is the establishment of a strong seed bank to enable regeneration. Traditional phase farming systems in NSW have required the pasture to be re-sown following each cropping phase. The new annual legumes with their higher hard seed levels have the potential to be used in self-sustaining crop-pasture rotations where pastures will regenerate without the need for resowing following crops. Additionally, the high hard seed content of the new annual legumes lend themselves to use in novel establishment systems where unscarified or in-pod seed is sown with the crop in the final crop year. There is minimal germination of the legume in the crop year due to the high hard seed level. For the legume seed, the final crop year is essentially a seed softening year. This type of establishment system does not result in competition between the pasture and

the crop as occurs in conventional cover cropping where scarified seed is sown under a crop. Further, in twin sowing there is no need to reduce the final year crop sowing rate compared to cover cropping. Therefore farmers can still achieve a one pass crop-pasture establishment but remove the competition between crop and pasture and still have a full final year crop.

Survey of 300 famers within the Pastures Australia project in 2009 found that 80% of NSW farmers were using cover cropping as their main means to establish pastures, but only 30% found it highly successful. Most (90%) acknowledged that stand alone sowing of pastures was the most successful way to establish a pasture, but they cited high establishment cost as a barrier to using this type of establishment. Less than 5% of farmers had heard of twin sowing but all wanted more information on the efficacy of this technique in establishing pastures.

This final report contains findings of the final season of a project which examined three techniques – stand alone, cover cropping and twin sowing, methods of establishing self sustaining crop-pasture rotations. The final year data also included sequential sampling of herbage quality of bladder clover, biserrula and French serradella grown in separate fodder conservation trials. The feed quality results of the sequential sampling were then used in Grazfeed to determine potential liveweight gain in weaner cattle. The draft management packages developed within the Pastures Australia project were updated as a result of this project and have been supplied separately. The additional MLA funding resulted in these packages containing more comprehensive information on productivity of regenerating pastures following cropping in the crop-pasture rotation sections and information on herbage production, herbage quality and implications for potential livestock production utilising these pastures. This report also contains details of the 2011 field days and workshops held throughout NSW where surveys were undertaken to collect information on farmer knowledge, legume use and future requirements and to compare that to the level of knowledge at the commencement of the Pastures Australia project.

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1 Background

Over the last 20 years, Australian plant breeding programs have developed and released a wide range of new annual legumes for use in Australian agriculture. Several of these new legumes including biserrula and bladder clover, or new varieties of existing legumes such as French serradella, have significantly higher hard seed levels compared to traditional pasture legume species. The higher hard seed levels confer increased persistence in the soil seed bank due to reduced susceptibility to false breaks. Additionally, species such as biserrula and French serradella are known to have a significantly deeper root system compared to subterranean clover and therefore they have greater capacity to survive drought and seasonal dry spells and thus greater propensity to produce seed even under adverse conditions.

The hard seed levels of these species/varieties, then lend themselves to investigating alternatives to traditional crop-pasture rotations where pasture has to be resown following each crop phase. The hard seed levels of the new legumes are, at least, in theory capable of surviving cropping and regenerating without the need for resowing. Such crop-pasture rotation systems are then potentially a self sustaining type of system. Such a system should provide high quality feed for livestock in the crop year, but also fix nitrogen and reduce the need for nitrogen in the crop year.

This type of 1:1 crop-pasture rotation system commenced in NSW experiments in 2009 (with a second commencement in 2010) in the Pastures Australia project. This report provides results of the final year (2011) pasture establishment or re-establishment (in the case of third year pastures) as well as information on quality of new legumes from sequential spring sampling in a separate experiment. The results of the quality analysis were subsequently used in Grazfeed to determine potential liveweight gain in livestock.

2 Project Objectives

The objectives of this project which funded the final season of the field experiments established in the Pastures Australia project ‘Agronomy and management of new annual legumes’, was to

- Collect new annual legume regeneration data from pasture rotation treatments implemented in 2009 and 2010 based on the twin sowing method
- Analyse the suitability of these new legumes in flexible pasture – crop rotations, in comparison to traditional phase farming on sub-clover
- Provide serial sampled nutritional information on new pasture systems
- Determine suitability of existing NIR calibrations for the new annual legumes
- Update the management packages developed in the Pastures Australia parent project including recruitment data after two seasons, modelled animal production opportunities and the compelling case for adoption
- Conduct spring field days targeting 300 participants and promote the opportunity in time for the 2012 sowing season with updated management packages
- Evaluate producer’s knowledge change from the start of the parent project regarding opportunities from new legumes

3 Methodology

Collect new annual legume regeneration data from pasture rotation treatments implemented in 2009 and 2010 based on the twin sowing method.

Two sites where biserrula, bladder clover, French serradella and subterranean clover had been sown were monitored for regeneration in the crop-pasture rotation experiments – Beckom, NSW and Harden, NSW. The Beckom site represented the drier fringe of the cropping zone (long term average rainfall 425 mm), while Harden was representative of the higher rainfall areas of the mixed cropping zone (long term average annual rainfall 625 mm). The rotation trials were set up with pasture establishment technique to commence in two years with the type of rotation shown in Table 1. The highlighted cells show the legume regeneration results measured in this project.

Table 1 Rotation experiments at Beckom and Harden NSW

2009 treatments	2010 treatment	2011 treatment
Stand alone scarified legume	Wheat	Legume regeneration
Scarified legume + cover crop cereal	Legume regeneration	Wheat
Scarified legume + cover crop cereal	Wheat	Legume regeneration
Unscarified or in-pod legume+wheat	Legume regeneration	Wheat
Wheat	Stand alone scarified legume	Wheat
Wheat	Scarified legume + cover crop cereal	Wheat
Wheat	Scarified legume + cover crop cereal	Legume regeneration
Wheat	Unscarified or in-pod legume+wheat	Legume regeneration

Provide serial sampled nutritional information on new pasture legumes

Twelve annual legumes were established as standalone sowings at Harden in 2011 in a replicated (n=3) experiment. These were; Seaton Park subterranean clover, Antas subterranean clover (a brachycalycinum sub clover), Casbah biserrula, Margurita French serradella, Bartolo bladder clover, Prima gland clover, Paradana balansa clover, Dixie crimson clover, Sothis Eastern Star Clover, Electra purple clover and Zulu arrowleaf clover.

Harvests were taken approximately every 2 weeks on four occasions from mid spring. Additional measurements were taken on plots in mid January where sufficient material remained for sampling.

Determine the suitability of existing NIR calibrations on the new annual legumes

Feed quality data was analysed at the Wagga feed test laboratory using NIR. There had been some conjecture in the past on whether current NIR calibrations were suitable for new some of the new annual legumes. Analysis by staff at the NSW DPI feed test lab confirmed that current calibrations were adequate for all legumes grown in this experiment. Some wet chemistry was undertaken for the purpose of spot checks and it was found that results were well within the expected range.

Utilise Grazfeed to estimate the likely impact of new legumes on potential animal production

To assess potential animal production on various legume species Grazfeed was used. The Grazfeed model chosen examined potential liveweight gain in British bred weaner cattle of 240 kg bodyweight being fed an ad-lib diet containing the said legumes. No wastage factors were included.

Update the management packages developed in the Pastures Australia parent project including recruitment data after two seasons, modelled animal production opportunities and the compelling case for adoption

The additional season of funding provided by MLA allowed pasture productivity after cropping in crop-pasture rotation experiments to be analysed and included in the final management packages giving a much broader suite of information to producers on the worth of this type of systems. It also showed that these systems were more favourable using new hardseeded pasture legumes compared to traditional pasture legumes. It was also possible to include comprehensive information on herbage production and herbage quality over the spring period and this was then used to predict likely animal production.

Conduct spring field days targeting 300 participants and promote the opportunity in time for the 2012 sowing season with updated management packages

Six field days were held on-site at annual legume sowing sites – either experimental sites or in farmer sowings. The field days involved presentation of information from the research and extension sites, promotion of the management packages and quantification of producer knowledge change and future needs, that is, the field days fulfilled the requirements of field days and concluding workshops. An additional four workshops were held which were purely information sessions, management package promotion and assessment of farmer knowledge change and needs. Two of the additional workshops – Tocal and Nyngan were held in conjunction with the Pastures Updates run by the Grassland Society of NSW. In total, more than 350 farmers attended these functions with 300 useable surveys collected. Locations of field days and workshops included – Narrabri, Purlewaugh, Peak Hill, Greenethorpe, Beckom, Ungarie, Wagga, Scone, Goolma, Tocal and Nyngan. The survey was a modified, shortened version of the original 2007 survey.

4 Results

Collect new annual legume regeneration data from pasture rotation treatments implemented in 2009 and 2010 based on the twin sowing method.

Regeneration from 2009 sowings following a crop year in 2010

In general, there was increased productivity in regenerating pastures following a one year of cropping if pastures were originally established using stand alone sowing. This occurred at both Beckom and Harden (Figure 1 and Figure 2).

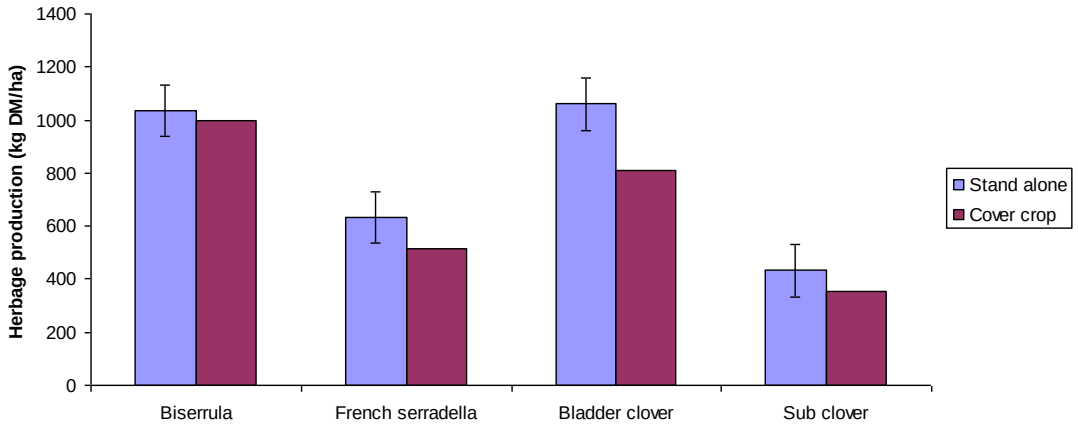

Figure 1. Herbage production (kg DM/ha) in 2011 following cropping for one year for several annual legumes established either by stand alone or cover cropping in 2009 at Beckom NSW

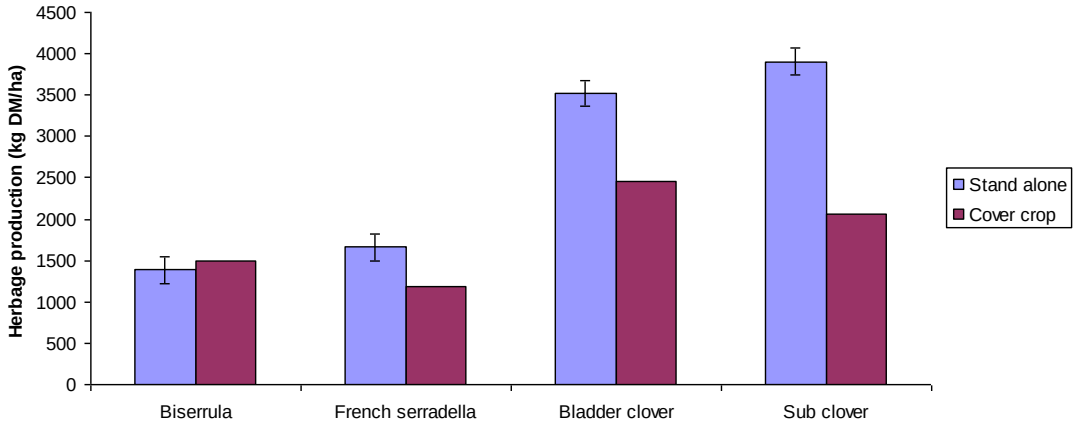

Figure 2. Herbage production (kg DM/ha) in 2011 following cropping for one year for several annual legumes established either by stand alone or cover cropping in 2009 at Harden NSW.

Regeneration of pasture from 2010 cover cropping and twin sowing

Of the three species (biserrula, French serradella, bladder clover) where twin sowing is feasible – that is they can be sown in an unscarified or in-pod form, twin sowing produced significantly higher herbage production in the regenerating pasture stand for bladder clover at Beckom and for biserrula at Harden (Figure 3 and Figure 4). Cover cropping produced significantly higher regenerating herbage production in French serradella at Beckom and in bladder clover at Harden. Interestingly, all species, regardless of establishment technique produced significantly more herbage than regenerating subterranean clover at Beckom (Figure 3) while at Harden, subterranean clover produced similar herbage to bladder clover. Overall, bladder clover production was outstanding at both Beckom and Harden.

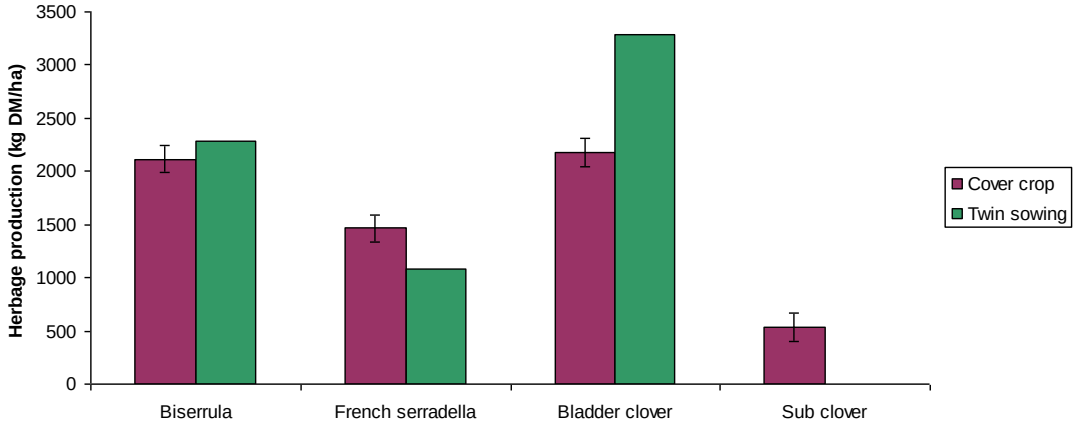

Figure 3. Herbage production (kg DM/ha) in 2011 for regenerating pastures established either by cover cropping or twin sowing in 2010 at Beckom, NSW.

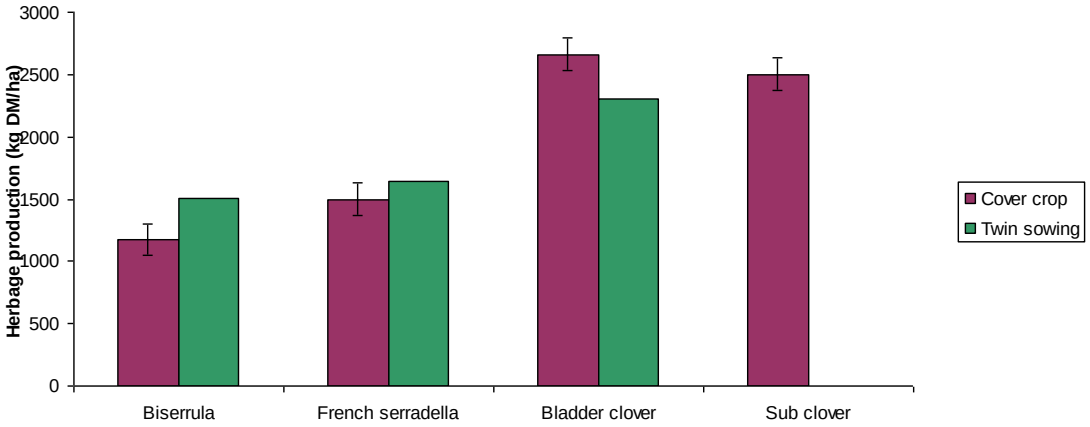

Figure 4. Herbage production (kg DM/ha) in 2011 for regenerating pastures established either by cover cropping or twin sowing in 2010 at Harden, NSW.

Changes in herbage production, feed quality and potential animal production throughout spring and early summer.

Provide serial sampled nutritional information on new pasture legumes

a) Herbage production

Herbage yield of all species except balansa clover, arrowleaf clover and purple clover peaked at the second harvest time (Figures 5-8). Balansa clover yield was greatest at harvest 1 (Figure 7), while the late maturing varieties of arrowleaf clover and purple clover peaked at harvest 3 (Figure 8).

Zulu arrowleaf clover and Electra purple clover (Figure 8) produced significantly more herbage compared to Seaton Park subterranean clover at all harvest times. At the third harvest the yield of these species was 3.5-4 times greater than Seaton Park.

The ability to produce significantly more herbage compared to Seaton Park subterranean clover was most evident at the second harvest time where all species except yellow serradella (Figure 1) and Eastern star clover (Figure 3) produced significantly more herbage. Again, herbage quality will need to be assessed to

determine whether the increase in herbage production translates to increased animal production.

Some species produced significantly more herbage compared to Seaton Park subterranean clover at the first harvest. These were Antas subterranean clover (a brachycalycinum subterranean clover, gland clover, balansa clover, purple clover and arrowleaf clover.

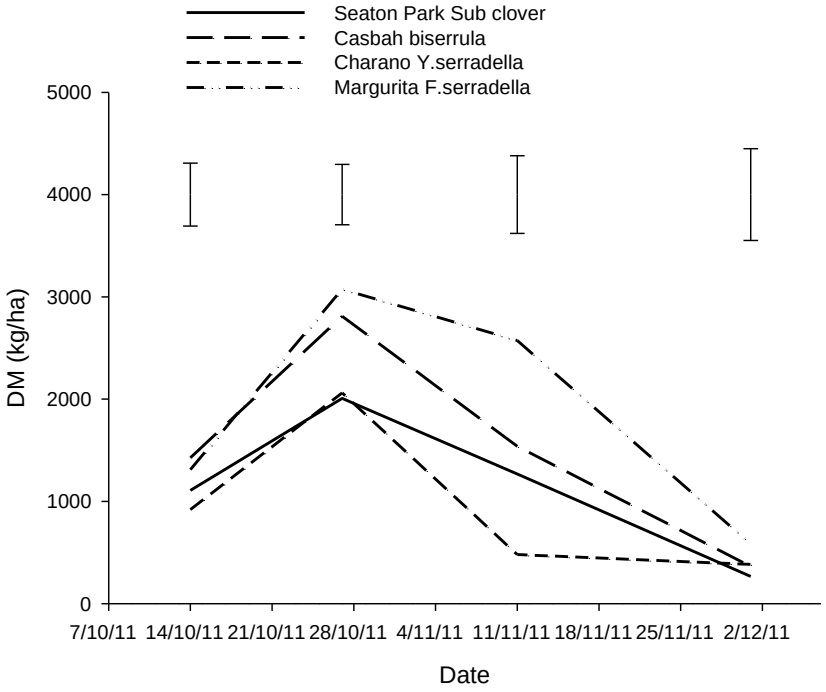

Figure 5. Herbage production (kg DM/ha) of four annual legume pastures at four times through spring 2011 at Harden NSW. Legumes were sown in May and herbage production measured is from sowing until sampling date

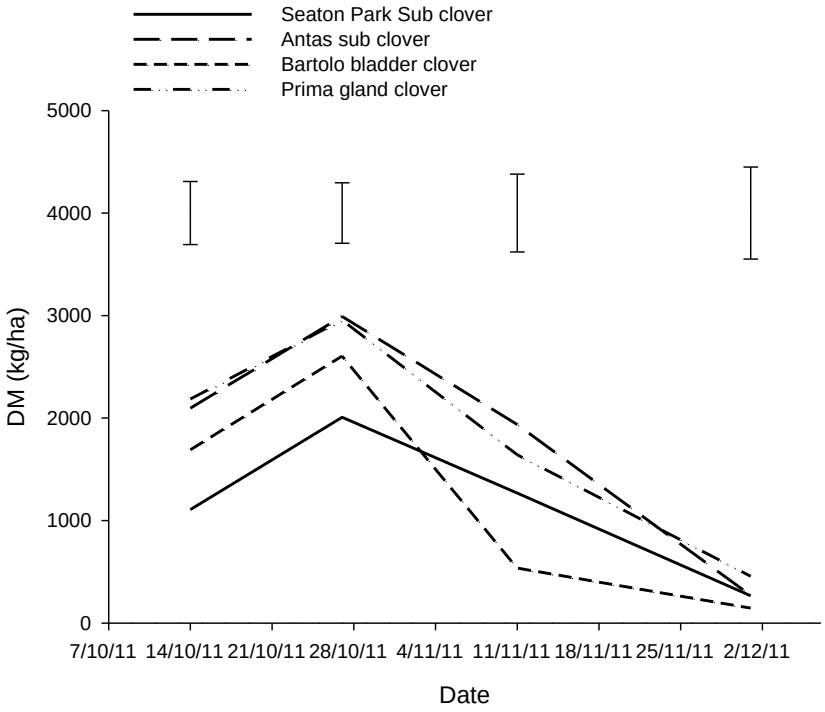

Figure 6. Herbage production (kg DM/ha) of four annual legume pastures at four times through spring 2011 at Harden NSW. Legumes were sown in May and herbage production measured is from sowing until sampling date

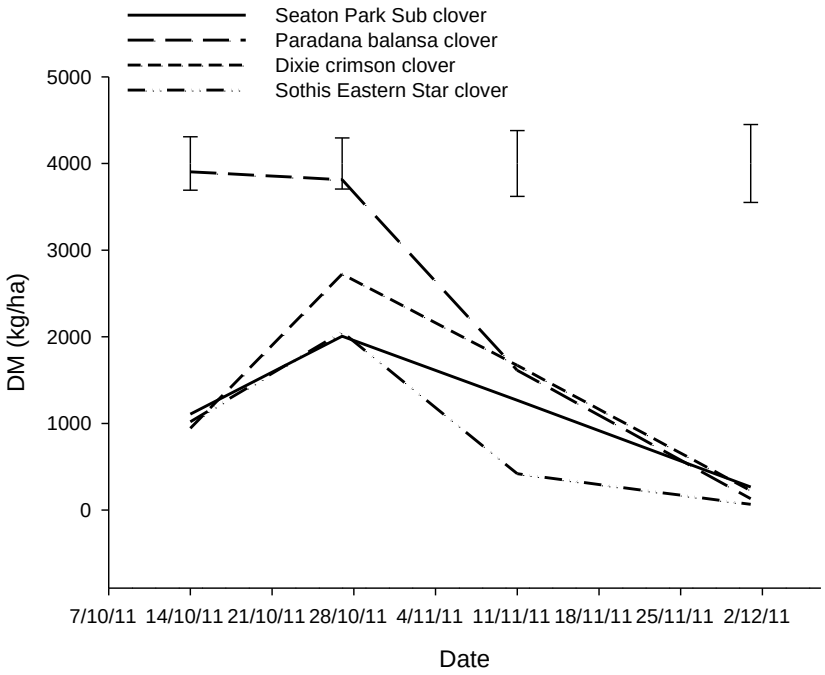

Figure 7. Herbage production (kg DM/ha) of four annual legume pastures at four times through spring 2011 at Harden NSW. Legumes were sown in May and herbage production measured is from sowing until sampling date

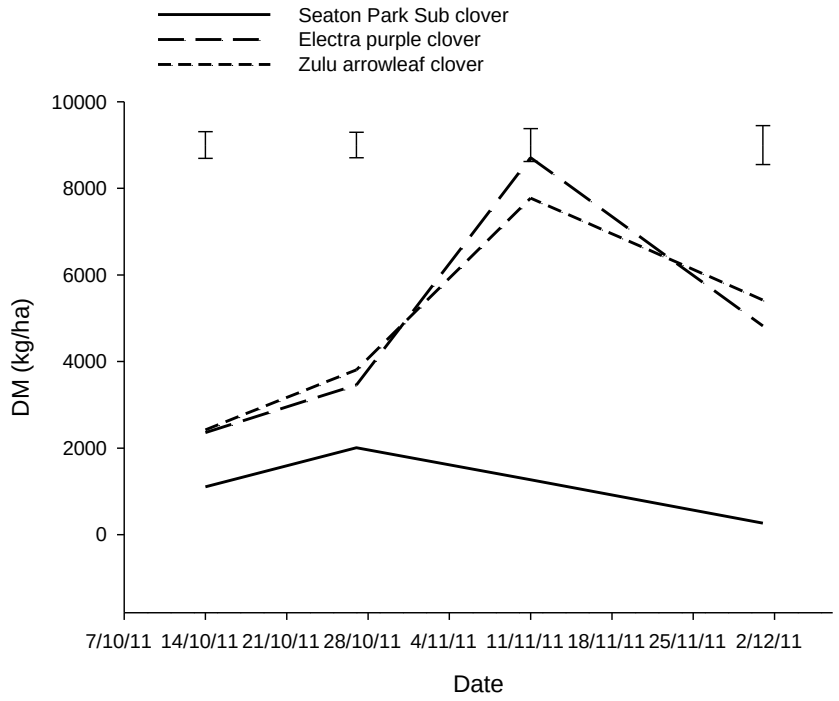

Figure 8. Herbage production (kg DM/ha) of three annual legume pastures at four times through spring 2011 at Harden NSW. Legumes were sown in May and herbage production measured is from sowing until sampling date

b) Digestibility

Digestibility of annual legume varied within and between harvests and between species (Figure 9). There was insufficient material of some species to collect herbage for quality analysis in December, but for some, there was still sufficient in January. Electra purple clover and Zulu arrowleaf clover maintained considerably higher digestibility throughout the experimental period compared to subterranean clover. Similar results were seen for Casbah biserrula and gland clover. The only annual legume where digestibility was consistently lower than subterranean clover was Sothis Eastern Star clover. It is interesting to note the relative stability in digestibility of Casbah biserrula, Prima gland clover and Paradana balansa clover into mid summer. Dixie crimson clover showed a significant increase in herbage quality from December to January which may be associated with the formation of seed and seed heads making up a large component of the final quality sample.

c) Protein

Protein levels of most legumes were initially lower than Seaton Park subterranean clover (Figure 10). In general, protein level declined more quickly in Seaton Park subterranean clover than in other species. Again several species showed good stability in protein content of remaining herbage through into mid summer.

d) Liveweight gain (kg/hd/d)

By the fourth harvest in early December, Grazfeed analysis indicated that weaner cattle would be losing weight on Seaton Park subterranean clover (Figure 11). Notably, Casbah biserrula, Bartolo bladder clover, Paradana balansa clover, Zulu arrowleaf clover and Electra purple clover were still maintaining weight gains in excess of 0.5 kg/hd/d at the same stage. Initial weight gains in early spring was similar for most species at 1.4-1.5 kg/hd/d. Exceptions to this were Prima gland

clover and Sothis Eastern Star clover, where predicted weight gains were 1.2 and 1.1 kg/hd/d respectively. This is not surprising given the early maturing nature of these species.

e) Liveweight gain (kg/ha)

Due to the higher productivity, in terms of herbage production coupled with the generally high feed quality of many of the legumes evaluated, the potential weight gain that could be achieved by using new annual legumes was considerably higher than that from Seaton Park subterranean clover (Figure 12).

Species such as gland clover, balansa clover, purple clover and arrowleaf clover had predicted liveweight gain per hectare 1.5-2 times greater than Seaton Park sub clover at the first harvest time. Purple and arrowleaf clover maintained higher potential production throughout the experimental period peaking at eight times potential liveweight gain at the third harvest. Many other species were had predicted absolute liveweight gain more than 1.5 times that of Seaton Park through the second and third harvest periods.

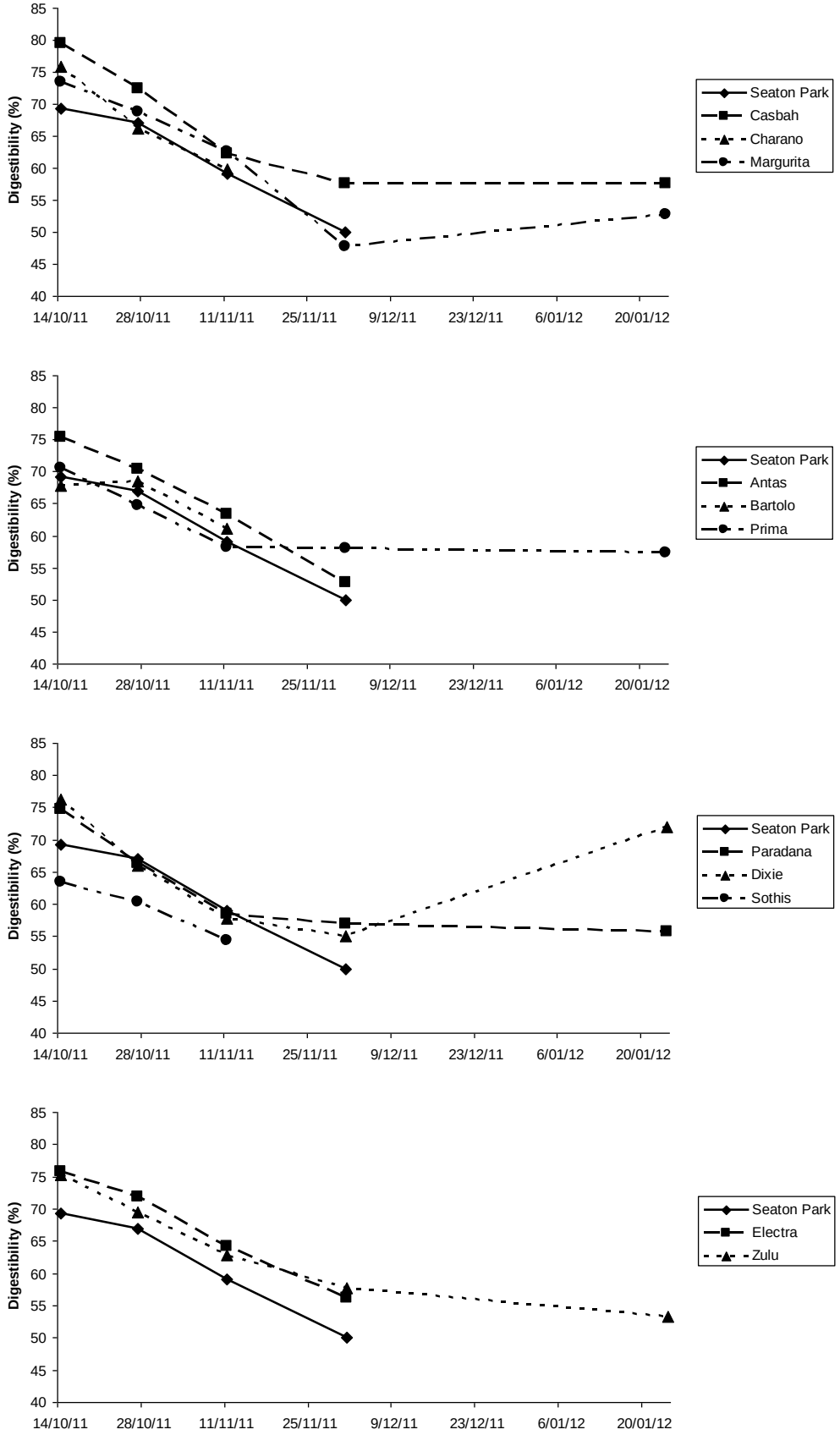

Figure 9. Digestibility of various annual legume species compared to Seaton Park subterranean clover at various times through spring and early summer 2011/12 at Harden NSW.

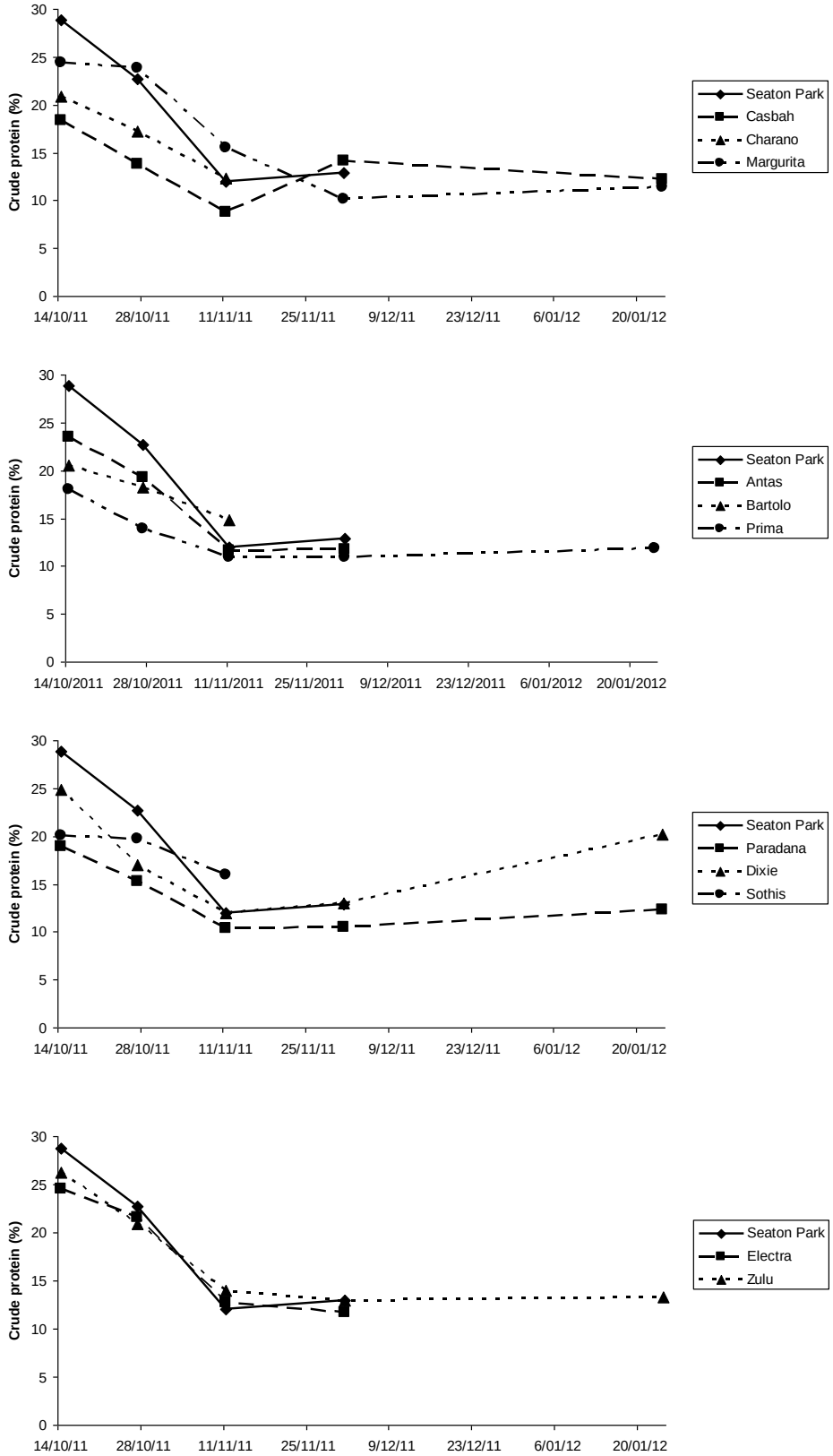

Figure 10 Protein content (%) of several annual legumes through spring/summer 2011/12 at Harden NSW compared to Seaton Park subterranean clover

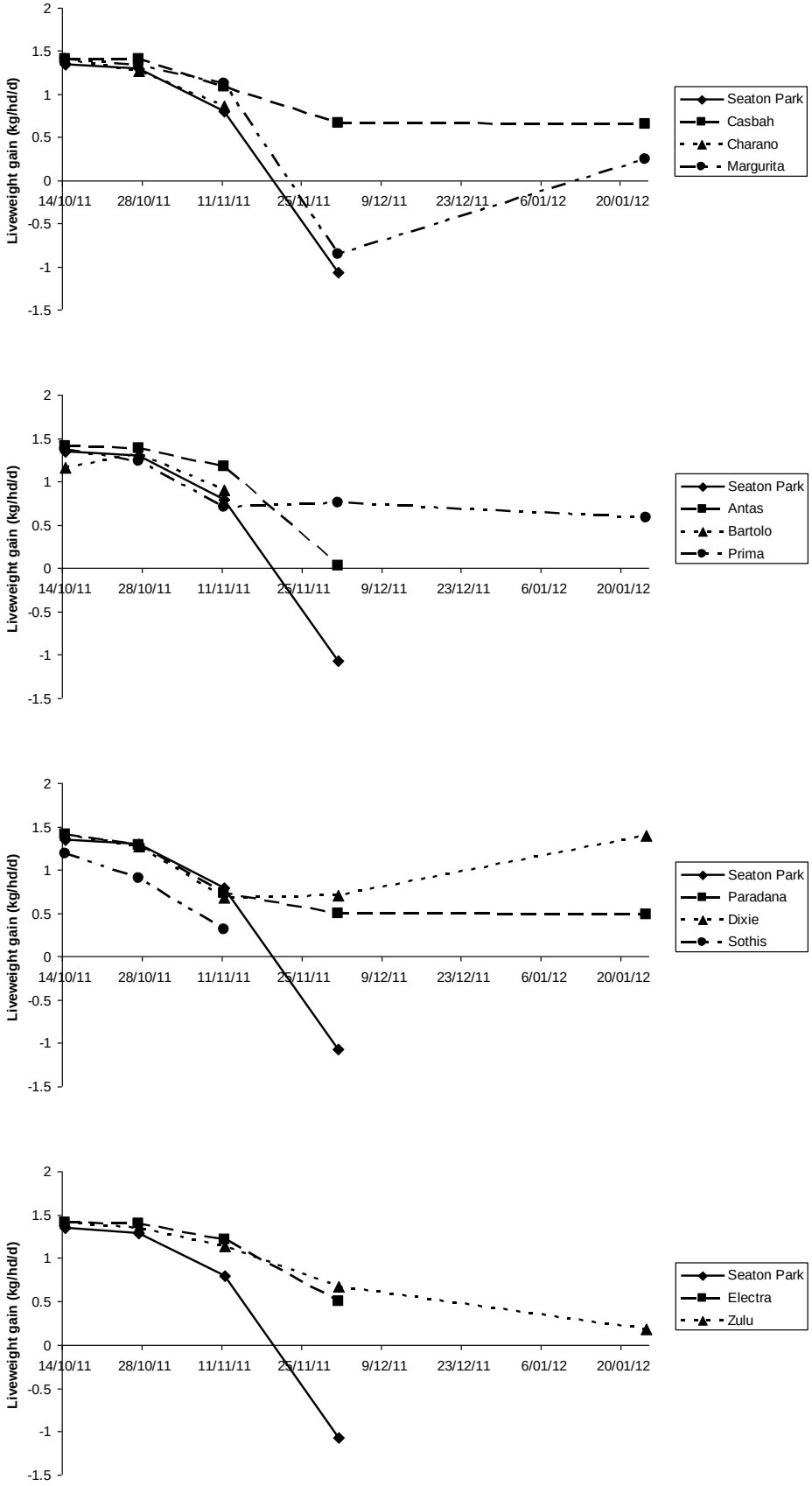

Figure 11. Predicted liveweight gain (kg/hd/d) of weaner cattle on a range of annual legumes through spring and summer 2011/12

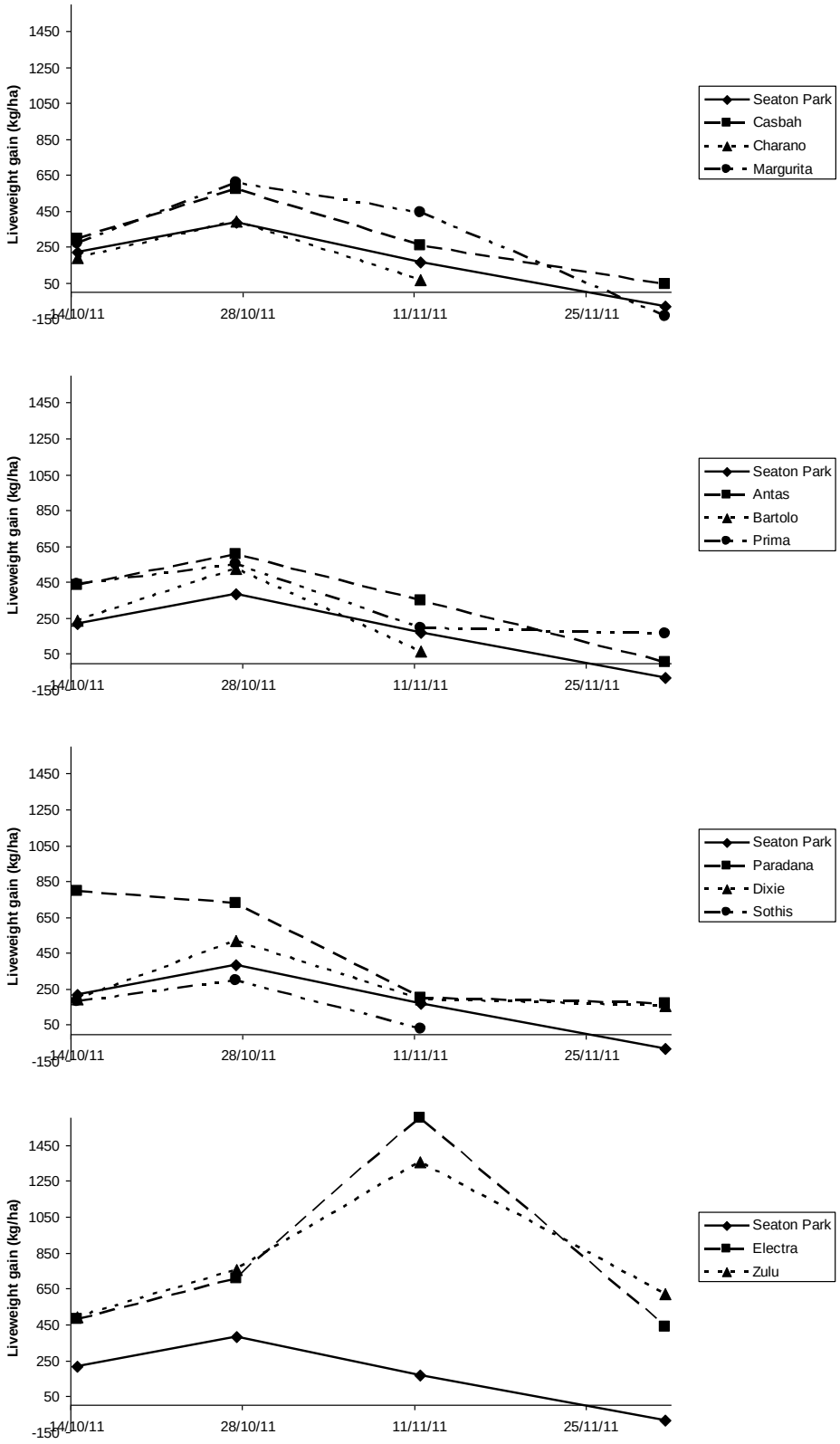

Figure 12. Predicted potential absolute liveweight gain achievable per hectare based on herbage production and herbage quality at time of sampling for weaner cattle on a range of annual legumes at various times through spring/summer 2011/12

Evaluate producer's knowledge change from the start of the parent project regarding opportunities from new legumes

Field days, workshops, producer knowledge change and future needs

Surveys undertaken at producer field days and workshops found the following:

1. Of the 300 surveys returned, 16% of respondents had grown one or more of the new legume species.
2. 80% of producers had heard of the new species and had some knowledge of how to grow and manage them. This compares to less than 5% in the 2007 survey. 93% requested further information on how to successfully grown and manage the new legumes.
3. The areas sown to new legumes was still relatively small – most commonly less than 5% of the farm
4. The most common of the alternative species sown were arrowleaf clover, balansa clover, French serradella, biserrula, bladder clover and gland clover.
5. Most interest for future sowings was also for these species
6. Farmers had experienced problems in sourcing seed in time for sowing and this was a key area holding back sowing of new species as well as all pasture species in general.

Areas specifically identified by farmers as requiring future research effort included:

1. The longevity of the seedbank under longer cropping phases. How long do the very high hardseeded species last?
2. In pasture situations, how long and how hard can the pastures be grazed and still set sufficient seed to stay in the system
3. What is the actual animal productivity from these new species as opposed to the modelled productivity
4. What is the best combination of annual legumes for a mix either in crop-pasture rotation systems or for permanent pastures in association with perennial grasses and lucerne
5. What is the feasibility of summer sowing in NSW
6. How can legumes be reintroduced to grass dominant pastures without having to go through a complete pasture renovation phase

5 Discussion and Conclusions

Collection of the final season data achieved through this project on the previously established Pastures Australia research sites has added considerably to our understanding of the role of new annual legumes in crop-pasture rotation systems and their potential impact on animal performance. The inclusion of further field days and workshops has allowed collection of knowledge change in the farming community in relation to these species as well as directing where efforts of future research and development should focus in order to meet industry needs.

With regard to regeneration of annual legumes in the crop-pasture rotations – the performance of new annual legumes indicates significant potential for NSW farming systems. The rotation experiments commenced in 2009 showed that stand alone sowing resulted in significantly higher first year herbage production, seed set and seed size (see management packages) compared to cover cropping. Results presented here from the final year where regeneration of the pasture was measured again following the cropping phase would suggest that in general, the stand alone

initial establishment resulted in better regeneration following a cropping phase. There was no significant difference in some species and it may be that the relatively soft 2010 season contributed to this. There was germination of some species under the crop in the 2010 crop year. Where normally these legumes would have been outcompeted by the crop, they generally went through to set seed and thus the seed bank was topped up to some degree in the crop year. Under normal farming conditions, these legumes would normally be taken out by a broadleaf weed spray in winter. Therefore it is probable that, particularly for the 2009 cover crop established pastures, their reasonable 2011 regeneration performance may have been heightened by refreshment of the seedbank in 2010.

Regeneration in 2011 from twin sown and covercrop 2010 established pastures showed more favourable outcomes for the cover crop treatment than was experienced in the previous year data (see management packages). Again, the better than expected result for the cover crop establishment treatments is possibly due to the very high rainfall experienced at both sites in 2010. This has probably allowed higher levels of seed set in the cover crop treatments than those measured in the 2009 season. Given the very wet conditions, the regeneration from twin sown treatment was very good. Both sites experienced high soil moisture levels in 2010 which could potentially have led to premature seed softening or rotting of seed. Twin sowing has proved to be a legitimate alternative to conventional pasture sowing methods now in very dry (2009) and very wet (2010) seasons. Bladder clover again proved to be a very robust species regenerating very strongly at both sites regardless of establishment technique. In comparison, sub clover regeneration at Beckom, the lower rainfall site was significantly less than all other species. Overall, the results indicate that new hardseeded legumes are capably surviving crop-pasture rotations that utilise their higher hard seed levels and that twin sowing has been a successful and in some cases, particularly in drier years, a superior alternative to cover cropping as a means of establishing a self-sustaining crop-pasture rotation system.

In terms of herbage production, feed quality and predicted animal production, several species were superior to standard subterranean clover. Given that seed cost is only a small component of the overall cost of preparing for, and sowing of, a new pasture, there appears to be considerable potential to incorporate new legumes into the pasture production base to achieve higher level animal production. Species including arrowleaf clover, balansa clover, biserrula, French serradella and gland clover appear to have significant scope to considerably increase animal production either throughout the entire season or strategically earlier in the season. Given the productive capacity and high feed quality of these species, it appears there is great potential to utilise them either for grazing in spring, or alternatively to capture the spring growth as silage or hay and use it to bridge the autumn winter feed gap commonly encountered through southern Australia.

The change in knowledge of new annual legumes in the four year period of the previous Pastures Australia and the current MLA project has been substantial with those indicating that they have some knowledge of how to grow and manage the species rising from less than 5% to 80%. While this has been a substantial step forward, there is still a great need to move these famers further along the knowledge pathway to a point where they have sound knowledge of how to grow and manage the new species. It is critical as this tentative stage of adoption that farmers continue to have the backing of industry relevant research and development which meets their needs to ensure that those who have adopted the new technology continue with it and draw others along who are not yet confident enough or aware enough of the attributes and advantages of inclusion of new legumes into their farming system. The feedback from surveys showed overwhelming want for specific management

information on the new legumes and this will be partly met by the release of management packages submitted with this report.

Farmers have identified, in the final field day and workshops the areas they see as requiring research input in the future. Key areas identified centre around gaining a better understanding of seedbank dynamics and longevity. Certainly, in NSW we have observed in this project distinctly different behaviour of species with regard to hard seed breakdown compared to Western Australia – this is most evident in biserrula where second year regeneration is virtually non-existent in WA. In NSW by comparison, biserrula has not failed to regenerate in any of the research experiment sowing sites or farmer sowing sites associated with this project. It is critical then, that the longevity of such seedbanks are understood in both states – therefore the farmer question of how long can an existing stand be cropped and still have sufficient seed for regeneration is a very legitimate one. Further, given differences in hard seed breakdown between species and seemingly between states, what is the role of other novel pasture establishment techniques such as summer sowing in NSW? Similarly, greater research is needed under grazed conditions to understand how much grazing duration and intensity affects seed production. The clear fit of these species is in crop-pasture rotation systems and therefore the effect of the animal on pasture seed set and consequently its ability to reliably regenerate should be at the forefront on future research. Similarly, these species are most likely to be grown in mixtures – either with other annual legumes, perennial grasses and/or lucerne. What then are the best mixes and particularly in regard to mixing with perennials –which ones are going to be most successful at competing with the perennials and regenerating reliably in these conditions? Further, given the decline in pasture quality and particularly in legume content of existing pastures – how can new legumes be introduced successfully to such pastures without having to go through a complete pasture renovation.

This project and the previous Pastures Australia project have been very successful in identifying new annual legumes for use in NSW farming systems and investigating ways of incorporating them into pasture-crop rotations. The projects have also been very successful in engaging farmers and delivering new technology to industry. The projects were essentially run with co-located research sites and farmer sowings so that at field days producers were able to inspect both areas. This approach created significant discussion amongst attendees and gave them confidence that what was been done in research experiments had practical application. Throughout this project there have been more than 2600 farmers attend field days and workshops associated with new legumes. The project was essentially designed to make farmers aware of the role new legumes could play in their pasture production systems and to encourage adoption of them. The result has been the development of strong farmer groups within regions who have learned from each other as well as researchers involved in the project. Farmers have been very supportive of the continuation of the projects so that remaining questions they have may be answered. The cooperative nature of research sites co-located with farmer sowing sites has proved to be a very efficient vehicle for helping to overcome constraints to adoption of new legumes.