finalreport

Project code: B.PAS.0005

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Date published: December 2006

PUBLISHED BY
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Review of PAST.001, Perennial Grass Improvement

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Abstract

MLA commissioned a research project in December 2003 with the Plant Based Management of Dryland Salinity CRC to enhance the improvement of perennial grasses for the grazing industries by screening accessions of perennial grasses and developing experimental varieties of tall fescue, cocksfoot and subtropical grasses suited to low rainfall regions. A review of this project was required at the end of 2006 to assess progress and achievements.

Delivery of the research objectives is going very well and there appear to be good prospects for the sub projects in each State to achieve the challenging breeding goals. The goal of developing at least 1 new fast-tracked tall fescue cultivar was abandoned because of contamination with wild endophyte. The risks associated with achieving satisfactory outcomes for more marginal rainfall zones, often with difficult soils are high. For this reason the recommendations focus on the future direction of the project to ensure the greatest chance of delivering products that will succeed.

Acknowledgements

To Bob Hannam and the research leaders at each site – viz Carol Harris, Geoff Moore, and Zhongnan Nie - for assisting with organisation of the visits; to all those in the research teams for their preparation for and constructive approach during the visits; and to Zhongnan Nie as overall project leader in particular for his efforts in making these visits run smoothly and for organising the compendium of documentation. Also to Brian Dear for his contributions in NSW and WA.

Executive Summary

MLA commissioned a research project in December 2003 with the Plant Based Management of Dryland Salinity CRC to enhance the improvement of perennial grasses to the grazing industries by screening at least 400 new accessions of perennial grasses and developing 4 experimental varieties of Australian-adapted temperate perennial grass species (fescue, tall fescue, cocksfoot and sub-tropical grasses) suited to low rainfall regions. These were to be selected for yield, ease of establishment, higher water use, nutrient value, summer/winter growth and persistence. The aim was to get these lines to seed bulk-up stage, ready for comparative testing by a commercial partner. The project will conclude in December 2008.

A review of this Perennial Grass Improvement project (PAST.001) was required at the end of 2006 to assess progress and achievements with respect to project objectives and particular emphasis on the merits of continuing to develop the target species.

Drs Roger Barlow and Sidney Cook, undertook this review for MLA during November and December 2006 during which they visited the research teams and one or two of the experimental sites in each of northern NSW, WA (north of Perth), and western Victoria. A template of questions was constructed, based on the terms of reference, and distributed to the research teams prior to the visits. This together with an open discussion environment should lead to a 'no surprises' report for the project teams.

Delivery of the research objectives at the sub project levels in each State is going very well particularly when the adverse seasonal conditions are taken into consideration. We observed dedicated and enthusiastic project teams using innovative means to address any unanticipated circumstance – and all this was based on thorough initial planning, and provision of adequate resources for the research phase.

There appear to be good prospects for the sub projects to achieve the challenging breeding goals, relative to the nominated control species or cultivars. Selections from the best tall Fescue and cocksfoot accessions are now in the crossatron at Hamilton. Similarly, large variation has been observed among the subtropical genera and accessions providing optimism for greatly improved material to be isolated here as well. There are particular problems experienced with dormancy, germination and seed production among subtropical species, of which the project teams are acutely aware and have taken measures to manage in the research phase.

The goal of developing at least 1 new fast-tracked tall fescue cultivar derived from line 358 (MRC Project No. DAV.095) for commercial release had to be abandoned because of contamination with wild endophyte

Given that the research phase is tracking well, attention to the next phases of the project, involving evaluation and development of the best options toward marketable commercial products, is now warranted. It is here that the reviewers saw particular challenges given that the project is targeting solutions for more marginal rainfall zones, often with difficult soils. The risks associated with achieving satisfactory outcomes in

these situations will escalate, and it is for this reason that the recommendations focus on the future direction of the project to ensure the greatest chance of delivering products - improved plant genetics plus management advice - that will work in the market place.

Recommendations

Recommendation 1: Undertake a rigorous analysis of the reasons why 'the market has failed', and review the assumptions in the benefit cost analyses conducted by the CRC Salinity as a prelude to planning beyond the current research phase. Economic assessment needs to include costs, benefits and potential impediments at farm level in each of the target regions.

As part of this develop a complete understanding of the possible risks and their projected impacts on this project achieving its objectives.

Recommendation 2: That a workshop/think-tank be convened as soon as possible to map out the evaluation, development, extension/commercialisation and communication strategies, and the resources required using the outputs from 1 above.

A key output will be a matrix of the trigger points for key decisions across the Research, Development, Extension & Commercialisation continuum.

Contents

1 Background

1.1 The Purpose and Description of the Review

"MLA commissioned a research project in December 2003 with the Plant Based Management of Dryland Salinity CRC to enhance the improvement of perennial grasses to the grazing industries by screening at least 400 new accessions of perennial grasses and developing 4 experimental varieties of Australian-adapted temperate perennial grass species (fescue, tall fescue, cocksfoot and sub-tropical grasses) suited to low rainfall regions. These were to be selected for yield, ease of establishment, higher water use, nutrient value, summer/winter growth and persistence. The aim was to get these lines to seed bulk-up stage, ready for comparative testing by a commercial partner. The project will conclude in December 2008.

A review of the project is now required to assess progress and achievements with respect to project objectives with particular emphasis on the merits of continuing to develop the target species."

2 Project Objectives

2.1 Review Terms of Reference

The objectives or terms of references for this review were:

"By 18 December, 2006 complete a report on the progress of the project which contains an assessment of progress of the project against milestones and contract objectives and recommendations on the merits of continuing the work. The report should place particular emphasis on:

1. performance and achievements of the project against stated objectives
2. project management and administration
3. potential for the project to deliver outcomes for dry-land pasture based industries recommended commercialization opportunities for project outputs"

"With additional detail in relation to the tasks being:

1. Submit to a briefing on the project by the MLA project coordinator and manager to obtain an understanding of the project and clarify expected outcomes of the review
2. Review all documentation relevant to the project including strategy documents, project descriptions and reports, minutes of relevant meetings and reports submitted to the management committee from time to time.
3. Review and assess the underpinning project strategy and offer recommendations for improvement if required.
4. Review all sub-projects with respect to objectives, methods, achievements.
5. Visit field sites and researcher laboratories to receive presentations from researchers engaged in active projects and ascertain performance in project activities and progress.
6. Review and make recommendations on all sub - projects with respect to progress, performance against milestones and identify significant issues and opportunities that need to be addressed for the project to be successful
7. Assess the potential for the project to deliver outcomes for industry including plans for delivery, new information needed, improvements in project structure required, potential commercialization opportunities, value to the pasture based industries.
8. Assess the fit of project outcomes with planned activities in the proposed CRC for Future Farming Industries.
9. Prepare a consolidated report of findings and make a presentation to the program investor committee on same."

An interim report, post visits to the research teams, was delivered to MLA on 30th November, detailing 'first impressions' of research progress at each of the sites. The present report delivers on the last milestone: a final report and briefing accepted by MLA by 18th December 2006.

2.2 Perennial Grass Improvement Project Objectives

As stated in the contract schedule:

The Research Organisation will achieve the following objective(s) to MLA's reasonable satisfaction:

By 30 December 2008:

1. Develop a persistent summer active tall fescue variety so as to extend its area of adaptation into lower and less reliable rainfall regions receiving a high proportion of their annual rain in summer (500-600mm per year). Relative to Demeter fescue, the elite line will have increased green biomass over summer by 20% leading to improved water use, total annual biomass by 25%, and plant persistence by 20%.

2. Develop a persistent winter active cocksfoot variety with some summer activity and selection for nutritive value for low input recharge areas and acid soils in areas receiving

400-600mm per year. Elite genotypes will increase the digestibility by at least 2%, cool-season dry matter yield by 10% and summer vigour/growth by 5-10%, relative to Currie cocksfoot.

3. Develop varieties of sub-tropical grasses suitable for profit driven adoption inTemperate and Mediterranean climatic regions. Elite lines will have 20% greater persistence, 20% greater spring dry matter and 3% increase in digestibility relative to nominated control cultivars.

4. Develop at least 1 new fast-tracked tall fescue cultivar derived from line 358 (MRC Project No. DAV.095) for commercial release of an Australian adapted temperate perennial grass species suited to medium to low rainfall regions and improved for water use, nutritive value, summer/winter growth and persistence. Selected genotypes will show a 20-30% improvement in winter and summer herbage yield compared to Demeter fescue; a 20% increase in seedling vigour compared to Demeter and improved digestibility (3%) compared to Demeter in spring, at maturity and in autumn.

5. Establish an arrangement, approved by MLA, with a commercial partner, approved by MLA, for the fast-tracked fescue and selected sub-tropical lines, and develop a commercialisation plan for elite lines of fescue and cocksfoot.

6. Subject to clause 5.5, seek interim protection from the plant breeder's rights (PBR) office and provide a commercial brief suitable for attracting expressions of interest from potential licensees, who will be expected to pay for PBR application, extended merit-testing, seed increase and marketing costs.

Additional details were agreed by MLA and the Salinity CRC to be undertaken to achieve the objectives of the project, as follows: To achieve the objectives by December 31 2008, this project will have:

1. Identified the main divergent groups of cocksfoot and tall fescue by analysis of the genomes through cooperation with the Molecular Plant Breeding CRC, including ploidy analysis and phenotyping

2. Developed a database of elite temperate grass plants from the broadest genetic base to guide future plant breeding activities

3. Developed a database of elite sub-tropical grass plants as germplasm for future breeding of varieties suited to the western and eastern wheat zones following comparative testing against the best available commercial cultivars of broadly adapted grasses/herbs.

4. Supported a Management Group of the representative scientists, the CRC and MLA to manage the project, and develop annual operational plans for the project.

5. Distributed promising perennial grass material for evaluation at widespread and contrasting sites by co-operators within the CRC PMDS regional evaluation network, and related producer sites where deemed appropriate by the Management Group. Advanced testing of new lines will be conducted on farmers' properties to facilitate technology transfer and adoption. Also, advanced lines of promising material will be provided to other programs within the CRC such as the farming systems program to evaluate water use; Grain and Graze project and to farmer groups such as the Evergreen group for demonstrations to advance the rate of adoption, provided IP of MLA and CRC is adequately protected.

6. Initiated links with private sector seed companies by June 2004 by seeking their participation in the project management

7. Participated in an external review of the project in 2006. This review will be funded separately from the contract.

Included in this documentation of additional details, there are slightly different emphases on the desired outputs, but the stated biological targets are the same for each of the species groups [see appendix 7.1].

And to the point at which this review was undertaken in November 2006, the project milestones were primarily reporting achievement of objectives against operational plans. One of the roles of the Project Management Committee (PMC) is to monitor progress and vet the milestone reports, the 6th of which is due on 31st December 2006, as set out below. Given that the investors are represented on the PMC, and it would be in their interests to undertake this monitoring role diligently, the role of the current review is to provide an external and independent view of progress but more importantly prospectivity regarding the proposed project outputs.

Milestones for the project to December 2006

Number	Milestone and achievement criteria	Due date
1	1.1 Operational plan, including breeding and selection objectives, method and protocols, prospective sub-tropical species, availability of germplasm. 1.2 Development of database containing a compiled list of germplasm for selection and breeding.	28/02/2004
2	Achievement of objectives against operational plan	30/05/2004
3	Achievement of objectives against operational plan	30/12/2004
4	Achievement of objectives against operational plan	30/06/2005
5	5.1 Achievement of objectives against operational plan. 5.2 An outline of a potential process for development of commercialisation plans.	30/12/2005
6	6.1 Achievement of objectives against operational plan. 6.2 Review annual operational plan. No/Go Point: Decision made by MLA as to whether to progress the fast-tracked fescue, tall fescue, cocksfoot and subtropical projects following an external review initiated by MLA.	30/12/2006

3 Methodology

Review team
MLA contracted Dr Roger Barlow (of R&PA Barlow P/L) to lead this review. He and Dr Sidney Cook, (previously with the Division of Tropical Crops and Pastures, CSIRO; Landmark; and now with Queensland Murray-Darling Committee Inc.), undertook the review during November and December 2006.

Prior reading
A compendium of prior reports, and relevant email traffic was provided in electronic format by MLA; and the main reports were provided as bound hard copy by the research leader, Dr Zhongnan Nie, immediately prior to the research site visits. A list of this material is:

1. Project team, project overview and summary of progress provided by Dr Zhongnan Nie
2. Project contract and 'additional details' document.
3. Project proposal
4. Project protocol and operational plans
5. Project team and Project Management Committee meeting agendas and minutes
6. Commercialisation documentation
7. Milestone reports
8. Additional material included:
    a. Presentations by the research teams at each site
    b. Graphical presentation of results
    c. CRC economic analysis documentation
    d. CRC phase 2 bid documentation relevant to the Perennial Grass Project

Research location visits
The research teams in each of the three states, NSW, WA and Victoria were visited by the review team and Dr Bob Hannam (and also by Dr Brian Dear in NSW and WA) during the period 14 to 23 November 2006 (see appendix 7.2). The format of all the visits was to visit one (WA) or two (NSW & VIC) of the research sites with local members of the research team, followed by a meeting and formal presentation (at DPI/DAF offices in Inverell, Perth and Hamilton, PRI). At each of the three locations the local research team members presented their results and views on how the project was going and what the next steps should be, with an interactive discussion between the research and review teams taking place. Initially it was proposed to conduct a structured interactive SWOT, but in the end this was not done at any site because of the way the discussions developed. Nevertheless, the original objectives of the SWOT were achieved. Consequently this be a 'no surprises' report for the project teams.

Given that the project leader, Zhongnan Nie (recently appointed to this position following Dr Kevin Reed's retirement) is based at Hamilton, there was more discussion at this location about how the administration and management of the overall project was tracking. However questions about this were posed at the other sites as well.

A template of questions was constructed and distributed to the research teams prior to the visits. The elements of this were extracted from the terms of reference above as the key questions about which the review team needed to come away with satisfactory information. The draft completed templates for each site were submitted as part of the interim report, and since these have been amended following feedback from the research leaders the updated versions are appended here (Appendix 7.3). This is the detailed material for the conclusions and recommendations below.

4 Conclusions

4.1 Conclusions and Discussion

The key elements of the terms of reference and the additional details requested for this review have been integrated below so that conclusions can be aligned to best advantage:

4.1.1 Review and assess the underpinning project strategy

The elements of the strategy are:

- Research to identify superior accessions to the current benchmark species, within species [and between and within genera for sub tropical species], by screening large populations derived from similar climatic regions, with the option to use between family variation subsequently. This appears sound from a genetic theory perspective, given the reasonable assumption of large variation between and within such populations; and innovative in terms of attempting to minimise the time to market of .
- Developing synthetics from crosses among the best of this material and selecting superior offspring in the case of cross pollinating species; or in the case of subtropical species, material superior to current cultivars will be identified for further development. Again there is no obvious reason why this should not work (although selection to deliver security of Intellectual Property (IP) through Plant Breeders Rights (PBR) runs counter to maximising genetic gain – see later).

In relation to both the above points the major caveat is - as long as the criteria upon which selections are made at this early stage are highly correlated with performance under the range of commercial conditions in which they will be expected to perform, as measured by sustained improvements in animal and environmental performance. This is no small assumption. One safeguard would be not to narrow the material down too quickly to a few selections – but this does have cost implications. A balance would need to be struck. Further to this there are other important traits that will need to be considered (such as palatability and persistence under grazing), and the more traits under selection the less progress that can be made in any one of these.

- Wider, scaled up evaluation of the material identified as superior is proposed and this will be essential to develop confidence that there is a reasonable probability

of improved performance under such commercial conditions. The methodology to be chosen here will bear considerable thought [see Section 4.1.4].

This project is attacking a difficult 'market' – more marginal rainfall areas, often with difficult soil types, in which there are currently no suitable perennial grasses. In other words the low hanging fruit have been picked, which makes good sense, but now we are attempting to deal with more difficult goals. As such it is important to be clear on why the market is failing here [there are generally good reasons for markets failing] and then [having already decided that this appears a worthwhile prize] examine why and how this project can succeed in the face of what will be inevitably greater difficulties than have been experienced in higher rainfall areas with better soils. Even under favourable conditions, payback periods for pasture improvement on farm can be considerable. And more marginal conditions will bring greater risks, such as failure to establish a sufficiently vigorous stand. We expand more on these considerations in Section 4.1.4.

- There could be merit in categorising and perhaps selecting subtropical grasses based on their response to fertility. For example, the *Panicum*, *Setaria* and *Cenchrus* species tend to have a moderate to high fertility demand, *Chloris* spp have a moderate fertility demand, while *Bothriochloa* and *Digitaria* species have a moderate to low fertility demand. In other words, *Panicums* will not persist and produce well on lower fertility soils unless additional nutrition is provided. Where nutrition is marginal, the *Bothriochloa* and *Digitaria* species are likely to persist better. Providing options according to the likely nutrient status of the soils in the target environments may therefore make sense.

- Very sensibly, benefit cost analyses (BCA) were conducted at the outset to determine that the size of the prize is worth the investment, and these looked very favourable. But as is well known, the outcomes BCA are dependent on the validity of the assumptions that underpin them. For this reason BCA is better used as a planning tool with rigorous reality checks about the investment strategy, rather than simply as an attempt to come up with a number that justifies the investment.

How realistic were the initial BCA assumptions? These would be worth re examining in light of information contained in the more recent market research conducted by Gout and Jones for Pastures Australia. For example there is considerable sensitivity to the likely area to be impacted, the per hectare profit margin, and the timing. And can the high levels of attribution be defended? The answer to the latter depends on the extent to which the outcomes are independent of non-project funded inputs.
Potentially competing technologies like the phalaris cultivars recently developed by CSIRO [and mention was made of a cold tolerant Setaria being developed by CSIRO, as well as new Tasmanian cocksfoot(s)] also need to be taken into account when estimating likely market share. It is not clear whether this was considered.

- To attain rapid and sustained practice change at the levels assumed in the BCA, the proposed investments in developing rigorous management packages around

the improved cultivars, and the allied extension strategy, are going to be important.

A question that arises here is – will the amount proposed to invest in development and extension be sufficient to deliver the levels of change assumed in the BCA. Given the modest levels indicated, and the short term time frames over which investment is projected, our view is that it is likely to fall short of what will be needed eventually.
And there is some 'baggage' regarding prior experiences with a number of the target species, which is considered at least in part to be due to inappropriate grazing management. This emphasises the importance of getting it right this time. The flip side is that the more robust the new cultivars are to 'mismanagement', the more likely they are to succeed.

- Engaging with potential commercialiser(s) at an early stage, as was planned and is happening now, is to be applauded, as these parties should bring a dose of market reality to the table (notwithstanding tactics to position themselves favourably for subsequent negotiations).

The development of commercialisation strategies and discussions should be informed by the above mentioned analyses. Intellectual property (IP) protection and management strategies should be considered as part of this. The CRC Salinity is responsible for managing both IP and commercialisation on behalf of MLA as we understand it.

Is it reasonable to assume that the main aim of IP management will be freedom to operate and to get improved cultivars out onto farms for the benefit of farmers, rather than recouping costs or revenue-raising per se? Clarity here will help to formulate the best approach to IP protection. For example the requirements for uniformity to attain PBR will dissipate selection effort for productive traits and extend the timeframe. It is noted that in the case of apomictic bunch grasses it is proposed to use a trademark approach instead.

4.1.2 Achievements of the project against objectives

a) Review all sub-projects with respect to objectives, methods, achievements.
b) Ascertain performance in project activities and progress.
c) Review and make recommendations on all sub - projects with respect to progress, performance against milestones

- Delivery of the research objectives at the sub project level is going incredibly well particularly when the adverse seasonal conditions are taken into consideration. Milestones and targets appear to have been met by the indicated time lines. In the case of the subtropical species, the WA project team faced and overcame additional problems - of expert opinion based on Queensland experience providing almost counter-productive advice on the best prospects for that region; the need to work with AQIS/WAQIS to obtain approval to introduce new material into WA; developing new knowledge and capacity in relation to seed production; and new methodology like NIR calibrations for quality measures.

- We observed very dedicated and enthusiastic project teams using innovative means to address unanticipated circumstances – and all this was based on thorough initial planning, and provision of adequate resources (at least for research). Detailed protocols were agreed at the outset, but where necessary these have been adapted to suit particular problems – dealing with rapidly spreading Rhodes grass being one example. Another example of innovation was the mapping of the climatic zones in the SW of WA, which established likely zones of subtropical species applicability and identified a cold zone where winter survival will present a particular challenge.

- There appear to be good prospects for the sub projects to achieve what have to be said are quite challenging breeding goals, relative to the nominated control species or cultivars. Phenotypic variation in individual traits is large in all cases as depicted in Figure 1 below, in line with the underpinning assumption of the breeding strategy. The challenge is to find variation in the desired direction in all target traits simultaneously. Improving digestibility of cocksfoot by the required amount looks like it will require use of between family variation.

There is large variation between and within the subtropical grass genera. However, Rhodes grass accessions appear to be based on a narrower genetic base than the bunch grasses and so improvement within this species, if required as one of the key core species, will mainly derive from further breeding and selection using the most diverse parent material available. (The costs and risks of attempting to access new material from South Africa are high, so it is worth trying this avenue first). And this there is considerable variation in ‘non target’ traits like rate of spreading which could have particular value on light WA soils in summer.

- Selections from the best tall Fescue and cocksfoot accessions are now in the crossatron at Hamilton – right ‘on song’.

- There are particular problems experienced with dormancy, germination and seed production among subtropical species, of which the project teams are acutely aware and have taken measures to manage in the research phase. We expand on this in Section 4.1.4.

- The goal of developing at least 1 new fast-tracked tall fescue cultivar derived from line 358 (MRC Project No. DAV.095) for commercial release had to be abandoned. This was because it had not been tested for endophyte status previously, and when it was tested it was found to be contaminated with wild endophyte. (Milestone Report 4 has more detail on this testing). There is a lesson here regarding risk management as it is now relatively cheap to do this and so the earlier this is done in the breeding program the less costly development will be.

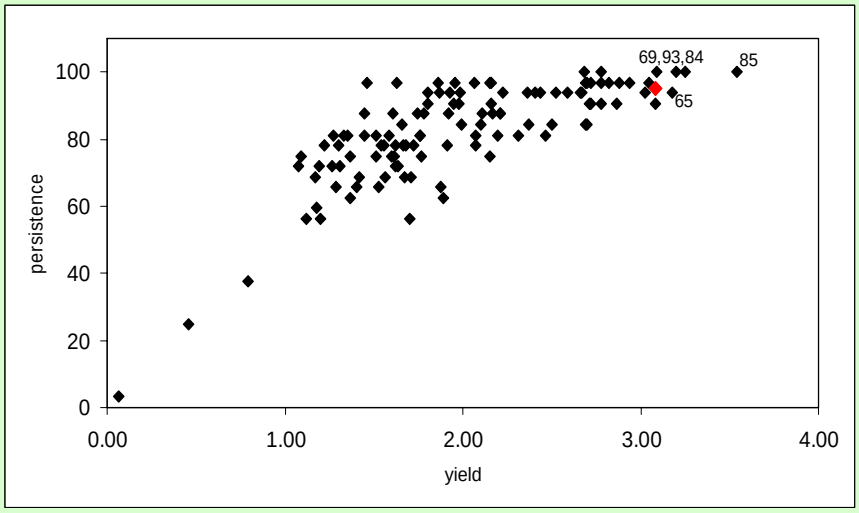
- Real world assessment is yet to come, and we consider the particular challenges that need to be met during the development phase of the project in greater detail in Section 4.1.4.

- We consider that extension and awareness effort has been pitched at just about the right level by the project teams. With a project such as this where products are not expected to be on the market for some years yet, there is a balance to be struck between raising expectations prematurely and promoting the work. From here on the emphasis will swing more toward D&E and so this can be ramped up over time, as we discuss below, and in particular the *involvement* of farmer and commercial representatives in the project will be warranted.

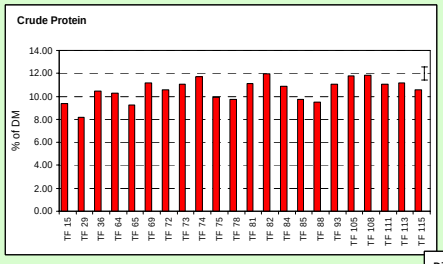
- Although we have not undertaken an exhaustive audit, the publication efforts of the teams seem reasonable at this early stage of the project. The book "Perennial Pastures for WA" was a considerable effort in its own right. Opportunities for scientific and extension publications as well as development of management packages will ramp up from here on.

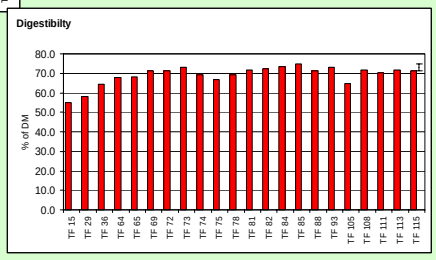
NSW Fescue examples of variation for traits of interest

Inverell-yield & persistence

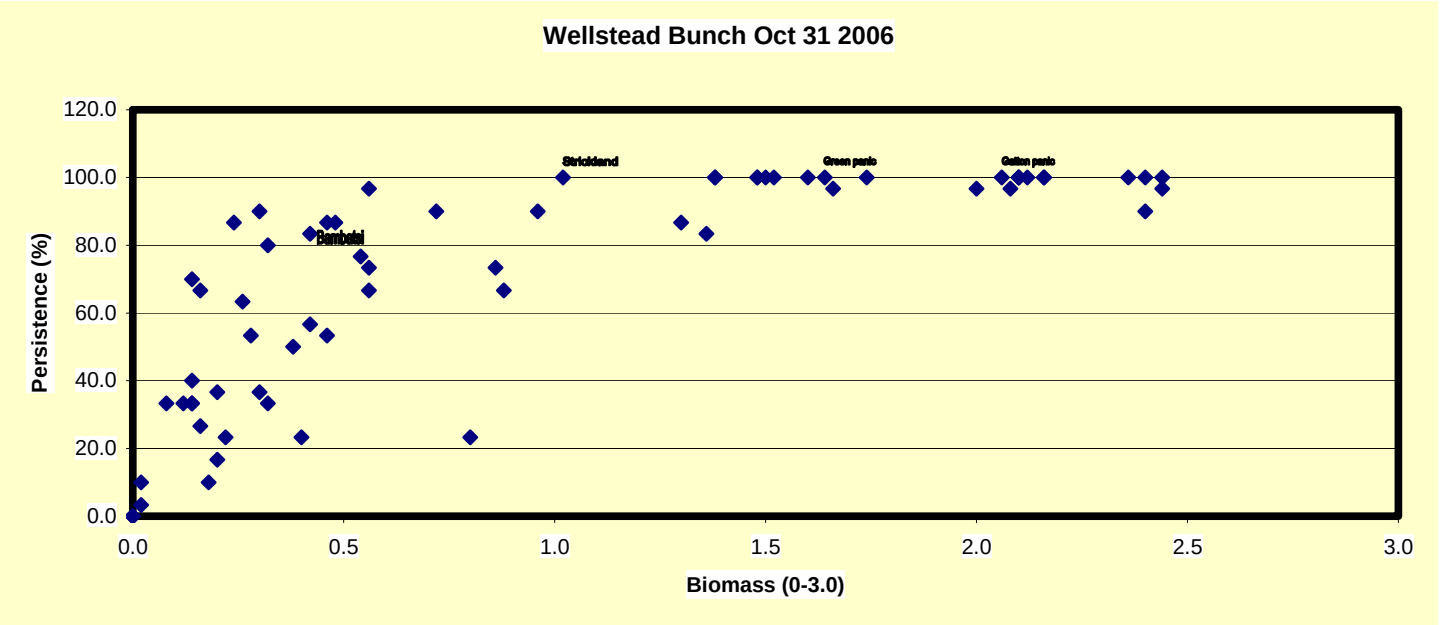


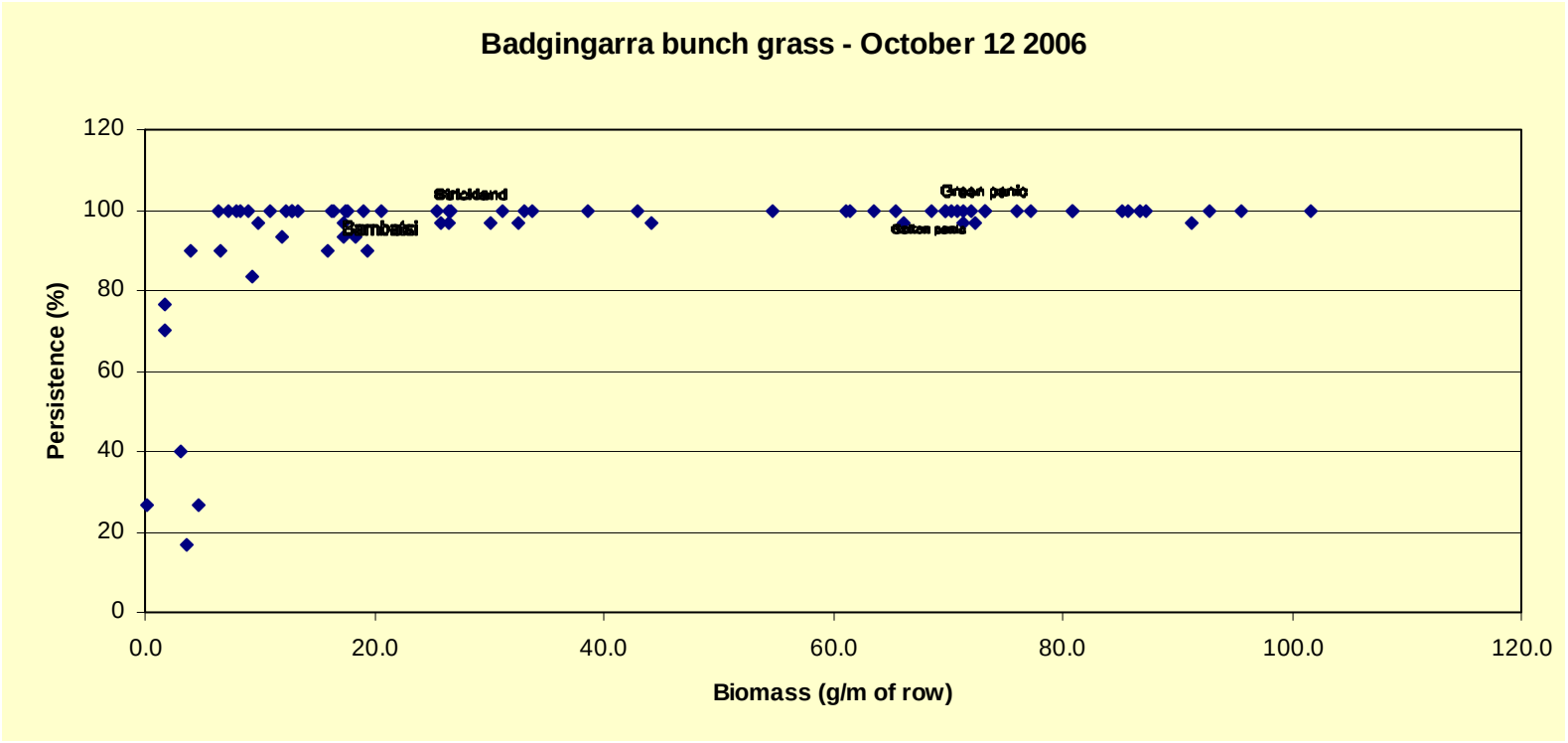
Inverell-nutritive value



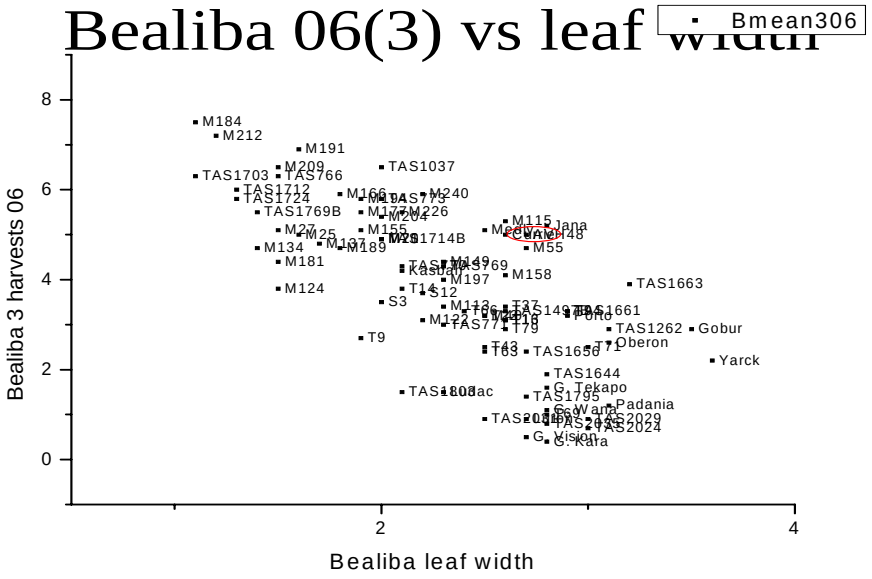


WA bunch grass spaced plant row trials bi-plot examples of variation




Badgingarra bunch grass - October 12 2006
Persistence (%)
120
100
80
60
40
20
0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
Biomass (g/m of row)
Strickland
Bambatsi
Green panic

Victorian cocksfoot bi-plot examples of variation.



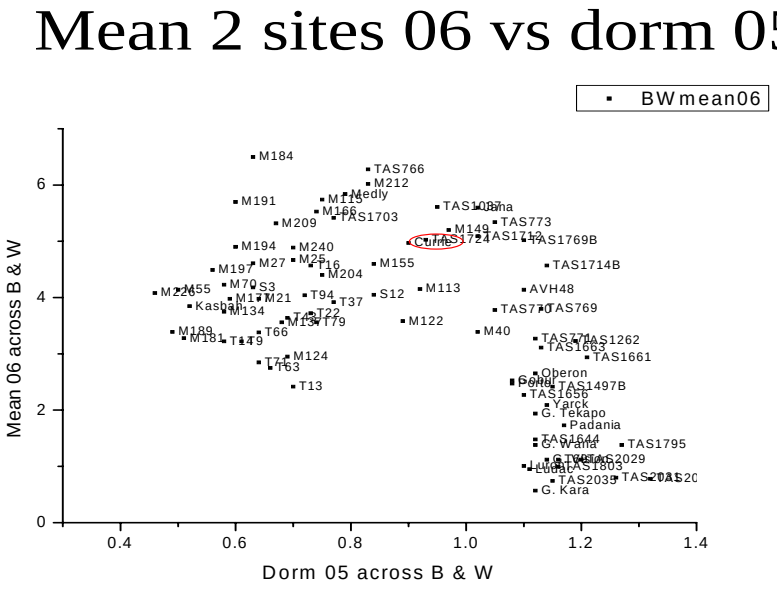


Figure 1 – Examples of the variation in the primary species and target traits at each site

4.1.3 Project management and administration

- Each sub project leader was asked how the project and MLA administration was going and whether there were any issues or problems that they thought needed attention. All responded that there were no issues and that it was working very well, with the recent transition from Kevin Reed as overall project leader to Zhongnan Nie being particularly smooth.

- Certainly the review team's brief encounter with the project at its various levels gave us confidence that there is very dedicated and capable team leadership in place.

- One issue that we did raise was the difficulties and potential OH&S issues raised by servicing remote sites, which involve travelling back to base late after a long day's work. While it was not considered to be a particular issue at any site, it is something to keep an eye on in terms of staff safety and potential liability. The only issue that was raised in relation to this was the difficulty of organising staff to work outside public service hours. Having said this, at all sites support staffing was considered by the research teams to be adequate.

- Zhongnan Nie raised a few points, some of which should be followed up with MLA:
    - MLA's contract period and the DPI financial year do differ and this presents some additional work for him in managing financial reporting
    - In WA unplanned salary rises are eating into the operating budget, with potential impacts on project outputs. This needs to be explored.
    - Although there are different reporting requirements for the various parties (MLA, CRC, DPIs) this does not seem to present particular issues. MLA has the most voluminous requirement and this provides the material for the other parties' reports.
    - The CRC is very supportive and facilitates greater collaboration than would otherwise occur. Bruce Cook's inputs have been funded by the CRC for example. However we noted that involvement with the CRC has not brought PhD students into the project in the numbers we would like to see. Apparently they are difficult to 'recruit' (a common story in agricultural faculties), but we wonder if more of a natural resource management emphasis was applied, whether this might make a difference. And this could be turned into a win-win.

- We have no direct experience with the way the Project Management Committee (PMC) operates but knowing the capability of each of the committee members, and scanning the minutes of their meetings gives confidence that overall direction as well as monitoring and evaluation are in capable hands. MLA has two members on this committee, who together with Mike Ewing and Brian Dear provide a measure of 'arms length' representation. Consideration might be given

to including 'independent' farmer representation on the PMC in the next, more applied phases of this project.

4.1.4 Potential for the project to deliver outcomes for industry

Assess the potential for the project to deliver outcomes for industry including :

a. plans for delivery,
b. new information needed,
c. improvements in project structure required,
d. potential commercialisation opportunities,
e. value to the pasture based industries.

To date the main focus has been on screening of genetic material. However, once elite lines have been identified, and/or new cultivars have been produced, there will need to be a much greater focus on extension activities if the Project outcomes are to be successfully adopted by farmers.

- In this regard, we believe that the northern NSW team is in the enviable position of having two experienced extension officers associated with the Project. These two have already identified the need for the key outputs of the Project, both for the tall Fescue and subtropical grasses in the region. They are also aware of many of the issues facing the introduction of this technology in the region (McGufficke and McCormick, 2005).

- The Western Australian team has the benefit of being closely associated with the Evergreen farmers, who are already experimenting with subtropical grasses. We can only reinforce the importance of such groups during the adoption of new technology. We also believe that the Project team should start feeding new ideas into this group so that some of the practical issues facing successful adoption of outputs generated by the Project can be tested by the time that the new genetic material is ready for release.

- The Victorians appear to be light on in this area, with few departmental extension staff available and no direct association with farming groups like Evergreen. Some issues might be tested in other associated research projects being run in the area (eg. Grain and Graze, Evergraze). We understand the Birchip cropping group might also present an opportunity.

- Apart from that planned within the Project, the project team needs to investigate other outlets for dissemination of ideas and information relating to the Project. For example, it seems important to engage local agribusiness outlets, especially in Victoria where, as we were told, most farmers obtain their pasture planting advice, including what species and cultivars to plant. Local agribusiness needs to understand the background to the Project, the deficiencies of existing varieties and cultivars, and the role of new genetic material emanating from it. This may help reduce 'substitution' of inferior

material and the likely failures that would result, thereby damaging the credibility of the technology being promoted.

- The CRC might consider [if it has not already] developing closer relations with the Catchment Management Authorities (CMA's) in the different States. These organisations are involved in Natural Resource and Environmental Management in their respective areas. Many of these, at least in southern Australia, do not support the sowing of introduced pasture species. Many of the staff in CMA's tend to have training in Natural Resources and the Environment and have little understanding or appreciation of agriculture. On the other hand, their objectives in relation to salinity control line up with the objectives of the CRC, and they often control large budgets for environmental management.

Negotiating a successful outcome may not be easy, but gaining the support of CMA's could have widespread advantages in assisting the extension and adoption of outcomes generated by this and other projects. It could be a 'win-win' for the CRC and the Project as well as for the CMA's who do not currently have viable solutions for recharge management, at least solutions that are favourably disposed to farmers. CMA's may also be able to provide "incentive payments" for adoption of new technology that directly addresses a natural resource/ environmental issue, such as is already the case with deep rooted, improved perennial grasses in Queensland.

- There are a number of questions that will need to be answered prior to the widespread adoption of the technology emanating from this Project. For example, most of the target areas tend to be low fertility sandy soils and some of these areas are in marginal to low rainfall environments. Weeds were reported as being a problem at most of the field sites. Grazing management may also be an issue. It is one thing for the new material to persist in these somewhat hostile environments in small experimental plots, it could be another when they are subjected to defoliation on top of environmental stress. Information packages need to be developed and available for when the new technology is ready to be rolled out.

- All grasses are being evaluated using a basal application of both phosphatic and nitrogen fertilisers in the breeding and screening nurseries. But how is it proposed to supply nutrients to these grasses in commercial practice? Are the basic requirements for persistence and production known? Will it be economic to apply mineral fertilisers? The Victorian target areas have particularly hostile soils with high acidity and high levels of aluminium. Are lime applications warranted or economic? What is the requirement for trace elements on these soils?

- Will legumes be used as a source of N? How compatible are temperate legumes with the subtropical grasses and will any special management be required to maintain a favourable botanical balance? Sub clover is likely to

be trying to set seed at a time when the tropical grasses are starting to 'take off'. Maturity length in sub clover, or indeed other legumes, may therefore become more of an issue than it has been, in the same way as it is for annual medics in southern Queensland. Are there legumes that will grow and 'fix' sufficient nitrogen to sustain the grasses on the highly acid, high aluminium soils in Victoria? We note that while some screening for alternate legumes has already begun on these soils at the Bealiba site, this may be a project in its own right.

- Weeds were reported as a major problem at all field sites. Annual grass weeds (ryegrass and silver grass) were an issue at Victorian sites, and certainly could be where old cultivations are being returned to pasture in northern NSW (Barnyard grasses, liverseed grass). Broadleaf weeds were an issue in Western Australia and at Inverell, because of the late rains delaying establishment of the grasses. The greatest threat is from grass weeds as control measures are limited once they are present. Packages have already been developed for the northern NSW situations by the two experienced extension officers associated with that site (McGufficke and McCormick, 2005). In other situations the information packages dealing with weeds in the different environments need to be developed, so that they can be implemented during the roll out of the new technology.

- The harvesting and marketing of tropical grass seed is quite specialised and generally varies from that of temperate species. The book "Forage Seed Production – 2. Tropical and subtropical species", edited by D.S. Loch and J.E. Ferguson (CABI Publishing, 1999) outlines the issues well.

In their overview chapter Loch and Ferguson state that "Most of these grasses and legumes come from species new to agriculture. In contrast with the other major temperate forages (e.g. Festuca, Lolium, Medicago, Trifolium spp.), they have not undergone long periods of domestication through hybridisation and selection. Instead, they still retain many 'wild' characteristics – attributes which aid their natural spread but pose difficulties for commercial seed production". (It is not uncommon for Panicums to be shedding mature seed from the bottom of the panicles whilst the uppermost florets are still flowering). Hence, many tropical grasses have to be harvested at high moisture content when some of the seed is still immature. Harvested seed lots are therefore likely to contain both immature as well as mature seed. Seed dormancy is a well known characteristic of many tropical grasses. The establishment problems encountered at both the Inverell and Western Australian sites could be avoided provided the particular forms of seed dormancy are understood, with the type of dormancy varying from one species to the next. In many cases dormancy is overcome by seed storage, and seed treatments are rarely necessary. These issues will need to be fully understood by any commercial partner.

- Market failure? One might ask why the market place has failed to develop solutions for these target regions in the past. The answer to this question probably lies in how the original R & D programs that were developed during

and since the 1940's were set up. Many of these original programs focused on the high rainfall areas where returns to R & D were likely to be higher. The location of major Research Centers throughout Australia would tend to support this. While there has been work done in the arid areas, much of that focus has been on managing native pastures. Pasture improvement developed in areas where the basic agronomic R & D had already been done. Most subsequent species selections and breeding programs then focused on making improvements in these areas, not extending into more difficult, lower rainfall environments.

It was also generally accepted that in the lower, winter rainfall areas of southern Australia, annual species were the choice for improved pastures. The extensive work done on sub clover in southern Australia over a long period of time is an example. The benefits of perennials over annuals in terms of production and botanical stability have been known for many years (Michael 1970) in areas where perennials could be grown. However, it was only in areas that had adequate year-round distribution of rainfall where perennials were considered to be viable. There were a few exceptions, with work being done on Phalaris around Canberra. Phalaris was one species that had been shown to be very drought tolerant during the dry summers, partly because of its deep rooting and partly because it became semi-dormant over this period. Certainly, few would have considered perennials in the low rainfall areas around Bealiba or Warrak in Victoria, or in Western Australia.

- Commercial companies are not known for taking large market risks and have basically concentrated on the supply of products into a market that has already been developed.

Virtually all commercial breeding takes place in, and for environments, where pasture improvement is well established. The solutions are not just in breeding a new cultivar or selecting a new species, but there has to be a lot of agronomic support research that needs to accompany this breeding/selection work. In fact, it is the agronomy research that usually highlights a deficiency in existing species/cultivars and provides the case for more breeding or selection work. Then, when the breeder delivers a new cultivar, there can be a need for additional 'agronomy support' R & D to work out how to use and manage the new material, especially in 'new' and difficult environments.

Commercial seed companies that have plant breeders generally also have agronomy support to help market the products based on existing agronomic principles. They do not normally undertake new basic work and develop new principles for novel environments. Once the basic work is done then they are in a better position to capitalise on it. The majority of the research being conducted in this Project could be regarded as 'platform' R&D, which is unlikely to be done by a commercial company.

4.1.5 Identify significant issues and opportunities

The issues and opportunities below are a distilled list, as most of these have been discussed above.

Issues and risks:

- Assessment of difficult traits like palatability, disease and parasite resistance, and persistence and animal performance under grazing.
- Germination/dormancy and seed production for the subtropical species.
- Bad experiences by farmers with earlier/other cultivars of these species.
- The potential for other options, like the CSIRO phalaris lines, to erode market share.
- A decision not to include novel endophytes in the Fescue lines runs some risks, but the project team considers these are low. This can be discussed with the commercial partner.
- The higher degree of difficulty associated with more marginal rainfall and problem soils.
- Unknown and untested soil factors like pathogenic microbial agents.
- Design of the commercial evaluation and methods to be applied eg the types and levels of management inputs.
- Need for compatible legumes to generate the nitrogen needed by the grasses in extensive situations.
- The likelihood of inadequate resources for the evaluation and extension phases. It does appear that the extension strategy will require a range of complementary activities across a number of players.
- Commercialisation strategy - pros and cons for going with a larger international company with the capacity for overseas sales, investment in agronomic support and to synchronise advice and seed sales, versus aligning with smaller companies with more dedicated local interest. A clear position on the purpose of obtaining IP.

Opportunities:

- Manage risks proactively, for example by screening Fescues for endophytes; and making duty of care assessments (eg weediness, toxin production) at an early stage, to reduce the chance of continued investment in cultivars that will not be acceptable to the market.
- Investigate possible synergies with proposed Pastures Australia investments, such as the ‘pasture picker’ expert system, information and databases, development of management packages.
- Parallel consideration of the companion legumes – leveraging off prior work in this area.

- Learning from the parallel work going on in WA such as the cutting trial and the grazing work, as well as the QnQ and Evergreen collaboration should provide a powerful platform for the evaluation phase.
- Considerable experience has been gained during the seed production work in WA regarding improved sowing methods. This will be useful information for developing management packages for the establishment of subtropical species.
- Investigate the possible co funding opportunities with Catchment Management Authorities. In a similar vein, groups like Birchip should offer opportunities during the evaluation phase of the project.

Given the decline in extension capacity among State agencies, alignment with such groups at an early stage, as is being done with the Evergreen group in WA, and with appropriate private consultants and commercial companies would make sense.

- There has to be an opportunity to capture the farmer learning through the evaluation and early adoption phases. This would require more resources but a case study or 'blogging' type approach could be worth considering.
- On the one hand CSIRO's new Phalaris lines, (and perhaps others as indicated above), might be seen as competition, but there is an opportunity to make sure that the temperate grass selections from this project perform as well as or better in the target environments early in the evaluation phase. (Is there also a case for considering the N African ryegrass lines held by DPI Victoria in the same light, or are these too 'soft'?)
- Use of greatly improved modelling capability (eg SGS and GrassGro) to assist with the planning of and to interpolate from data points during the evaluation phase to other non-tested situations. Greg Lodge has had considerable experience with the SGS model and with modelling pastures in the Barraba locale, so he presents a potential collaboration opportunity. (This is a two way street as these models may well be improved as a consequence of such interaction).
- Bio-physical and economic modelling to revisit and examine some of the original BCA assumptions about likely on-farm benefits. The market research by Gout and Jones (2006) would help inform the extension targets and provide a form of reality check.

The reason for this is not just to re-evaluate the size of the prize (given that we have better information now), but to ensure that resources and planning are adequate for the D&E phase of the project to deliver the projected practice change and on-farm benefits.

- There have to be opportunities to access more PhD students for this project via the CRC.
- Publications should begin to flow from this point on.

4.1.6 The fit of project outcomes with CRC for FF Industries.

Below is a brief provided by Professor Mike Ewing, Deputy CEO for the CRC Salinity, that covers the issue of potential continuity between CRC Salinity and Future Farming Industries (FFI) CRC for the grass breeding output. The documentation of FFI CRC in the Stage 2 application is somewhat limited by the process designed by the CRC Secretariat and is weakest in the area of specifically identifying scientific activity. However the future intent should be clear from the text below.

"The FFI CRC will, if successful, be the recipient of substantial intellectual property that will require on-going development to fully exploit the commercial opportunities flowing from preceding activities conducted as part of CRC Salinity.

The project 'Perennial Grass Improvement for Low-Medium Rainfall Recharge Environments' currently underway in CRC Salinity is an example of a circumstance where key project outputs from CRC Salinity will begin to deliver benefits in the period following the completion of the current breeding phase of the project. The extent of the delivered impact will depend on development of commercially distributed cultivars that are used effectively by producers in farming systems. The extent and rate of uptake by producers will be impacted by the suitability of the identified plants in fitting current or modified systems and producer knowledge and understanding of the effective management of such systems.

Detailed project level planning for FFI CRC which will potentially provide continuity in these has yet to be undertaken but the outputs of current grass breeding activities have been identified in activity level documentation as examples of developed germplasm that will require on-going systems development R&D and support in the adoption phase through demonstration and communication.

Page 13 of the Stage 2 application has drawn attention to this approach with specific reference to the key outputs of the grass breeding project.

*'New cultivars of a diverse array of perennial plants will be produced, building on research in CRC Salinity (including species of the genus Lotus, Melilotus, Medicago, Cichorium**, Panicum, Fescue, Dactylis**, Eucalytus, Acacia and Atriplex). Breeding efforts will be supported by studies in plant physiology by UWA and CSIRO. While breeding efforts will be linked to existing infrastructure and skills, new plants will be field-tested in target environments by regionally dispersed staff of the four State agriculture agencies. New perennial plants need to be embedded in farming systems and, in the case of woody perennials also, into emerging industries'.*

FFI CRC activities that will provide continuity of research effort to the current grass breeding activity have been identified in both Program 1 – 'Future Livestock Production' and Program 2 – 'Future Cropping Systems' because it is envisaged that the temperate

perennial grasses cultivars produced will have application in permanent pasture based farming systems and those involving mixed farming and crop rotation.

Program 1 has identified a specific target in system development which aligns closely with the current development of sub-tropical grass pasture systems. This is spelled out as: '*A new herbaceous forage for the warm season, summer dominant or high rainfall zone with a commercially released management and utilisation package - from PastureSearch with application in EverGraze'*

Program 2 has identified – '*System development and enhancement with perennials focusing on situations where these perennials are commercially available or near to market.' as a key driver of its work.*

The capacity of FFI CRC to undertake this work has been strengthened by the inclusion of additional scientific capacity in the area of farming systems research and development. A key element of this increased capacity comes from CSIRO Plant Industry scientists based in Canberra who have a track record of involvement in development of systems and agronomic practices for perennial grasses in farming systems.

FFI CRC will also have enhanced focus on the adoption of outputs and this will draw on existing partner capacity as well as develop wider networks, particularly with those involved in commercial extension delivery. This will provide strong support to the uptake phase of newly released grass cultivars by creating an understanding of the cultivars and their system and management needs".

5 Recommendations

Recommendation 1: Undertake a rigorous analysis of the reasons why 'the market has failed', and review the assumptions in the benefit cost analyses conducted at the outset by the CRC Salinity, as a prelude to planning beyond the current research phase. Economic assessment needs to include costs, benefits and potential impediments at farm level in all of the target regions.

As part of this develop a complete understanding of the possible risks and their projected impacts on this project achieving its objectives.

Recommendation 2: That a workshop/think-tank be convened as soon as possible to map out the evaluation, development, extension/commercialisation and communication strategies, and the resources required using the outputs from 1 above.

This should involve the commercialiser, the investors, the CRC and project team, and appropriate outside expertise, including potential users of the technology.

A key output will be a matrix of the trigger points for key decisions across the Research, Development, Extension & Commercialisation continuum.

Additional inputs to this workshop will be a summary position by the project team on the projected performance and timelines for superior lines coming on stream; and the perspectives of the commercialiser on what will be required to present a real value proposition for them.

6 Bibliography

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7 Appendices

7.1 Appendix 1 – 'Additional Details' Targets

These targets were extracted from the 'additional details' documentation to the contract agreed between MLA and the salinity CRC at the outset.

Tall Fescue
The project will aim to produce new more drought tolerant summer active tall fescue cultivars targeted at regions that receive significant summer rain but experience periodic droughts that limit the persistence of conventional cultivars. The goal is to increase green biomass over summer by 20%, total biomass by 25%, and plant persistence by 20% relative to Demeter fescue, the standard cultivar in this environment.

Cocksfoot
The project will evaluate an extensive range of new cocksfoot accessions toidentify sources of winter-active germplasm with capability for some summer growth, that will improve the adaptation of cocksfoot to lower rainfall, highly acid and light textured soils and low input hill country currently lacking suitable species for reducing recharge. Elite genotypes will be combined to develop a cultivar having an increased digestibility of at least 2%, cool-season dry matter yield of 10% and summer growth of 5- 10%, compared with Currie cocksfoot (the current cultivar best able to persist in this environment).

Sub-tropical grasses
This activity will produce a database of priority species of sub-tropical grasses for ongoing genetic improvement resulting from a review of current knowledge followed by empirical evaluation for adaptation in widely contrasting climatic regions of temperate/Mediterranean zones in Australia. It will provide knowledge of the genetic diversity available in germplasm to breeders/selectors for priority species of sub-tropical perennial grasses in characteristics important for establishment, productive and profitable growth. Finally it will identify elite accessions and selections from populations with potential to be used directly as cultivars in temperate/Mediterranean environments or as parents in crosses. The goal is to have germplasm which has 20% greater persistence, 20% greater spring dry matter and 3% increase in digestibility relative to nominated control cultivars.

Fast tracked cultivar release of advanced tall fescue lines
From the MRC project DAV 095 the spring/active accession '358' was selected for progression to cultivar status. Reselection from within 358 would lead to the development of a cultivar with increased winter activity, increased nutritive value and persistence as a replacement for Demeter for the mid-high rainfall temperate pasture zone of Australia.

The proposed project would commence in January 2004 with first generation seed harvested in autumn 2006. Selected genotypes should show a) a 20-30% improvement in winter and summer herbage yield compared to cv. Demeter, b) a 20% increase in seedling vigour compared to Demeter and c) improved digestibility (3%) compared to Demeter in spring, at maturity and in autumn.

7.2 Appendix 2 – Program of Visits

Program of visits to each site in November 2006:

Inverell, NSW

Mon 13th - Travel to Inverell that afternoon – stay overnight

Tue 14th –
08:30am – Context of the work and overview presentation of NSW component, including an introduction to the nursery sites, demography and intra site design
11:00am – Travel to one nursery site and have lunch there or on the way; return to Inverell
02:30pm – SWOT and discussion in relation to the T of Ref
05:00pm – Summarise and wind up
05:15pm – Review team recap on process

07:00pm – Dinner with research team; stay overnight

Wed 15th am - travel back to home bases

Perth, WA

19/20th – travel to Perth

Mon 20th – We need to ascertain if it will be sensible to try to visit one of the nursery sites given the time available, and the distances involved. How much additional time is needed is the question. In the event that it is not, the following plan is suggested:

12:30pm – Lunch with the research team
1:30pm – Context of the work and overview presentation of WA component
A nursery site slide show to give a temporal and demographic picture of the sites, and intra site design.
Discussion

7:00pm - Dinner with research team; stay overnight

Tue 21st –

8:30am – Recap, SWOT and discussion, in relation to the T of Ref

12:00pm – Summarise, wind up and lunch

2:00pm fly to Melbourne; stay overnight at Tullamarine airport
Hamilton Victoria

Wed 22nd –

8:00am - drive to Hamilton [discuss Perth process on the way, if not done beforehand] via one of the nursery sites; lunch on the way, or at the site
2:00pm – At Hamilton - context of the work and overview presentation of Vic component
A nursery site slide show to give a temporal and demographic picture of all the sites, and intra site design
5:15pm – review team recap

7:00pm - Dinner with research team; stay overnight

Thur 23rd –

8:30am – Recap, SWOT and discussion, in relation to the T of Ref
11:00am - Summarise
11:30pm Snack

12:00pm drive to Tullamarine, Melbourne for a 3:30pm arrival; fly on to home bases

7.3 Appendix 3 – Site Templates

Site templates containing observations collected during the visits to each State

NSW sites template

Sites based around Inverell [Barraba site was not visited]

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
Performance measured against:		Visit with Carol Harris and Bob McGufficke [Lester McCormick was not present]
a) Objectives		See contract
- At project level		This is the main program of work with tall Fescue (2 sites) in this project with a third site dedicated to subtropical species.
- At subproject level		Clearly the dry years during which the project was set up have taken their toll, on establishment at one of the tall fescue sites, and at the sub tropic species site; but in spite of this, progress against objectives has been commendable. The Barraba tall fescue site [not visited by the review team] established quite well in spring 2004. However the first planting of fescues at the Inverell site on MacIntyre Station in March 2005, had to be replanted in September 2005, despite attempts to irrigate the first planting (by hand as there was no river flow for irrigation) – it was just too hot. But some information has been gleaned from the first planting based on survival under extremely hot and dry conditions, this will complement the results from the second planting. Given that the Barraba site is a year ahead of the Inverell site it is likely that the latter will be employed to provide supporting information to what is observed at Barraba, and it covers a different soil and climatic niche. An additional 15 tall fescue lines were included at the second planting at Inverell which was a bonus.

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		The sub-tropical pastures at the Wallangra site were off to a poor start when sown in 1st week of February 2005 (no rain until May), and this is evident in patchy plant populations for some lines in particular (there may also have been seed problems as all 6 reps failed for these lines), while others have fared incredibly well [like Consul love grass which was like 'hairs on a cat's back'], to the point that they are virtually overcrowded. Persistence was scored rather than based on counts [as for Fescue], which is normal procedure for drill row observations.
- At 'breeding objective' level		The tall Fescue breeding objectives were particularly challenging, to the point that they appeared almost impossible to achieve. However, material has been identified among the tall Fescue lines that will meet the stated breeding objectives (and for some parameters exceed breeding objectives), and 59 plants have been transferred to the crossatron facility at Hamilton for development of 3 synthetics. It is less clear whether the subtropical work will meet the stated objectives at this stage. However the best Panicum maximum, Chloris gayana and Panicum coloratum lines do have much higher yields than the control cultivar, Katambora.. The research team proposes to take samples for nutritive value over this summer
b) Milestones		Have been met, notwithstanding the difficulties due to the drought. The fast tracked fescue line (produced as part of prior MLA investment) was abandoned because it had not been tested for endophyte status and when it was tested it was found wanting. (Milestone Rpt 4 has more detail on this testing).
R&D Methods	Design and variance structure, measures, analyses	Reflecting on the methodology being used for the sub tropical lines – which were sown from seed rather than as spaced plants [as was the case for the Fescue accessions] - given their very variable germination/dormancy: variable germination performance due to dormancy differences is part of this response, as was use of a constant weight of seed per row, [adjusted for germination differences from tests in WA], in the presence of considerable differences in seed size. Weed problems were

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		also experienced, some quite unexpected, which no doubt impacted on germination and survival. This is both an issue for evaluation, in the sense that we need to ensure establishment of comparable stands for this purpose; but will be a big issue also for commercial release in relation to ensuring that the sowing advice and germination data are conducive to a high probability of successful establishment. [Brian Dear observes that moving forward we will need a two pronged approach – a) progress to screening of germplasm that has good performance for germination, establishment and persistence; and b) use spaced plant studies to evaluate the persistence of species that had germination problems – these problems will need to be resolved for anything that passes this test] The presence or absence of effective endophytes [for the plant] could have larger impacts in environments where insect pests exist [like black beetle in the Bega region] but there are no significant pests problems on the Northern Tablelands and probably the slopes – so GxE needs to be considered as part of the scaled up evaluation. MaxP technology = animal friendly endophytes Crash grazing with sheep after the measurements are taken is not revealing any differences in palatability or acceptance. One wonders if this was done in two stages, such that lesser numbers were used during an initial observation period [followed by the crash grazing/mowing to give an even starting cover] whether we might not provide some useful indication of relative palatability, particularly for the lines of interest [no differences are useful data, if collected under a rigorous measurement regime]. Parallel observations on things like stage of maturity would be necessary to interpret any observed differences. [The research team's response to this was that they have done such a study on a smaller fescue trial at Glen Innes where the commercial cultivars are being evaluated for yield, persistence and nutritive value and they found very little difference in preference for cultivars]

Key items from the Terms of Ref	**Notes re points to raise**	**Notes on the day**
		Some of the factors observed are part of the problem of dealing with 'remote sites' – see comment below on the people side of this. Conidia work? – 2 sites in Vic, 2 in NSW and one in Sardinia
Management and admin		
- Local		Appears to be very well managed.
- Project		
- MLA		
Team views on Project strategy and probability of success		
- R&D		
- Commercialisation		Sub tropical grasses will need a complimentary legume. Critical success factors were seen to be: Seed yield This is a new market for new environments Expansion to other regions Brian Dear pointed to the importance of ground cover, residual remaining after grazing, filling the feed gap and the possibility that some will be more attractive to overseas markets
- Delivery	Additional info needs eg on management; systems fit	Tall fescue has been sown on the slopes for a number of years and in recent years there has been a growing interest in using new varieties. Glen Innes has been the DPI base for tall fescue improvement and management work since 1995 – so there is experience on the practical application. [Note that Carol is working with the CRC media team on a series of new fact sheets for Fescues currently for various States]. Also this location has a head start with tropical species due to the prior work and

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		interest shown by Bob McGufficke and Leicester McCormack, and Warren McDonald before them. With 10 years of prior experience in sub-tropical grasses, there is a head of steam here on the practical application that can be capitalised upon by the project as a whole. Already these extension officers have put together advisory notes and packages, but it will be important to update these to accommodate the latest information on the dos and don'ts.
- Risks		Duty of care – the risk that the chosen synthetics will not pass the tests in relation to such things as propensity for weediness, toxicity to animals, herbicide tolerance. Endophytes for tall Fescue. It is now cheaper to do the endophyte screening so it is possible and wise to screen in advance of investing, so this becomes an opportunity.
Any Issues? Or threats?	Run a joint SWOT to help inform this and the next item	A SWOT was not done formally as we picked up the main issues as we went along, and time was a little limiting. The project team is a bit stretched in servicing the sites given the distances they need to travel (~3hours from leaving Glen Innes to starting work at Barraba. 1 ½ Macintyre and 1 ¾ Wallangra. While there appear to be sufficient support staff, there are potentially OH&S issues here in returning to base late in the day after a full day's work. Getting people to work outside of normal PS working hours is an issue as well – what's new?
Opportunities?	Resource implications	Run risk assessments in advance of the synthetics to ensure the investment is not likely to be compromised. The Wallangara site north of Inverell is complementary to the larger scale sub tropical evaluation in WA, and in this environment, unlike WA, there is a predominance of summer rainfall. There appears to be a growing interest and demand for tropical grasses on the NW slopes and plains.
Comments		There appear to be no farmers and very few extension operators actually involved in this project. [There were some farmers present at the 2 planning workshops held prior to the commencement of field sites]. But there are Landcare groups etc who

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		visit these sites on a semi-regular basis and provide good feed-back. This may be the only State where extension people are involved on the project team?? Is there scope for a farmer/extension involvement in some form of reference group as the project goes into the evaluation and then commercialisation phase? Publications – Carol is the lead author on a paper into a special edition of AJEA being coordinated by the CRC. Check the work being done by Greg Lodge with sub tropical species in the Salinity CRC. Greg's knowledge and use of the SGS model [climate/soil/water/nutrient/plant] could be worth thinking about in relation to asking the what if questions regarding testing the likely scenarios for the larger scale evaluation and beyond phase of work for the synthetics, eg in relation to levels of nutrition and soil water impacts on zones of applicability. The CSIRO summer dormant phalaris lines need to be considered for inclusion in any scaled up evaluation of synthetics The CRC work for the drier zones prior to this project was aimed at broad species evaluation. In general the subtropical lines were disappointing – but note that germination and establishment were part of the evaluation. This has resulted in farming systems advice: • Temperate grasses [fescue, cocksfoot and phalaris] plus Lucerne • Temperate grasses plus other legumes • In WA either temperate species in the south or sub tropical species in the north
Commercialisation and successful uptake by industry		C4 grasses will need to be of sufficient quality (digestibility), have acceptable germination, plus a comprehensive package on sowing advice, and have complimentary legumes. Choice of legumes to suit particular species and circumstances will be important.

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		Weediness in old crop areas has been a problem in establishing tropical species in the region Discussion about whether a large seed company v smaller 'more locally based' companies is the way to go. The smaller companies will not have money to invest in development, but might have greater commitment. Also larger companies are more likely to be looking to export opportunities to give critical mass to seed production. One potential issue with a larger company could be insistence on using their pelleting technology – it is known that this is to the detriment of seed numbers per unit weight of purchased seed, so the other advantages need to be considerable. Evaluation using larger plots will need to be done using fertilizer, soil and rainfall conditions closer to commercial reality – how to design the complementary legume components will be a challenge.

Western Australia template

Badgingarra and Perth [Wellstead not visited]

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
Performance measured against:		Project team includes – Geoff Moore, John Titterington, Paul Coombe, Tim Wiley (Extension), Dave Henry, Elizabeth Hume, Paul Sanford, [Dean Revell?] Those underlined were in attendance as well as Phil Nichol and Mike Ewing (Salinity CRC)
a) Objectives		See contract
- At project level		This is the main program of work with subtropical species and accessions in this project. There are multiple trials sown at two locations as part of this project in WA, plus associated work in other projects not funded by MLA [more on this below]. The sub-tropical grass improvement project started from a very different position than the either the cocksfoot or tall fescue projects which are both proven commercial species in their target environments. This project needed to access germplasm from Genetic Resource Centres and undertake a seed increase program prior to evaluation in the field, plus prepare submissions to AQIS/WAQIS for species which had not been assessed. This together with limited knowledge about the performance of most of the subtropical species in WA provided a considerably higher degree of difficulty than with the temperate species, but along with this the excitement of potentially greater prospectivity. So unlike the temperate species, it is not expected that new synthetics will be developed from subtropical species and accessions – rather that material superior to current cultivars will be identified for further development. And some of the subtropical species are in fact partially or totally apomictic. AQIS and WAQIS have prevented the introduction of a number of species and

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		accessions that were identifies as potential candidates for screening
- At subproject level		The only prior work comparing sub tropical species in the winter dominant rainfall regions of WA was sowings in the early 1990s which had very poor establishment, [but some surviving plants showed promise], and then by Sanford et al on the south coast during the 2000 to 2003 period ie relatively recent history. Based on this it is expected that the subtropical lines will be slower in coming to fruition than the temperate lines, given that less is known about their performance in this environment, so more developmental work is needed. Also it is clear from Bruce Cook's recent report that prior experience in the tropics of Queensland has not been particularly useful in winnowing out the most likely performers for this environment [and the work at Inverell does seem to be coming up with rather similar results?] Progress against objectives has been exemplary. There is actually more work going on in WA in relation to subtropical species than was contracted, including additional plantings within the project, and a cutting trial, stocking rate work and communication and extension that lie outside this project. There is a real sense that this project is providing a focus to pull all the various projects involving subtropical species together into a more cohesive whole – [but resources might be limiting the extent to which this can be achieved from here on?] The drier season this year has taken its toll on recent plantings in particular – but provided a more rigorous test of survival.
- At 'breeding objective' level		The terms core, promising and exploratory species have been coined, with movement of material possible between these [see report]. The most prospective [core] species have been identified for both the northern and southern regions, but as at Inverell, it is too early to say whether the challenging breeding objectives can be met. The most likely species and accessions to meet the contracted breeding criteria will be some of the Panicum maximum lines, which look very promising. Three new nurseries of the most prospective of these [9 + 2 controls] have been planted at

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		Irwin, Buntine and Muresk. Having said, this new material has been introduced into new plantings every year right up until 2006. Further to this more traits need to be considered than just the ones identified as breeding targets in the contract, eg cold tolerance, particularly in the south. The plan over the next 24 months to December 2008 is to consolidate the list of 'elite' lines of *P. maximum* from nine to have two to three elite lines which meet or exceed the germplasm improvement targets as well as possessing all the other desirable characteristics which are essential to make a successful cultivar (e.g. high seed production potential). Assessing their persistence under grazing will be a key part of this. It does appear unlikely that new Rhodes grass accessions will surpass existing cultivars for the stated criteria, [but they are very impressive in terms of ground cover and out of season production]. To meet the germplasm improvement targets for Rhodes grass will almost certainly require going to a full breeding program and the selection of elite individuals from as wide a germplasm base as possible. Germination/dormancy and establishment issues pervade here as they do at Inverell; and measurement of pasture quality and animal performance will be a challenge.
b) Milestones		Have been exceeded in terms of the amount of experimental work done; and in terms of the communications and extension work with farmers – particularly with the Evergreen group. Geoff Moore has been heavily involved also in dealing with WAQIS protocols and requirements.
R&D Methods	Design and variance structure, measures, analyses	The project team has been learning from the outset about the 'behaviour' of the various species of subtropical grasses, and the appropriate methodology to use and this has meant that trial layouts have been modified and improved with each new

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		planting. For example the rapid spreading nature of the Rhodes grasses provides a particular challenge. And NIR calibrations needed to be developed for quality measures of C4 grasses. There has been some neat work in better describing the climatic nature of the SW of WA, which gives a better picture of the likely zones in which different grasses are likely to be adapted. The QnQ program [Quantity and Quality] with Evergreen farmers adds Mingenew and Buntine as sites in the north to the Badgingarra site [plus two sites in the south] to give a wider spread of climatic and soil evaluation. Kojonup in the south [cold zone] is providing a real test for the subtropical species – only the rhizomatous types like Paspalum nicore can survive the frosting here; but dry matter production has been quite high under cutting at the Esperance site. As at Inverell, variable germination performance due to dormancy differences is part of the response that will eventually need to be measured; this is not picked up in spaced plantings; and sowings were usually at quite high seeding rates to overcome any possible problems. Weed problems were also experienced here, which may have impacted on germination and survival. As indicated in the Inverell report this is both an issue for evaluation, and will be a big issue for commercial release to ensure the sowing package and germination data are conducive to a high probability of successful establishment. The seed production work at Medina has increased local knowledge about seed production but also about plant phenology, sowing methods and dormancy issues. Both plant and crown counts are taken for presence/persistence measures Part of the problem of dealing with 'remote sites' – such as stock grazing plots when they are not meant to – is having the research station manager working with the project team and reporting [rather than 'hiding'] these type of occurrences. Eventual choice of the right package will be species that provide a combination of attributes including survival, production and cover, complementarity with a

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		companion legume and animal performance. Given that only a few of these attributes are able to be measured in the early screening stages, the challenge is not to narrow down too early based on the few measurable criteria. As suggested for Inverell plantings, it may be possible to collect some data on palatability with a different approach; crash grazing with sheep after the measurements will not reveal any differences in palatability or acceptance. Current analyses of how the comparisons were tracking seemed to be wanting – is there an issue here in relation to gaining access to biometrical assistance in a timely manner? There was some discussion about what might come out of the cutting trial at Moora [not part of this project] given the measurement regime and the method a management v what would happen under grazing – we conclude it is a brave attempt to gain advance knowledge of plant behaviour under closely managed harvesting regimes, but acknowledge that testing under grazing will be needed as well. Trace element deficiencies are rife in WA – these are managed in the nurseries but will be an issue in real world. It was noted that there may be some compromises across sites in adhering to experimental protocols due to a need to accommodate differences in staff skills across sites – we are uncertain about the likely impacts of this.
Management and admin		
- Local		Appears to be well managed and adequately staffed.
- Project		
- MLA		
Team views on Project strategy and probability of success		
- R&D		

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
- Commercialisation		Sub tropical grasses will need a complimentary legume. Critical success factors were seen to be: ▪ Out-of-season green feed (extending the growing season) ▪ Increase the carrying capacity ▪ Reduce the need for conserved feed ▪ Increase plant water use and decrease the spread of secondary salinity ▪ Herbicide resistance ▪ Reduce the risk of wind erosion ▪ Annual pasture decline / false breaks / Climate change *Panicum maximum* is an apomictic species and the current plan is to release a new variety under trademark (not PBR).
- Delivery	Additional info needs eg on management; systems fit	It is encouraging to see that the WA team is working with the Evergreen group of farmers already as part of the communication phase, and it may even be possible to capture learnings from farmers gaining novel experiences with the use of subtropical species. BUT this would require additional resources. The reach of the Evergreen group seems to be potentially large, and it is an admirable model in the absence of sufficient advisor capacity (Tim Wiley is based at Geraldton?) to have farmer champions taking the messages up to other farmers. Further there is also a cutting trial and a stocking rate experiment being conducted using sub tropical species by Shanon Dellar, which will provide advance knowledge and demonstration on some aspects of managing these species. An updated version of the book 'Perennial pastures for Western Australia', funded by WADA and GRDC, and put together by Geoff Moore, Paul Sanford and Tim Wiley, will come out shortly under the CRC banner, along with a number of fact sheets.
- Risks		Duty of care – the risk that the chosen synthetics will not pass the tests in relation to such things as propensity for weediness and herbicide tolerance.

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		The reputation of African grasses has been such that they are regarded by many as roadside weeds. This might mitigate against rapid uptake in some quarters, and puts more pressure on weediness risk assessment of new material.
Any Issues? Or threats?	Run a joint SWOT to help inform this and the next item	A SWOT was not done formally as we picked up the main issues as we went along, and time was too limiting to pull this together on the day. Availability of sufficient quantities of seed – though great lead up work is being done here. If the CRC does not get up for round 2, DAWA will become the lead entity that deals with the commercialising parties. The path to providing sound recommendations and packaging of advice for commercial application is likely to be harder than we think [Brian Dear] and resource hungry. The budget is tight which does not allow much flexibility. [Salary increases have eroded operating expenses]. Initiatives like the review by Bruce Cook have been funded by the CRC
Opportunities?	Resource implications	Run risk assessments in advance of release of new material to ensure the investment is not likely to be compromised. Some work has already started here with the CRC [with Lilly Stone?] Complementarity of the Inverell and WA work may mean that lessons drawn from the considerable experiences in northern NSW can be drawn on for the roll out of selected species in WA Future directions/opportunities were identified by the research team as :identifying better 'cold zone' subtropical species with a rhizomatous habit; accessing a wider range of Rhodes grass material; access to more material from South Africa [but WAQIS will limit access]. Has anything been lost in the past from plantings that failed due to seed quality issues? There appear to be no PhD students coming out of the CRC into this project – what chance of ramping this up we wonder – according to Mike Ewing it is difficult to

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		interest students in this type of work; but maybe an NRM twist could alter the chances?
Comments and notes		Tim Wiley, an extension officer, is on the project team, but he is located at the northern extremity. As stated above, engagement with EverGreen farmers has been an excellent initiative. Is there scope for a farmer/extension involvement in some form of reference group as the project goes into the evaluation and then commercialisation phase The CRC work for the drier zones prior to this project was aimed at broad species evaluation. In general the subtropicals were disappointing – but note that germination and establishment were part of the evaluation. This has resulted in farming systems advice: • Temperate grasses [fescue, cocksfoot and phalaris] plus Lucerne • Temperate grasses plus other legumes • In WA either temperates in the south or sub tropicals in the north The CRC undertook initial ex ante B/C analyses, a summary of which we were shown. The assumptions are quite transparent, so variations on these can be tried. It will be important to examine these more rigorously given that 'the low hanging fruit have been picked'. CSIRO are modifying GrassGro to better incorporate C4 grasses and will use the QnQ data to test the revised model
Commercialisation and successful uptake by industry		C4 grasses will need to be of acceptable quality (digestibility) and palatability, have acceptable germination, plus a comprehensive package on sowing advice relative to soils and climate, and have complimentary legumes. Choice of legumes to suit particular species and circumstances will be important. It should be noted however that the digestibility and availability of annuals is quite low in summer, so this needs to be the benchmark to improve on. Evaluation using larger plots will need to be done using fertilizer [including trace elements], soil and rainfall conditions closer to commercial reality and in some cases

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		incorporate the likely situations in which they will be used [eg sown into run down pastures and not worrying about legumes in the first instance] – how to design the complementary legume components will be a challenge Geoff M has already started some preliminary work on this. Optimum plant spacing has yet to be determined – this could be less than we are used to with temperate annuals. Note that this wider commercial examination and testing has not been costed and budgeted for as yet. Seed is being produced to allow some initial plantings of larger plots in 2007.

Victorian sites template

Sites based at Bealiba and Warrak, as well as the Glasshouse Facility at Hamilton.

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
Performance measured against:		Project team – Zhongnan Nie, Steve Clark and Kevin Smith
a) Objectives		See contract
- At project level		The Bealiba and Warrak field sites are the major screening sites for cocksfoot in low rainfall, low fertility, acidic soils with high aluminium.
- At subproject level		Rainfall following planting was adequate at both sites to ensure good establishment of the spaced plants in spring of 2004, although one watering was provided at the drier Bealiba site. Abnormal out-of-season rainfall across the region (50-60 mm) in February 2005 further enhanced establishment but limited the opportunity for testing drought stress and persistence of the cocksfoot lines. Under these conditions existing commercial cultivars performed best. Both sites experienced below average rainfall during the 2005-06 summer and drought conditions have continued to the current date at both sites. All commercial cultivars have now slipped in rankings behind new accessions. These conditions have provided ideal selection pressure for testing persistence of accessions that had established well. On the other hand, the dry conditions have resulted in the failure of the drill rows, sown in September 2005, to persist at the Bealiba site, but the Warrak drill rows still appear to be performing well, despite the dry conditions.

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		The DPI Hamilton seedbank collection has a large number of cocksfoot and tall fescue lines, many of which are in short supply and / or have poor viability. A seed increase program is underway at DPI Hamilton to replenish the seed supplies for future field evaluation. The breeding program is described as "non-conventional". It adopts a more commercial approach than conventional agency programs by aiming to place a number of cultivars into the market place early, then let them find their place. Improvements are made at a later date, rather than "keeping the market waiting for the perfect product". The program was designed so that it captured a lot of existing experience and knowledge that had been built up over time, but never utilized in commercial practice.
- At 'breeding objective' level		The rainfall patterns have in many ways created ideal conditions for testing production and persistence of the spaced plants in low rainfall environments. In September 2006 the best plants from each of three types were selected and transferred to the glasshouse facility at DPI Hamilton for cross-pollination and development of four synthetic lines. The most promising accessions at the drier Bealiba site are fine leaved and high tillering of Mediterranean origin. These accessions have demonstrated greater persistence and vigour in the second year than other material, including existing commercial varieties. Greater emphasis is now being placed on production and persistence than on digestibility. There appears to be good evidence to indicate that the production and persistence targets will be met. However, the target of a 2% increase in digestibility may not be achieved, although the research team is still hoping to achieve this on an annual basis with any new cultivars expected to have a greater distribution of green leaf throughout the year.

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
b) Milestones		All milestones appear to have been met.
R&D Methods		
Management and admin		
- Local		Appears to be well managed.
- Project		Overall, this appears to be a good Project with well thought out and sound objectives. The Project appears to be well managed. However, a common problem across States appears to be that of declining extension staff numbers.
- MLA		
Team views on Project strategy and probability of success		
- R&D		Production and persistence of any new cultivars on these low fertility soils is likely to depend on plant nutrition. The field selection and performance was made using a base dressing of nutrients. Some consideration may need to be made on how this will be delivered in practice.
- Commercialisation		Cocksfoot cultivars arising from this project are targeted at low rainfall, low fertility acidic soils that are high in aluminium. Existing commercial cultivars often perform as well, if not better than, the new material in the first year. However, we were told, and the field data would appear to support, that existing commercial cultivars of cocksfoot will not persist on these soils. One potential problem is that many local farmers are not aware of which cultivars that they currently sow in pasture mixes. This decision is often made by local agribusiness agents. Many of the North African accessions survived well in the first year despite their poor

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		seed quality and seedling vigour compared to the commercial cultivar seed. Commercial seed would be equal in quality and resulting seedling vigour to that of existing cultivars. A targeted extension program into cultivar choice, seed establishment and management is planned as part of the commercialization program for new cocksfoot cultivars.
- Delivery	Additional info needs e.g. on management; systems fit	A strong education / extension program will need to explain the reasons and fit of any new cultivars. This could help prevent failures and substitution of cultivars by Agribusiness competitors. There are no farmers and very few extension operators involved in this project. Is there scope for a farmer/extension involvement in some form of reference group as the project goes into the evaluation and then commercialisation phase ? What about involvement with local Agribusiness agronomists (eg. Elders, Landmark, CRT). Their understanding of what the breeding program is about is quite important if local farmers get most of their advice from them. What about interactions with the Evergraze Project?
- Risks		How do you see nitrogen being delivered to the grasses in a commercial situation? Would legumes only exacerbate the already high acidity problem of the target area? Are there legumes that will grow and persist under these highly acidic, high aluminium conditions? Is liming an option, or economic in this low rainfall area? A range of legumes are currently being evaluated at Bealiba in an attempt to answer some of these questions.
Any Issues? Or threats?	Run a joint SWOT to help inform this and the next item	Agribusiness competitors may seek to substitute existing, non-adapted cultivars in place of new releases. Any resulting failures could damage the credibility of the "new technology". What chance of success? The fact that the soil types and rainfall areas for which

Key items from the Terms of Ref	Notes re points to raise	Notes on the day
		these products are aimed are so marginal [only a small % of income likely to be derived from these soils on a typical farm?] makes it a real challenge to provide an economically viable improvement package – some economic modeling would be useful at this point to consider the key success criteria and how sensitive the task is likely to be to variation in these. If the margins are sufficiently high, controlling this variation will then be the key to rolling the technology out and having a high level of industry uptake
Opportunities?	Resource implications	
Comments		
Commercialisation and successful uptake by industry		One potential issue with large companies could be their insistence on using their technology such as coated seed technology as part of any commercialization process. • Seed numbers per unit weight are significantly reduced by coating, often by 50% and more. • Seed coating aids the handling and flow of light hairy or fluffy seeds, enabling them to be sown through seed boxes of planting machinery. • Otherwise, with the exception of legume inoculation and reducing theft of seed by ants in certain situations where seed is broadcast on the soil surface, we have never seen data to support better establishment of coated seed, either from published research or commercial trials.