final report

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Climate change adaptation in the southern livestock industries

Also known as Southern Livestock Adaptation 2030 – SLA2030

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Abstract

The Southern Livestock Adaptation 2030 (SLA2030) project brought researchers, extension experts and producers together to look at a range of future climate scenarios (out to 2030, 2050 and 2070) and the potential impact on farm productivity and profitability.

The basis of the project was the view that for 'climate change' to have direct relevance to farmers, forecast changes in rainfall and temperature need to be converted into answers (at a local level) about "what impact will it have on my pasture production; on my livestock production; on my profitability; and what can I do about it?"

There were two key components to the project:

1. Producer locations – researchers, extension experts (from State agencies) and producers worked side by side at 46 regional locations across southern Australia.

2. Research centres - modellers / researchers at the University of Melbourne, the Tasmanian Institute of Agricultural Research and CSIRO undertook a series of modelling studies on climate change impacts, adaptation and mitigation strategies for southern Australian livestock industries.

The results of the program are available at the projects own website www.sla2030.net.au (see http://amonet.instanthosting.com.au/~sla2030/ until the site becomes live)

Executive summary

Generalised information about climate change, with potentially increasing temperatures and changing rainfall patterns does little to help farmers. Livestock producers basically grow grass and then convert that into animal products. So for 'climate change' to have direct relevance to farmers, climate change forecasts needs to be converted into answers (at a local level) for "what impact will it have on my pasture production; on my livestock production; on my profitability; and what can I do about it"? These are the questions that CCASLI has answered over the last 3 years.

Sophisticated modelling tools were combined with global circulation models (GCM's), local weather data and producers' own production and financial data to create 'future scenarios'. This resulted in researchers, extension experts and producers working together in a unique manner to explore 'possible futures' to 2030 and beyond. Working with producers in 46 locations across southern Australia, combined with research outputs on specific subjects at a further 43 locations, the program has, for the first time, identified some key answers, and raised some key challenges for the livestock industry in southern Australia.

In summary, modelling at most locations indicates:

- Future production systems will see increased temperatures and reduced rainfall leading to lower productivity (potentially 15 to 20% lower by 2030) and even larger impacts on profitability.
- Impacts vary significantly within and between states - being most severe in the lower rainfall parts of the sheep wheat zone, but positive for some currently higher rainfall / colder areas.
- As the impacts vary, so to do the adaptations which may help alleviate or enhance these impacts. No single adaptation provides all the answers, with a combination of adaptations likely to work best.
- Some of the best strategies or practices are already known to many producers (e.g. increasing soil fertility, genetic improvement of livestock) and are as applicable today as they will be in the future. Other adaptations which may not be applicable today may become so depending on the degree to which climates change in the future.

While the program has provided information not previously available, it has also unearthed some key R&D and policy challenges including:

- If climate change predictions prove correct, the impact on productivity and profitability across southern Australian livestock industries is very significant. The adoption of current technologies, development of new technologies and policy responses will all be required to reduce these impacts.
- As climate science gets better, will these impacts change?
- There is a need for whole farm systems evaluation - and what about mixed farming enterprises, and the pastoral zone?
- What policy instruments can help farmers have more flexibility and adaptation options, but in an emission constrained world?
- How can we better manage potentially increasing extreme events (droughts, floods, heat-waves etc.)?

Contents

1 Background

While we will never accurately predict the future (and shouldn't try to), it makes strategic sense for an industry to "peer over the horizon" and examine "what ifs" when it comes to the vast array of possible future climates. For example, what impact did the 0.6°C increase in mean temperature and 85 mm less rain, averaged over a decade, have on livestock enterprises at Yass in NSW (actual figures for 2001 to 2009). What might happen to production and profit if, over the next two decades, temperatures increase by 1 or 2°C, and rainfall decreases by 10 to 15% as is predicted by some models? Importantly, are there things that farmers can do (adaptations) that might help alleviate some of the impacts?

The majority of future climate scenarios suggest that much of southern Australia will become more difficult to farm in the future with more potentially more droughts, higher temperatures and less rainfall. However, until now, such predictions tended to be at a "broad brush" level and of little relevance to farmers who want to understand what the impacts may be on pasture production, livestock production and farm profitability. This information also needs to be relevant to their own 'location'.

The CCASLI program sought to address these questions. The availability of sophisticated bio-physical models (e.g. GrassGro, SGS), Global Circulation Models (GCMs) that were regionally down-scaled (i.e. using the latest downscaled climate change projections from Ozclim), local weather data and detailed farming systems data (either derived or actual from producers) provided an opportunity to obtain information that has not previously been available.

Such information was perceived to be of importance for producers (putting climate change into their own words and in their own locations) and industry and policy makers (what are the real impacts of climate change on livestock enterprises and what policy instruments and RD&E should be supported to assist).

2 Project objectives

The objective of the program was to:

1. Establish a knowledge base to underpin ongoing engagement with producers and facilitating further research, development and extension in climate change adaptation
2. 10,000 livestock producers across southern Australia will be aware of the key research outcomes of the project
3. Develop a program of on farm trialling of key recommendations within each agro-climatic region across southern Australia for implementation during the period 2012 – 2015
4. Establish improved modelling capacity across a range of industry RDE providers
5. 20,000 livestock producers in Southern Australia by 2020 will be equipped to adapt to climate change

3 Method

There were two distinct streams to the program:

1. **Research centres**
The University of Melbourne, Tasmanian Institute of Agriculture and CSIRO Plant Industries:

- Refined the existing models - the DairyMod and SGS models were expanded with a more sophisticated animal model, improved soil organic carbon modules, and the explicit treatment of urine patch dynamics. These have all enhanced the models capacity to predict methane, nitrous oxide, soil carbon and the interactions between these. GrassGro, apart from refinements via ground-truthing with producers at 46 locations across Australia, this model has been extended (e.g. to apply to C4 native perennial grasslands) and now has available a large number of representative grazing system data sets plus dozens of new producer data sets (lamb, wool and beef production data in numerous southern Australian locations) which will continue to be useful in answering future RD&E questions and further refining models.
- Transferred modelling capacity to personnel (mainly state department officers but also to consultants etc) so that they had the skills to complete activities described in point 2 below; and
- Used dedicated modellers to conduct, coordinate and publish a series of modelling studies on climate change impacts, adaptation and mitigation strategies for the southern Australian grazing industries. Such studies used a range of biophysical (DairyMod, SGS Pasture model, Grassgro and APSIM), farm systems and GHG (inventory calculators) modelling tools in a number of simulation studies. The project utilised a network of credible 'base' simulations for over 40 sites across southern Australia. The sites spanned a range of climates from high rainfall, cool temperate in Tasmania to lower rainfall, temperate environments of southern New South Wales, through to Mediterranean climates in Western Australia and sub-tropical climates in south eastern Queensland.

2**. Modelling at producer locations**

Regionally based research / extension staff (from NSW DPI, Victorian DPI, Tasmanian Institute of Agriculture (previously DPIWE), SARDI and DAFWA) were trained in the use of models and then worked directly with livestock producers (across 46 locations in southern Australia) to examine the impacts of climate change on farm productivity and profitability in 2030. Before embarking on such forecasts, it was critical to gain the confidence of producers by modelling the periods 1970 - 1999 and 2000 - 2009 so as to ensure that the models were able to accurately hind-cast what producers had experienced in the past.

A range of methods for engaging producers was adopted. These included:

- small workshops to confirm the model outputs and to examine likely future impacts from a changing climate on farm productivity / profit and identify a range of potential adaptations to help ameliorate such impacts
- workshops / seminars to deliver the findings and discuss the results with a brioader range of producers
- use of communication channels know to be important sources of information for producers including field days, conferences, radio interviews and articles in farm based magazines and rural newspapers

Program governance

The program was overseen by a steering committee, representing key funding and operational players, who met on a regular basis. The steering committee gave direction and guidance to program partners via a part time national coordinator.

4 Results and discussion

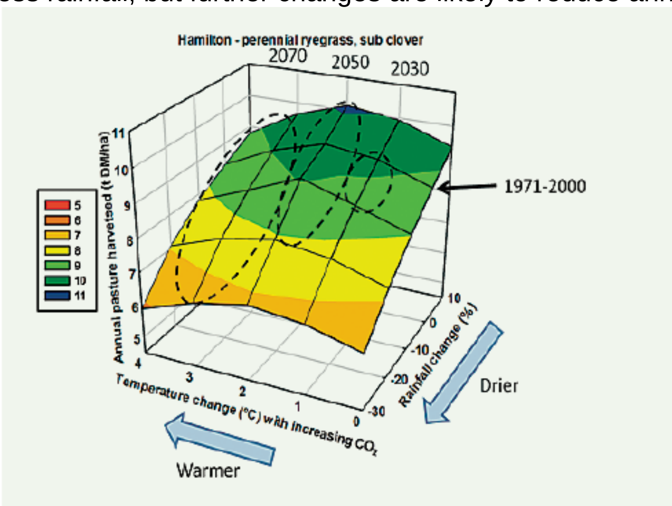
The following provides a high level summary of results emanating for the project. Further detail on all elements of the project can be found by visiting the website – www.sla2030.net.au. For information relating specifically to the outcomes from research centres see www.sla2030.net.au/research-centres

4.1 Research Centres

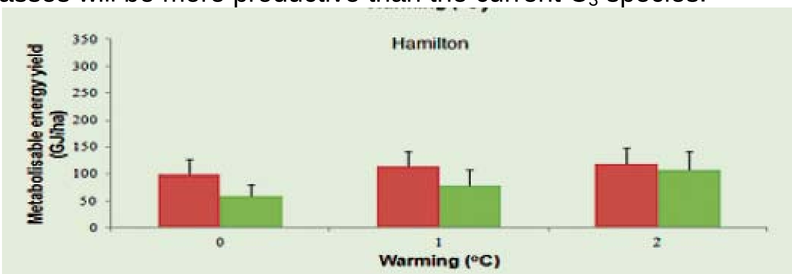
4.1.1 University of Melbourne

Adaptation

- Total annual pasture production in southern Australia is generally resilient to climate changes of +1° with 10% less rainfall, but further changes are likely to reduce annual pasture growth.

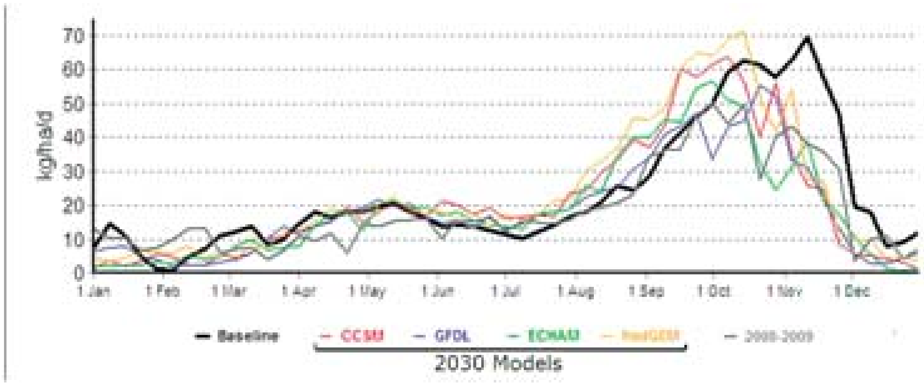


- Deep rooting and heat tolerant traits will be important adaptations for pasture species in future warmer and drier climates.
- In regions where C_4 grasses are not currently grown, substantial warming is still required before C_4 grasses will be more productive than the current C_3 species.



The impact of rising temperatures on ME levels for rye/sub pastures versus kikuyu/sub pastures-Hamilton

- Analysis of historical climate at five sites across Victoria and Tasmania indicates a trend for a greater frequency of short spring growing seasons across sites, but no clear trend of increasing variability in pasture production.
- Warmer and drier future climates projected for southern Australia will change the seasonal pattern of pasture growth, with higher pasture growth rates in winter and early spring but a contraction of the spring growing season, with an earlier onset of the dry summer period.



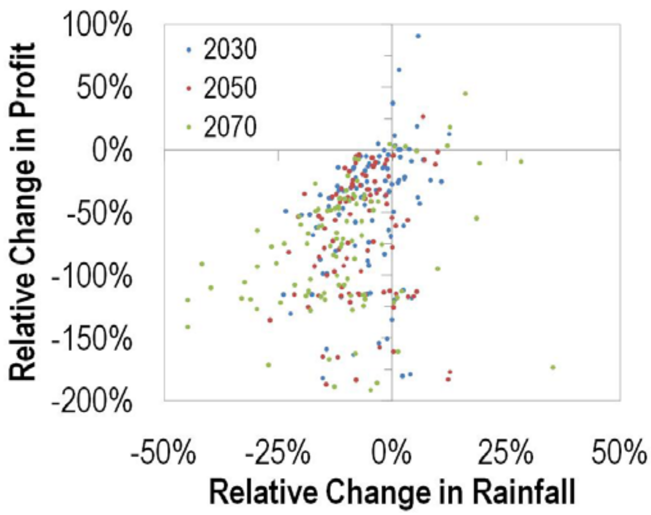
- Changes in the seasonal pattern of pasture growth will impact on animal production and ground cover, even if annual pasture production is maintained.

Mitigation

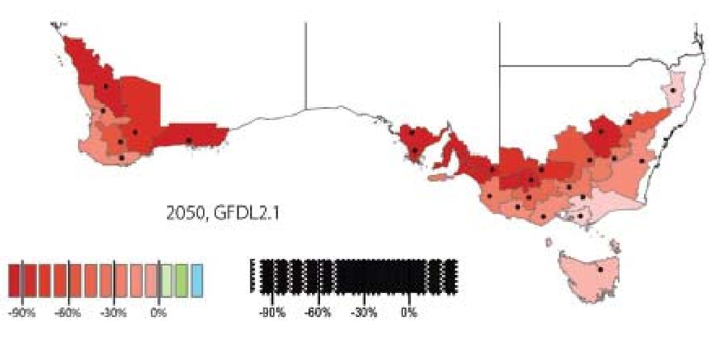
- A comparison of whole farm GHG emissions from different farm types in south eastern Australia showed dairy farms producing the highest emissions/ha, followed by beef, sheep and grains.
- When compared on an emissions intensity basis, cow/calf farms emitted more GHG/unit product than wool, followed by prime lamb, dairy, steers and finally grains.
- A range of currently available GHG abatement strategies are available that will lower the emission intensity of production, but for these mitigation strategies to be widely adopted these strategies must be profitable in their own right.
- Whole system mitigation modelling showed that the emissions intensity per unit product can be minimised simply by maintaining a productive pasture base.
- Inclusion of residual feed intake in national breeding schemes should reduce emissions intensity of ruminant production systems, over and above on-going reductions in emission intensity being achieved by the current production and fitness trait breeding goals used.
- Modelling of dung and urine distribution showed that the non-uniform distribution of excreta significantly influences the annual nitrogen losses through leaching and denitrification from a grazing system. When modelling N_2O emissions from grazing systems it is imperative therefore that dung and urine distribution be explicitly modelled and not assumed to be evenly spread across the pasture.
- While methane emissions will mainly change with livestock numbers, nitrous oxide emissions may increase with warmer climatic conditions in the medium-high rainfall zone of southern Australia, particularly in less free draining soils. This emphasises that mitigation modelling must include consideration of adaptation and vice versa.

4.1.2 CSIRO

- The magnitude of climate change impacts will be large and the potential exists for a significant decrease in the total value of livestock production.
- Based on the available projections, there is a real prospect of 15-20% overall reductions in pasture growth by 2030 in the absence of adaptation.
- Declines in production and profitability can be expected to be significantly larger than declines in total pasture growth. This differential is caused by the need to leave herbage unconsumed to protect the soil resource, and is probably exacerbated by increased variability in future climates.



- Climate change impacts, and hence the need for adaptive responses, are greatest in the lower-rainfall parts of the cereal-livestock zone and tend to be less severe in the south-eastern parts of the high-rainfall zone.



Reductions in total income – 2050

- Taken across southern Australia, all broadacre livestock enterprises are likely to be strongly affected by projected future climates. It appears that impacts on beef breeding will be somewhat smaller in relative terms than the impacts on other enterprise types; these differences are unlikely to be large enough to make beef cattle more economically attractive than other enterprises.

- The uncertainty associated with these projected changes in livestock production is large – and is caused by uncertainty in rainfall projections – but the above trends are discernable nonetheless.
- A range of different adaptations, based on currently-available technologies, are potentially effective in ameliorating the impacts of projected climate changes. The most important of these are:
  - increasing soil fertility, so increasing the water use efficiency of pasture growth;
  - ongoing genetic improvement of livestock;
  - introduction or increased use of summer-active perennials (particularly lucerne);
  - in some locations, the use of confinement feeding to protect ground cover.

	2030	2050	2070
Higher soil fertility	62%	67%	44%
No annual legumes	1%	1%	1%
Add lucerne to the feedbase	45%	50%	41%
Confinement feeding	15%	21%	24%
Increased livestock size	11%	27%	28%
Increased ram size	3%	6%	5%
Increased fleece weight	7%	16%	16%
Increased conception rate	15%	32%	31%

Impact of adaptations for recovering profitability - 3 timeframes

- No single adaptation will be completely effective adapting the broadacre livestock industries to climate change. In most situations, a combination of adaptive responses will be required.
- It is likely that in 2030, combinations of adaptations can be found to return most livestock production systems to profitability. By 2050 and 2070, on the other hand, our findings suggest that the lower-rainfall parts of the cereal-livestock zone will require either new technologies, a complete re-thinking of the feedbase or else sustained price increases in order for livestock production to remain viable.

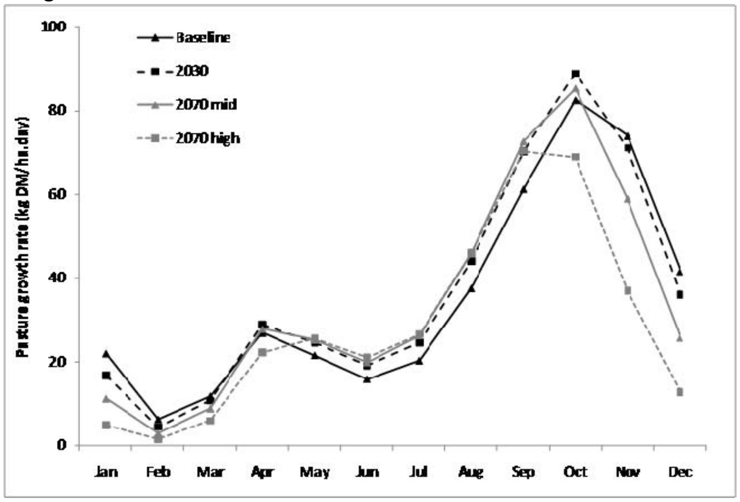
	2030	2050	2070
CCSM3.0	-22%	-21%	-25%
ECHAM5	-37%	-39%	-51%
GFDL2.1	-37%	-42%	-61%
HadGEM1	-3%	-29%	-48%

Projected changes in the value of livestock production - using 4 GCM's

4.1.3 Tasmanian Institute of Agriculture

- Simulation modelling of perennial ryegrass production has indicated that annual pasture production is likely to increase under most climate scenarios in the cool temperate

(Tasmania) pastoral regions with increases in pasture growth occurring during winter and early to mid-spring.



Mean monthly pasture growth rates under a baseline (1971-2000) and three future climate scenarios at Ellinbank (Tasmania).

- To capture the associate increases in pasture production in the cool temperate dairy regions of Tasmania, it was shown that adapting changes to stocking rate and calving date could improve dairy farm profitability.
- In the more temperate dairy regions of SE and SW Victoria, adaptations to calving date and stocking rate were unlikely to negate the effects of climate change suggesting that further changes to the farm system are required to maintain profitability.
- One hundred dairy farms throughout Australia have been assessed for their farm's GHG emissions. Data analysis of these 100 dairy farms has shown that 94% of the variation in total farm GHG emissions is explained by milk production alone, although the GHG emission intensity of milk production varied between 0.83 and 1.39 kg CO_2e/ kg fat and protein corrected milk (FPCM).
- The mean intensity of emissions associated with milk production was 1.04 kg CO_2e/kg FPCM. Milk production per cow, feed conversion efficiency and the amount of nitrogen based fertiliser applied were the key farm variables most influencing the GHG emission intensity of milk production.
- Adoption of abatement strategies that reduce enteric methane production, while assisting in improving milk production per cow and those focused on improving the efficiency of nitrogen usage on farm will have a positive impact on reducing the GHG emissions intensity of milk production in Australia.
- Several modifications and improvements have been made to the Dairy Greenhouse gas Abatement Strategies (DGAS calculator) as result of changes to the national inventory methodology and from user feedback. Webinars and face-to-face training in the use of the DGAS calculator has been undertaken regularly throughout the project for Dairying for Tomorrow co-ordinators, private consultants, milk factory and government department field officers.
- In collaboration with the University of Melbourne, the team has developed a MS Office Excel spreadsheet Carbon Offset Scenarios Tool (COST) calculator for the Australian dairy industry to explore the viability of a range of mitigation options that could be included as Carbon Farming Initiative (CFI) offsets. This spreadsheet tool allows for the exploration of key questions such as the price of carbon required to make a strategy profitable and costs of implementing these strategies.

4.2 Producer locations – State agencies

The following map shows the locations where both state agencies (producer based) and research partners (researcher based) undertook the program, demonstrating the wide coverage of southern livestock production areas. Key findings from each state are referred to below. Detailed information on each producer location can be found by visiting the website at www.sla2030.net.au/producer-locations

4.2.1 NSW

- Shorter growing season leading to reduced stocking rates to manage ground cover over summer/autumn which results in reduced profits.
- Tableland locations above 900m with high rainfall are not affected. The higher winter temperatures remove the current block - low winter pasture production. This offset any decline in rainfall.
- There is no single adaptation which recovers all the lost profit. It requires a combination of factors. The most promising are factors producers already know. The best adaptations vary between locations.

TIMEFRAME & ADAPTATION	% OF GROSS MARGIN	COMMENTS
Base - 1970 to 2000	100%	The base figure was $236/ha
2030 - Self replacing flock	60%	Business as usual - no adaptation
2030 - Summer feedlot	66%	The cost of labour is not accounted for. The feedlot would only be used in tough years.
2030 – Genetics	88%	No risk adaptation - 1% increase in fleece weight and 0.25% reduction in fibre diameter per annum.
2030 - Feedlot + Genetics	99%	Use of a combination of strategies is possible and provides greater benefit

The impact of adaptations on an 18 micron self replacing Merino flock at Goulburn, NSW

- The size of the impact appears to get greater as the rainfall decreases.
- Sheep enterprises appear to be able to handle the increased climate pressure better than cattle.

4.2.2 Victoria

- Lucerne as a pasture base in the low rainfall mixed livestock/cropping zone offers the ability to generate increased profits under future climate scenarios.
- Earlier lambing may become more profitable for winter/spring lambing enterprises.
- Despite shorter springs, lamb breeding and finishing looks likely to remain more profitable than quitting all lambs at weaning for winter lambing lamb enterprises in the high rainfall zone.
- Changing from autumn to spring calving in both moderate and high rainfall zones offers little improvement in gross margins.
- Spring calving beef systems don't appear to gain from calving earlier by 1 or 2 months.
- Optimising soil fertility, pasture production and utilisation (via increased stocking rate) offers major gains to livestock profitability, both now and in the future.

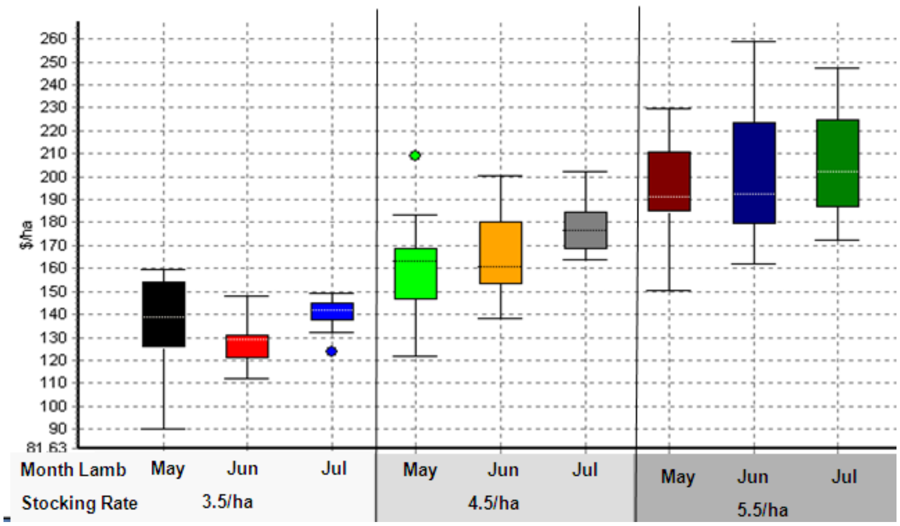
4.2.3 Tasmania

- The effects of climate change to the 2030 horizon on Tasmanian livestock systems are forecast to be generally benign. The key modelling outcome is that pasture production is indicated to broadly increase in this time-frame or remain similar with improved seasonal supply.
- This outcome is indicated for many key production areas within the state. Some areas in the central highlands and southern midlands may not realise this benefit.
- Generally it appears that increased temperatures and reduced frost frequency may improve pasture growth. This alongside a largely neutral or improved rainfall leads to forecasts of improved or similar pasture production. In the absence of any substantially increased seasonal feed deficit notably in summer, animal production is forecast to increase in many regions.
- The key adaptation facing many regions seems to be making use of improved opportunity for more effective utilisation of the pasture resource, with increasing stocking rate used to capture this opportunity within systems similar to those already being operated.
- Trends of increasing animal production and carrying capacity, and perhaps reduced variability of pasture performance may give producers greater confidence to adopt mechanisms for increasing overall pasture utilisation.

- One key question to be addressed though is at what point will producers feel assured enough to seek this opportunity?
- Part of the adaptive process may be significantly improved attention to performance monitoring. This may provide the evidence and assurance for reasoned adaptive changes that seek to make hay while the sun shines, so to speak, and bank the opportunity that improved pasture growth may offer.

4.2.4 South Australia

- Modelling in most locations indicated a shorter growing season with decreased pasture quality. There is also likely to be increased variability in pasture growth. Combined, these factors are forecast to result in increased variability in farm gross margin.
- In many cases, later lambing or calving compared to district practice would be more profitable, although this may mean that producers will have to supplementary feed their stock.



Impact of changing stocking rate and lambing time on Gross Margin - Merino flock - Keith SA

- But there are practical strategies that producers can implement to adapt to a changing climate. These include, increasing flexibility by varying sale times, confinement feeding, more animal trading (core breeding), self-replacing system and agistment
- Pastures based on an annual perennial mix are able to sustain a higher stocking rate due to more pasture being available over summer. And using such grazing management systems as controlled, cell, rotational, confinement, or techno grazing will ensure improved pasture utilisation. Ensuring adequate fertiliser applications will assist in maintain high levels of pasture growth.

4.2.5 Western Australia

- Results are quite varied across the two locations modelled - Kojonup (positive) and Ravensthorpe (negative).
- On balance, for both locations, there is expected to be increased rainfall variability and increased temperature. This will result in faster winter pasture growth rate but shorter growing seasons.

- Increased CO_2 and temperature will result in an increase in legume content. While this will be positive for animal production, the rate of decline of dry pasture residues over summer may increase, resulting in wind erosion and groundcover limits being reached quicker.
- As a result, confinement feeding is likely to be an essential component of a sustainable grazing system for producers in these areas.

4.3 Objective and outcomes

The project objectives listed in section 2 of this report were fully met by the project outcomes.

Objective 1: By 2011, a knowledge base established to underpin ongoing engagement with producers and facilitating further research, development and extension in climate change adaptation

Outcome:
This has been established at two levels:

- Models have been further developed and refined as a result of CCASLI. The DairyMod and SGS models were expanded with a more sophisticated animal model, improved soil organic carbon modules, and the explicit treatment of urine patch dynamics. These have all enhanced the models capacity to predict methane, nitrous oxide, soil carbon and the interactions between these. For GrassGro, apart from refinements via ground-truthing with producers at 46 locations across Australia, this model has been extended (e.g. to apply to C4 native perennial grasslands) and now has available a large number of representative grazing system data sets plus dozens of new producer data sets (lamb, wool and beef production data in numerous southern Australian locations) which will continue to be useful in answering future RD&E questions and further refining models.
- The transfer of modelling skills from research organisation (UoM, TIA, CSIRO) to regional research and extension staff, consultants and others has not only enabled the models and their outputs to be available to a broad range of livestock producers, but the increased confidence and capacity of regional staff as a result of receiving this training and applying the models in “real life” livestock enterprise situations had exceeded expectations. Many regional staff now have the confidence to manipulate, interpret and extend the results of modelling which will be a vital skill to help producers better interpret the impacts of a changing climate on their production systems in the future. In many cases, models are the only way to address such issues.

Objective 2: By 2011, 10,000 livestock producers across southern Australia will be aware of the key research outcomes of the project

Outcome:
As shown in the table below, over 14,000 producers are aware of the key research outcomes of this program (even excluding the several hundred farmers and industry personnel covered by UoM, TIA and CSIRO). Such awareness has come through a variety of means including direct involvement (helping develop data sets and interpret outcomes; suggesting adaptations to model); attendance at workshops across southern Australia; attendance at a range of other workshops / seminars where the outcomes were discussed; and exposure to a large number of printed / audio communication materials via channels including farm journals, newspapers, radio interviews, fact sheets etc.

It is noteworthy that the number of producers "aware" is continuing to be built upon via ongoing regional activities and subsequently by the launch of a dedicated website (www.sla2030.net.au) which will expose the results of all elements of the program further.

Objective 3: By 2011, a program of on farm trialling of key recommendations within each agro-climatic region across southern Australia will be defined, for implementation during the period 2012 – 2015 via MLA producer demonstration sites (PDS) and other RDE providers.

Outcome:
Achieved, but with three important points to note:

- CCASLI was not about seeking producer practice change during the program. It is unreasonable to expect that commercial producers will make adaptations to prepare for something that may or may not exist in almost 20 years-time. As a result, at an early stage in the life of the program, it was determined that it was important to look for adaptations that are either a) likely to be sound adaptations to changing climates, b) need to be carried out over the long term and c) likely to be sound investments in the present-day climate. This was achieved and material developed to extended these messages to producers and relevant industry bodies.
- Over the course of the three years in which CCASLI operated there was a significant change in the "politics" of climate change. The Federal Governments move from a CPRS scheme to subsequently introduce a Carbon Tax and related Carbon Farming Initiative (CFI) swung the pendulum from a focus on adaptation to one of mitigation. This has led to Programs such as Action on the Ground to be, initially at least, focussed exclusively on mitigation strategies for farmers, at the exclusion of adaptation RD&E
- Subsequent to SLA2030, program partners have held workshops to plan collective efforts to both retain the unique RD&E structure adopted by CCASLI and to identify commercially relevant future RD&E for livestock producers.

Objective 4: Establish improved modelling capacity across a range of industry RDE providers

Outcome:
Achieved - see point 1 above

Objective 5: 20,000 livestock producers in Southern Australia by 2020 will be equipped to adapt to climate change

Outcome:
While an aspirational objective, the program steering committee is extremely confident that given the significant progress made during CCASLI, the number of livestock producers now "aware" of the findings and on the basis that future climate change adaptation RD&E is undertaken, this outcome will be achieved.

The following table summarises the achievements of the program against the targets initially established.

CCASLI - Final Report against Targets									
	Regions	Locations	Workshops		Other Extension Events		Producers directly engaged	Comms. products	Producers aware
	Period	Period	Period	Total	Period	Total	Period	Period	Period
NSW	8	24	19		15		2122	12	8622
Victoria	3	7	9		15		784	5	2064
Tasmania	1	7	9		8		201	4	600
SA	4	6	10		12		322	33	2819
WA	2	4	4		0		100	4	100
Cumulative Total	**18**	**48**	**51**		**50**		**3529**	**58**	**14205**
Program Target	**12**	**24**	**24**		**50**		**NA**	NA	**10,000**
Note:	1. The above figures relate only to state producer workshops and do not take account of the several hundered farmers, public and private consultant and advisors, scientists, students and government representatives covered by UoM, TIA and CSIRO								

5 Conclusions and recommendations

5.1 Key conclusions

Based on the outcomes of modelling and working with producers in numerous locations:

- If climate change predictions prove correct, the impact on productivity and profitability across southern Australian livestock industries is very significant. The adoption of current technologies, development of new technologies and policy responses will all be required to reduce these impacts.
- Climate change predictions and their impact on production and profit vary across southern Australian locations.
- The research generally points to increased temperatures and decreased rainfall, resulting in shorter growing seasons and reduced stocking rates in order to maintain ground cover.
- There is a real prospect of a 15-20% overall reduction in pasture growth across southern Australia by 2030 and that in the absence of adaptation, reductions in profitability will be larger again. These results are concerning.
- Climate change impacts are likely to be most severe in the lower-rainfall parts of the cereal-livestock zone.
- For some areas e.g. parts of Tasmania and mainland higher rainfall / colder regions, the outcomes of a changing climate could be positive.
- While climate scenarios show that grazing systems will still be viable in southern Australia in 2030, there is strong evidence that shows with some adaptation these systems can claw back some, maintain or even increase profitability.
- The most advantageous adaptation strategies vary between regions. Importantly though, some of the best strategies or practices are already known to many producers (e.g. increasing soil fertility, genetic improvement of livestock) and are as applicable today as they will be in the future. Other adaptations which may not be applicable today may become so depending on any climate change

- While sheep may provide a buffer in bad years, there is no indication from any of the models that changing entire enterprises is going to be a fundamentally sensible thing to do in the future
- Modelling suggests that, with some adaptive breeding, current forage species will still be the most suitable into 2050, and there would be no production advantage moving to more tropical species within this timeframe.

5.2 Implications and recommendations

While the physical impacts of a changing climate pose a range of challenges for grazing systems, they also pose challenges to industry and government and how they may respond to it - from both an RD&E and policy perspective.

The following commentary provides an overview of future research needs and potential policy issues.

Some research issues

- Advances in climate science will continue to provide more answers, especially in relation to climate change predictions. As new predictions are released, there is a need to review the findings of SLA 2030 to see if they (and recommended strategies / adaptations) change dramatically.
- While the GRAZPLAN models (contained in the GrassGro software) have been extremely useful in this project, they have limitations that are likely to affect progress as investigation of climate change adaptation options moves to its next stage. The most important gaps in GrassGro are the effects of animal health issues (particularly parasites) on animal performance; the feedback between pasture production and soil organic matter; and its inability to represent shrubs such as saltbush.
- CCASLI covered many locations within southern Australia but further work is needed to fill in the geographical gaps existing so that the breadth of sheep and beef enterprises across southern Australia can be covered
- More detailed work on adaptations is needed in those area which have the greatest impact and currently have not been able to recover lost profit. The CSIRO work at 2050 and 2070 has identifies regions for the more detailed studies
- Whole of farm systems evaluation (rather than just at an enterpise level - usually just one component of a "farm") will strongly assist in providing a greater level of validation to the whole of system models currently available and highlight the potential adaptation opportunities within or across farming systems. Mixed farming systems and pastoral areas in particular are gaps.
- While some adaptations can be proposed now (as they are already applicable) for others, how will individual producers know when the right time is right to start changing farm practices, especially as change will, on average, be gradual? What are the trigger points?
- The incidence of extreme events may increase, but we do not have the tools to adequately understand their impact.
- Current modelling approaches compare 2010 systems with, say, 2050 climates. Future models need to consider the counterfactual i.e. comparing 2050 systems as they might be without climate change with 2050 systems that are affected.
- Plant breeders need to consider both new plant species for southern Australian livestock systems, as well as heat tolerance and rooting depth traits in existing pasture species to make them more resilient.

- There is a need to have the ability to effectively and efficiently quantify CFI offset methods across a broad spectrum of farming systems for the livestock industries (i.e further develop the COST calculator for dairy; incorporate it with DGAS and other calculators; and develop similar tools for beef and sheep enterprises).

Some policy issues

- While livestock production under various future scenarios will still be viable in 2030 and beyond, and adaptation strategies will assist, impacts on production and especially profitability will be significant. This will not only require ongoing reseach but new approaches to policy to reduce impacts on food and fibre production, and farming families, in southern Australia.
- Global food demand is increasing, there is more pressure on producers to mitigate emissions and yet a changing climate could negatively affect production. What policy approaches should Government and industry seek to best align these competing interests?
- Future modelling and policy approaches should consider the balance between adaptation, sequestration and mitigation impacts of proposed farming systems changes.
- It is likely that in the future, farmers will need even more flexibility. How can service industries to agriculture and governments respond to provide producers with that greater flexibility in the future?
- By 2050 and 2070, modelling suggest that the lower-rainfall parts of the cereal-livestock zone at least may require either new technologies, a complete re-thinking of the feedbase or else sustained price increases in order for livestock production to remain viable. Policy responses will be equally important.
- Farmers usually react to changed circumstances but tend not to react in anticipation of changed circumstances, especially as predicted by modelling. What R&D and policy can be employed to best help farmers be better prepared?

6 Reference list

For a full list of scientific and conference papers developed over the course of the program see www.sla2030.net.au/resources/scientific-papers