



Final report

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A feasibility study to assess changes to Tasmanian pastures: implications for NRM

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Abstract

This feasibility study explored the value of resurveying 354 pasture sites from 97 farms in eastern Tasmania that were originally surveyed in 1992 (Figure 1) with an aim to assess changes components of the natural resource base that were measured at that time. This included pasture composition to species level, ground cover estimates and soil nutrient tests including soil carbon. Satellite photography indicated that land use had changed on many properties, particularly irrigation development and cropping. Telephone interviews were used to contact sixteen producers to ascertain the availability of information about changes to land management, production per hectare per enterprise and on Return on Assets Managed. Most interviewees had information on ROAM. This knowledge enables us to rank properties according to production or profit in order to identify the top 20% and then to ask the question *'do the top 20% of producers provide the highest levels of natural resource management?'*

Changes to the natural resource base underpinning livestock production can be measured remotely and by intensively by resurveying reference sites. The impact of external drivers impacting on livestock production and natural resources can be determined and cross-checked using a variety of sources providing rigour to the research.

Executive Summary

In 1992 pasture agronomists surveyed 354 pastures on 97 properties in the eastern Tasmania (Figure 1). They collected information on pasture composition (to species level), ground cover estimates, soil nutrients (including soil carbon) and land management practices for the paddock at that time. This valuable dataset formed the basis of a project to assess change in natural resources over time by repeating the survey.

In order to explore the stability of the natural resource base underpinning livestock production, we need to account for as many variables as possible that would impact on change to the natural resource base over time. It was proposed that targeting properties that are under the same family ownership for the past 20 years should reduce the number of impacting variables, particularly land management practices.

The aim of this feasibility study was to collate baseline information on: changes in land use to the 354 sites; the current ownership of the 97 properties; and farm and paddock level information from a subset of 20 producers via telephone interviews.

A desk-top analysis using SPOT (2010) imagery was undertaken on the 354 sites to determine the extent of land use change over the 20 year period. The majority of sown and native pastures surveyed in 1992, were retained as sown or native pastures in 2010 (Tables 4, 5). Both SPOT imagery and producer interviews indicated that irrigation and cropping had increased over time with producers indicating that 20% of pastures had been converted to cropping. Some cropping activities were for fodder only (Table 6) while others include at least short-term pasture as part of the crop rotation. Some farmers used high value crops to pay for irrigation infrastructure but then used irrigation to develop lamb finishing enterprises. Increases in cropping do not necessarily mean a decrease in livestock production. *The extent to which cropping and livestock enterprises are integrated cannot be determined by satellite imagery alone. In depth consultation with producers in*

addition to pasture surveys are required to assess change to enterprise mix and natural resource condition.

A total of 62 properties were still under the same family ownership in 2011, accounting for 227 of the 354 pasture survey sites. The 227 sites represent all land use classes (1-6) surveyed in 1992 and are across the geographical range of study area. Landholders from 20 properties across the geographical range of the survey were contacted to determine what information was available on the pastures. Four of the 20 did not want to participate in the pilot project. The remainder provided information on land use for the target paddocks, general changes to land use over time in addition to enterprise mix and general financial information. *Most of the 16 knew the on their Return on Assets Managed (ROAM) and/or Gross Margins (GM) for their businesses (Table 6). This information allows us to rank producers according to production or profitability values, allowing us to ask the question 'do the top 20% of producers provide the best natural resource outcomes?'*

Drawing information out from producers via telephone interviews is a difficult process unless the interviewer has a good rapport with the interviewee. However, it is doubtful that farmers have detailed paddock records for the past 20 years. They were able to recall when paddocks were sown and talked about general approaches to grazing management and fertiliser use at the farm scale but not necessarily at the paddock scale. All interviewees said that they had not changed their grazing system (e.g. set stocking or rotational grazing) over time. The change of enterprise mix from mainly livestock to mixed farming indicates that large changes have occurred even within farms under the same ownership. *Therefore there appears to be very little advantage in focusing on only those properties under the same ownership. Targeting as many of the 97 owners (354 sites) as possible would provide greater statistical rigour.*

Records relating to crop area and yield are more likely to be kept than records of pasture management. This information will provide an indication of the length of time and proportion of income that cropping has provided to the farm enterprise, and diversification associated with this. *What impact has intensification had on natural resource values? Has intensification led to increased meat production by the ability to irrigate pastures within a cropping rotation?*

Opportunities exist to explore future meat production at a range of scales: at the farm scale using farming systems approaches to explore the best use of resources to promote meat production within the context of irrigation development; and the paddock, farm and landscape level to assess changes in land use/enterprise mix on natural resources, particularly the perennality and stability of the pasture resource, soil erosion potential and soil carbon storage and farm and landscape level biodiversity values. *Triangulation from a range of sources has been demonstrated to validate a range of different data sets.* Positive outcomes linking grazing management (persistence of perennial pasture base) to carbon storage will help to offset negative images of the livestock industry in a carbon-focused world.

Based on the information in this feasibility study, we recommend that as many of the sites as possible be resurveyed in spring 2012 to determine change in land use, enterprise mix and the condition of the natural resource base for red meat producers. The main research questions are:

- What impact has agricultural intensification had on natural resource values at the paddock, farm and landscape scales?*
- How can we improve the environmental performance of the top 20% of red meat producers?*

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Background

Producers are under continual pressure to adapt to changing conditions: abiotic (e.g. drought); biotic (e.g. pasture pests); economic (e.g. investment in irrigation); or social (sustainable land management). Since the early 1990s Tasmanian producers have experienced some of the warmest years on record and prolonged periods of dry weather. Increased reliance on irrigation for crops and pastures partly in response to highly variable seasons and also due to commodity prices has resulted changes in herd and flock dynamics. Shifts from wool to meat sheep breeds, including 'exotic' breeds, a reduction in livestock numbers due to drought, and an increase in the geographical extent of dairy enterprises facilitated by irrigation developments, have all impacted on grazing industries in the State. Further changes to enterprise mixes are expected with new Tasmanian specific climate projections, and with the planned irrigation development schemes, particularly in the Midlands region - the traditional strong-hold of extensive grazing enterprises.

Increased use of irrigation for crops and pastures has enabled producers to expand red meat production, generally sheep meat production on traditional wool grazing properties. This intensification of grazing enterprises has provided opportunities for the red meat industry, but it has also resulted in altered land use patterns. The introduction of cropping into traditional grazing enterprises has resulted in changes in the composition and perenniality of ground cover from relatively diverse perennial pastures to monocultures of annual species.

As producers move to more intensive systems, there are implications for natural resource management outcomes including biodiversity. Data from a benchmarking survey of Reid et al. (2003) suggested that the area of native pasture on farms belonging to the top 20% of producers was less than the mean for all farms surveyed, but that the area of 'bush' (woody native vegetation) on these high performance properties was similar to the average for all farms. The mean area of native pasture decreased while improved pasture increased over the two years of the study (2000-2001, 2001-2002). While these data are limited, it is highly likely that the top 20% are the 'early adopters', signalling the direction of potential changes to future management. If producers are under pressure to intensify in order to increase production, then we need to ask what implications are there of such a decisions on natural resources? The likelihood of meeting the goal of increasing production whilst maintaining environmental standards needs to be investigated, and can be done so retrospectively using long-term data sets.

Researchers have shown that agricultural intensification may lead to loss of biodiversity values at the landscape scale (Kleijn et al. 2009) and that perennial pastures are more biodiverse than monocultures (Bridle et al 2009). Soil carbon values are reduced under annual cropping compared to perennial pastures under the same soil type (Cotching 2009). Grazing management also affects soil physical characteristics through compaction and soil erosion where pastures are overgrazed (Greenwood and McKenzie, 2001), though attributing differences in soil carbon to grazing management has been shown to be difficult (Chan et al. 2010). Given changes in land use and enterprise mix on Tasmanian farms, what observable changes have there been on the condition of natural resources?

Plant and soil surveys, including soil carbon, of native and improved pastures were undertaken across 354 sites on 97 farms in eastern Tasmania in the spring/summer of 1992-1993 (Friend et al. 1997). This data set can be used as a benchmark for a longitudinal study of change in land use and pasture condition across the predominant land-classes within Tasmania's extensive grazing enterprises. The

condition of natural resources, including soil carbon stores, shifts in pasture composition and changes in management practices can be assessed in the context of opportunities for farmers to adapt to climate change.

Combining information on the biophysical components of pasture surveys, producer interviews and digital data layers provides an opportunity to assess changes in natural resource values over space and time under agricultural intensification. The addition of data on production and profitability facilitates the identification of the top 20% of producers in the survey to determine whether they have delivered the greatest natural resource outcomes over time. The following research questions can be addressed:

- *What changes in land use have occurred over the past 20 years and what are the drivers of change?*
- *What is the effect of pasture type (native, sown, volunteer) and change in pasture type on red meat production and natural resources in Tasmania over a 20 year period?*
- *What is the current condition of the pasture resource in eastern Tasmania?*
- *What associations exist between land use, management practice, pasture type and production and NRM outcomes?*
- *Are the top 20% of producers distinct from others for NRM outcomes? Can improvements be made to increase sustainability in the long term under projected climate change?*

Project objectives

The purpose of this pilot project is to assess whether sites and data are available at 354 Tasmanian sties sampled in 1992, as a basis for a larger program to determine dominant drivers and implications of change in the management of NRM outcomes.

This will be done by:

- Assessing the ability to access the 354 sites from the 1992 survey
- Identifying land use change around those sites (GIS mapping)
- Identifying available biophysical and economic data
- Drafting a feasible proposal to assess the impact of land use change due to changing grazing enterprise mixes, on the natural resources, pasture composition, soil carbon and native vegetation in the prime store production (cattle and lamb) and the lamb finishing regions of Tasmania's red meat industry

Methodology

The methodology includes incorporating a range of approaches from telephone surveys to desk-top analyses of available digital spatial layers. The original data files had information on the property name, the name of the owner, paddock name, paddock location (eastings and northings) and pasture class. Therefore a combination of approaches was needed to collate the necessary information.

Initial attempts at identifying properties using the telephone directory and local knowledge of brokers, farmers and extension specialists resulted in an incomplete database. Access to DPIPWE's property data base facilitated the identification of the 97 current property owners and their addresses. Telephone numbers were then accessed from the on-line telephone directory.

The telephone interview was designed to be a short (<10 min) information gathering exercise. A total of 20 producers were targeted for interview who had been involved in the 1992 survey. Human ethics approval was sought and granted and an introductory letter (Appendix 1), the interview questions (Table 1) and the human ethics information sheet (Appendix 2) were sent out via email or post to the producers. They were given up to two weeks to process the information before being contacted by telephone.

Other digital spatial layers, made available by the Department of Primary Industries, Parks, Water and Environment (DPIPWE), included the SPOT satellite imagery from 2010. Land use change was investigated by comparing the 1992 pasture classifications from the data set to the 2010 satellite imagery and cross checked with farmer comments on current land use for each surveyed paddock from telephone interviews.

Table 1. Telephone survey questions to 20 producers involved in the 1992 survey.

- 1) Farm Name
- 2) Age range (circle 1): 18-29, 30-39, 40-49, 50-59, 60+
- 3) Length of time farm has been owned/managed by the family
- 4) Length of time current owner has been managing the farm
- 5) Area of farm (ha)... ..

6) Please provide information on your farm enterprise mix and the relative area (ha) and relative contribution (%) of each enterprise to farm income 2010

	Area of farm (ha)	Relative contribution to farm income (%)
Irrigated cropping		
Dryland cropping		
Beef production		
Prime lamb production		
Wool production		
Perennial Horticulture		
Other (please list)		

7) Please provide information on the production per enterprise in kg/ha/product/year (2010-2011)

	Crops grown	Production kg/ha/yr
Irrigated cropping	e.g. poppies	
Dryland cropping	e.g. barley	
Perennial Horticulture		
	Pasture type	
Beef production	e.g. sown perennial (rye)	Yes
Prime lamb production		
Wool production		
Other (please list)		

8) What changes in land use and management have occurred on your property since 1992?
 e.g. shift from set-stocking to rotational grazing (year of conversion), conversion of x pasture to y pasture (year of conversion), development of irrigated cropping (ha/year of conversion)

.....

The paddocks that were surveyed in 1992/1993 were:

	Land use 2011 e.g sown pasture – phalaris sown (year)

9) Have you observed any changes over time relating to climate e.g. change in rainfall reliability, seasonality, change in frost frequency etc?
 If yes please provide details.

.....

10) Do you participate in financial benchmarking? Do you know your ROAM/GM for your farm business?

.....

Comments/any other information
 Thank you

Results and Discussion

Assess ability to access the 354 sites from the 1992 survey

Access to the restricted DPIPWE land and titles data base allowed us to trace the current ownership of 97 properties surveyed in 1993 (Figure 1). A total of 62 properties were identified as being under the same family ownership in 2011. This accounts for 227 of the 354 pasture survey sites (Table 2).

The original pasture survey classified sites into 1 of 6 classes. Classes 1 and 2 were sown pastures; class 3 was a mixture of native and sown species, while classes 4 and 5 were native pastures. There were only two samples in class 6. Over 50% of sites in all six classes have been retained under the same ownership (Table 2). Farms under continuous ownership occurred across all regions (Table 3).

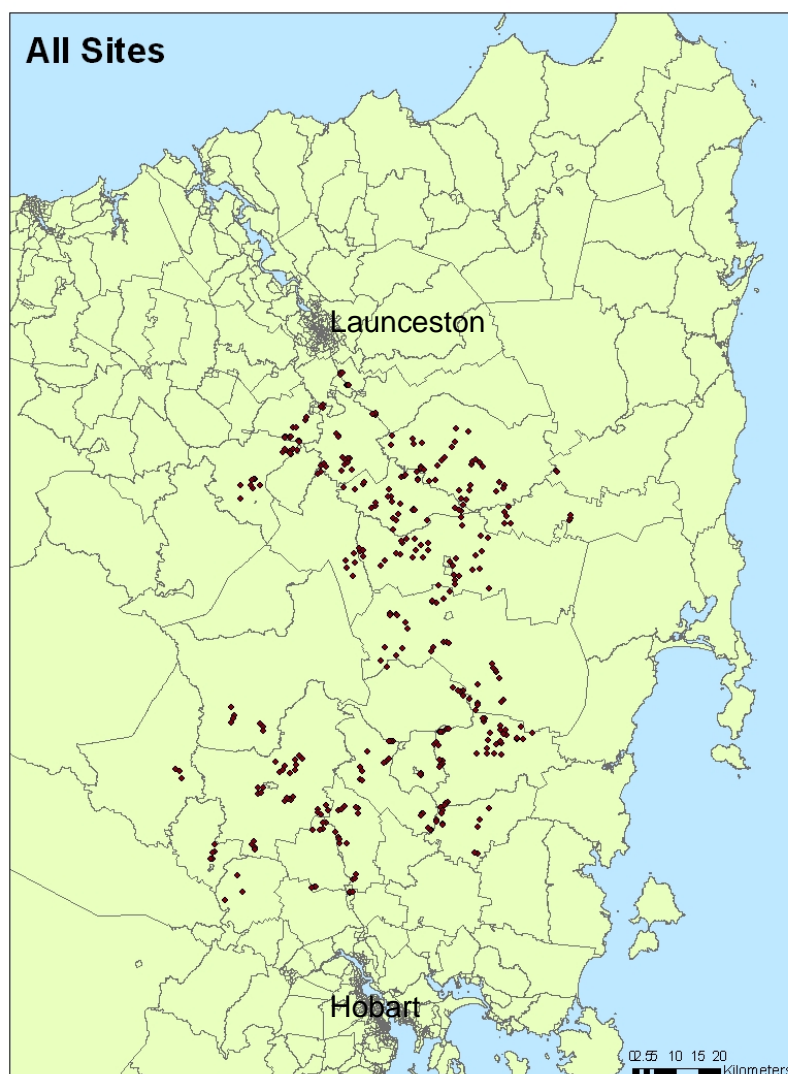


Figure 1. Location of the 354 survey sites in eastern Tasmania.

Table 2. Number of farms under the same ownership and number of survey sites by pasture class from 1992-2011.

Under same ownership	Number of farms	Pasture class						Total number of sites
		1	2	3	4	5	6	
Yes	62	67	104	27	16	11	2	227
	64%	68%	67%	56%	52%	61%	100%	64%
Total	97	98	156	47	34	17	2	

Table 3. Farm ownership by region 2011.

Region	Farm under same ownership	Total number of farms	%	Number of pastures under the same ownership	Total number of pasture sites	%
Evandale	7	11	64	28	44	64
Longford	7	16	44	23	49	47
Fingal Valley	1	3	33	3	11	27
Campbell Town	14	20	70	47	68	69
Ross	5	7	71	21	29	72
Oatlands	16	23	70	54	85	64
Bothwell	7	7	100	30	30	100
Hamilton	1	3	33	3	11	27
Green Ponds	4	7	57	18	27	67
Total	62	97	64	227	354	64

Identify land use change around those sites (GIS mapping)

All 354 sites were plotted onto 2010 SPOT imagery to assess land use under each site. DPIPWE also have an 'irrigation' layer which immediately classified 49 of the 354 sites as irrigated. It was assumed that plant composition for these sites would either be improved pasture or crop. Of those 49 sites identified as irrigated, only one site was classified as native in 1992. An additional 27 sites were classified as 'crop' in 2010, with 5 of these previously recorded as 'native' in 1992.

Comparisons were made between the classification of pasture classes 1 and 2 in 1992 and the desktop based classification using 2009 imagery. We assumed that a pasture class of 1 or 2 (improved) in 1992 could not become a pasture class of 4 or 5 (native) in 2009. If these sites were classified as 'native' in 2009 by using the desktop analysis then they were considered to be mis-classifications. Approximately one fifth of the sites were mis-classified i.e. classified as sown pastures in 1992 and fertilised native, semi-native or native in the 2011 desktop analysis (Table 4). These mis-classifications are a result of human error in interpreting the SPOT imagery. Colouration changed between sites, with certain shades of green not always indicating a particular pasture class. Clues such as intense greens were taken to be indicative of pasture improvement. Landscape context was also used with sites on hill slopes and rock outcrops likely to be more native than improved. Difficulties in classifying pasture composition through the interpretation of remote imagery are

common. Ground-truthing the sites is necessary to determine whether other mis-classifications have occurred. However, the desktop analysis provides a quick overview of potential changes to land use and pasture composition over time.

Table 4. Classification and potential for mis-classification of the 354 pasture types using SPOT imagery.

N.B. While the 2010 image may indicate a cropped area, it is not possible to ascertain whether the area is a crop, irrigated pasture or a pasture cut for hay or silage.

Pasture class (1992)	Total number in each class (1992)	Changed land use 2010	Mis-identification (2010)
1 – sown pasture	99	Crop?	22 (22%)
2 – sown pasture	156	Crop?	36 (23%)
3 – fertilised native	48	-12 (25%)	unknown
4 – native with Themeda	31	-3 (10%)	unknown
5 – native with Poa	18	-2 (11%)	unknown
6 - native (not described in 1997 report)	2	?	

Information from the farm interviews provided an additional review of land use change over time. The producers interviewed provided information on 88 of the 90 paddocks they managed between them. Of these, 72% were reported to be under the same land use class as in 1992 (Table 5).

Table 5. Change in land use class based on producer information from telephone interviews for 90 paddocks. ‘crop’ includes land under irrigation.

Land use 1992-2011	Number of paddocks	%
Sown pasture (class 1,2) to crop	18	21
Sown pasture to sown pasture	39	43
Native (class 3-6) to crop	1	1
Native to sown pasture	2	2
Native to native	28	31
Unknown	2	2

Identify available biophysical and economic data –telephone survey

Twenty property owners were selected across regions from the subset of 62 properties held in the same family. The interview questions required short answers but allowed producers to provide more information if they wished to (Table 1). The brief was to collate information on the *availability* of data relating to enterprise mix, production per hectare and financial data.

The drawback of telephone interviews is that it is difficult to develop a rapport with the interviewee, especially if they have never met the interviewer. Producers indicate a preference for face-to-face interaction but this option was restricted during this project due to its relatively short time frame. Therefore it was difficult to obtain detailed information through the telephone interview, particularly if the interviewer was unknown to the farmer. Despite information being sent out beforehand, very few of the producers had prepared responses to the question relating to production per ha. Of the 20 property owners who were contacted, four declined to participate. One stated that everything had changed (moved into cropping), another stated that nothing had changed (native pastures were surveyed in 1993), the third said that

they were too busy to participate and the fourth was denying access to his property due to long-standing issues with the state government.

Farm size ranged from 150 ha to 15000 ha (Table 6). Enterprise mix varied with 15 of the 19 properties that we had information for having some cropping activity. Some producers had dryland forage crops, some had irrigated pastures while others had dryland and irrigated cash crops. Cropping accounted for 0-100% of the income received on farm. Income from wool production ranged from 20-90% with most farmers commenting that they had diversified out of pure wool production after the fall in wool prices in the 1990s and with the onset of drought. Relatively few of the producers interviewed now receive the majority of their income from wool in contrast to the 1992 survey. Most producers had meat production as part of their enterprise mix. Income from beef cattle ranged from 0-25% while income from prime lambs ranged from 6-50%. One farmer stated that 2010 was the first year that he had earned more from meat production than wool production.

Where possible we tried to speak with the person who was managing the property in 1993 as they were best placed to describe changes over time. Due to the short duration of the survey, responses were very general, and were at a farm level rather than a paddock management level. e.g. 'a higher percentage of improved pastures than in 1993' or 'more cropping'. It is doubtful that many farmers would have accurate records of land management changes for each surveyed paddock over the 20 year period, though they were able to say when one of the surveyed paddocks had been sown or resown. Producers talked in general terms about fertilising pastures, which appeared to be linked to times of high rainfall and high commodity prices to maximise returns. Grazing management did not appear to change substantially over time but livestock enterprises did. Producers reported that cattle were a component of their enterprise mix in 1993 but were sold off during drought. Over the past 2-3 years, with good rainfall, cattle numbers have been reintroduced to some of the properties surveyed.

Nearly all of the producers interviewed thought that they would be able to supply information about production measured in kg/ha for each enterprise if given enough time to prepare, but that livestock enterprises would be more difficult to separate than crops (Table 6). Two producers did not know this information but one added that he had the 'paper trail for someone to work it out'. The second producer had a small sheep flock and was supported by off-farm income. Six of the 14 producers who replied to all questions were involved in financial benchmarking, but seven of the eight who were not thought that they would be able to supply figures relating to Return on Assets Managed or Gross Margin at the farm level. This information would provide a method of ranking farms in terms of relative business success for the purposes of correlating farm business success and a number of environmental outcomes.

Some producers felt that the climate had always been variable and that now is no different. Others thought that the extremes (wet and dry) were more extreme. Drought promoted many to increase on-farm water storage or develop irrigation infrastructure and move into cropping in an attempt to minimise risk associate with rain fed agriculture...'the cycles of wet and dry drove us to crop production'. Producers in one region agreed that winters were milder (less frosts) and that failed springs, including drying up of water holes and rivers, were more common in recent years (not including the high rainfall of 2010-2011). The autumn break was seen as 'random' and weather as 'not regular' indicating that these producers were well used to dealing with variable climate.

Table 6. Summary of property level information collected during the telephone surveys.

Property	Area (ha)	Proportion of income derived from each enterprise (%)				Availability of economic information		
		cropping	wool	prime lamb	beef	Production kg/ha/yr	ROAM/GM	Bench-marking
1	1400	0	70	30	0	y	y	y
2	7000	60	20	10	10	y	y	n
3 (2 properties)	3000	30	40	25	5	y	y	y
4	890	y	y	Information not given in interview but is available				
5	12000	65	28 (4000 xbred lambs)		7	y	y	y
6	15000	10	55	35 (10000 xbred lambs, 1000 cows)		y	y	n
7	2675	25	75 (inc surplus stock)			y	y	n
8	6000	Fodder only	85-90		10-15	y	y	y
9	2373	0	94 (inc 34 surplus)	6		y	y	y
10	253	Fodder only	35	40	25	Can be worked out		n
11	336	Fodder only	50	50		n	n	n
12	1400	5	50	45		y	n	n
13	2600	65	35 (inc surplus stock)			y	y	n
14	150	100				y	y	n
15	1868	y	y		y	Information not given but available		
16	2000	n	y		n	y	y	y
17 (2 properties)	9180	y	y	y		Declined to participate		
18	3166	Fodder only	y		sold in drought	Declined to participate		
19	41	unknown				Declined to participate		
20	308	y				Declined to participate		

Identify available biophysical and economic data – other data sets

Spatial layers allow us to quantify land use change within a region. The images in Figure 2 were taken from Google Earth and indicate land use change, particularly irrigation development, from 2004 to 2010. DPIPWE staff have mapped changes in land use from remote images from 1995 to 2010. This information will be available in early 2012. While the mapping cannot easily distinguish between different classes of grazing land, it does allow us to interpret changes in land use over time with respect to cropping activity which could be correlated with changes in red meat production at the farm level.

The original report states that only 13 sown pastures were irrigated, and that these were flood irrigated, this is in stark contrast with the amount of irrigation apparent today. Interpretation of the DPIPWE land use layer based on 2010 SPOT imagery shows at least 49 irrigated sites, many of which use overhead pivots and a further 27 sites that appear to be cropped. It is not known which of these 76 sites are under pasture.

DPIPWE have spatial layers relating to the proportion of native vegetation on farm (TasVeg 1:25,000) and the presence of rare or threatened species within and beyond the farm boundary (Natural Values Atlas). These landscape context measures can be applied to each farm and may be correlated with farm level information such as proportion of perennial pasture/crop, production (kg/ha/yr), ROAM, farm area and proximity to native vegetation off farm. Figure 3 is a map of native vegetation 1-3 km from the farm boundary for a mixed farm in northern Tasmania. Other layers include soil mapping and salinity mapping. This work can be undertaken on any of the 354 sites if current landholders are willing to cooperate by providing basic information on their enterprise mix (including ROAM or GM). All 97 property boundaries have been added as a layer to a digital database (Figure 4).

The ability to rank landholders in terms of production and/or profitability is useful when trying to determine whether the top 20% of landholders are efficiently producing while maintaining their natural resource base. Results from the telephone survey suggest that over a third of landholders are actively involved in financial benchmarking. However, Holmes Sackett (2011) state that the bottom 20% of their landholders who are involved in benchmarking activities are generally farmers who would be rated as 'average' for on-farm productivity and profitability according to ABARE surveys, therefore they are not representative of the wide range of producers. These indicators can be used to rank the 97 farms in order to determine whether the top 20% do deliver the best environmental outcomes in terms of maintaining a perennial pasture base, limiting soil erosion, maintaining soil carbon and supporting biodiversity assets on farms.

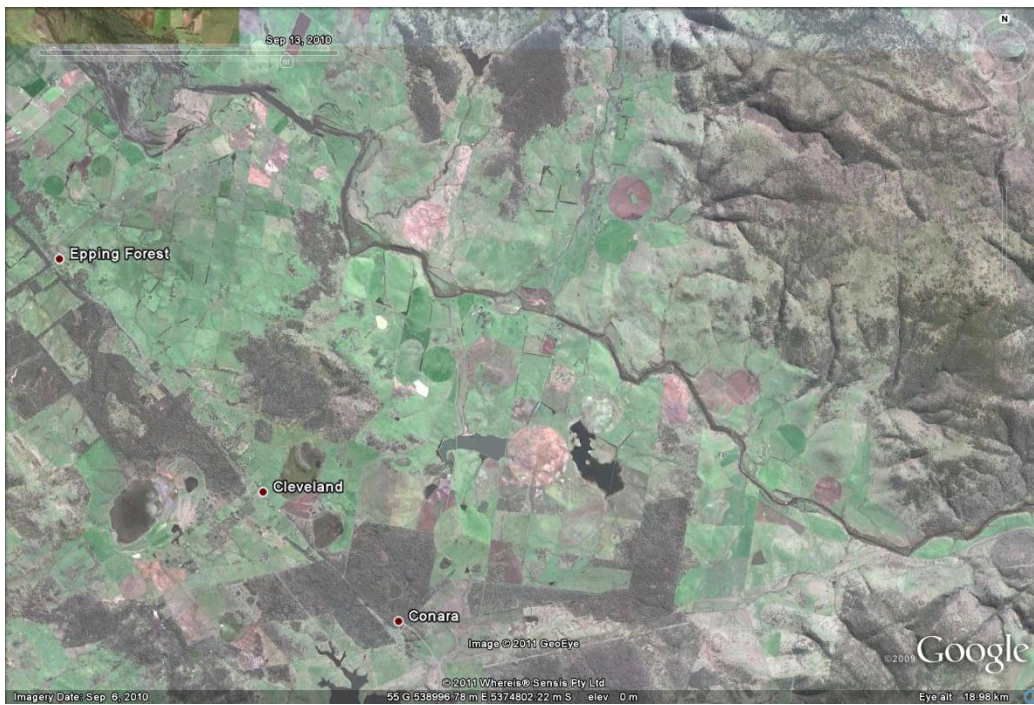
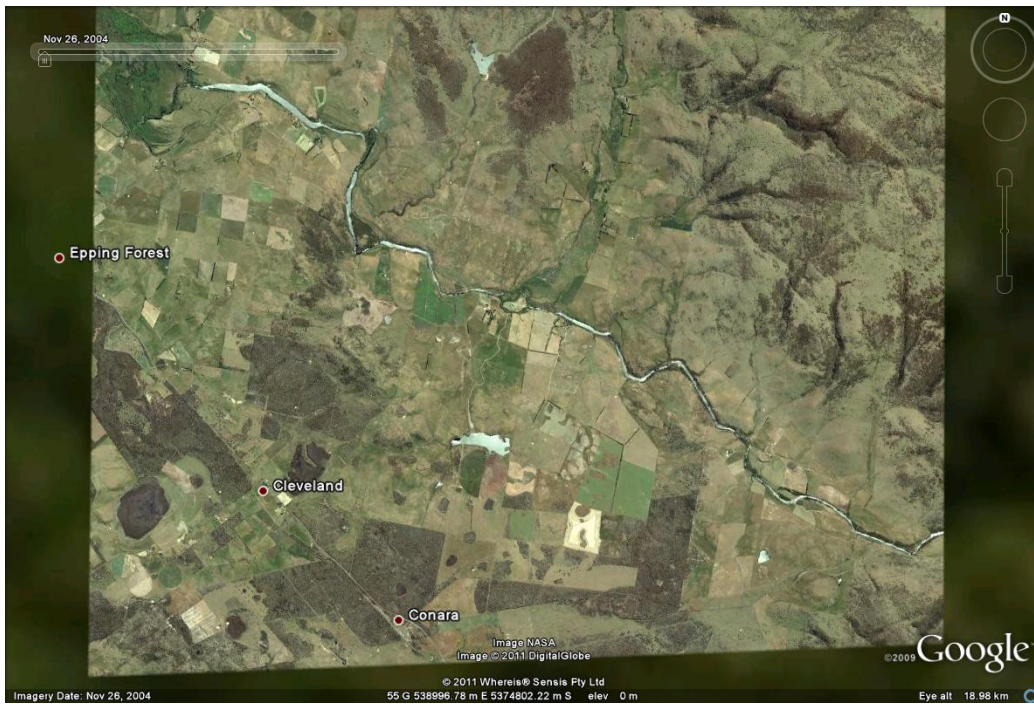


Figure 2. Google Earth images around Cleveland in 2004 (above) and 2010 (below), showing the increase in extent of overhead pivot irrigation in the region.

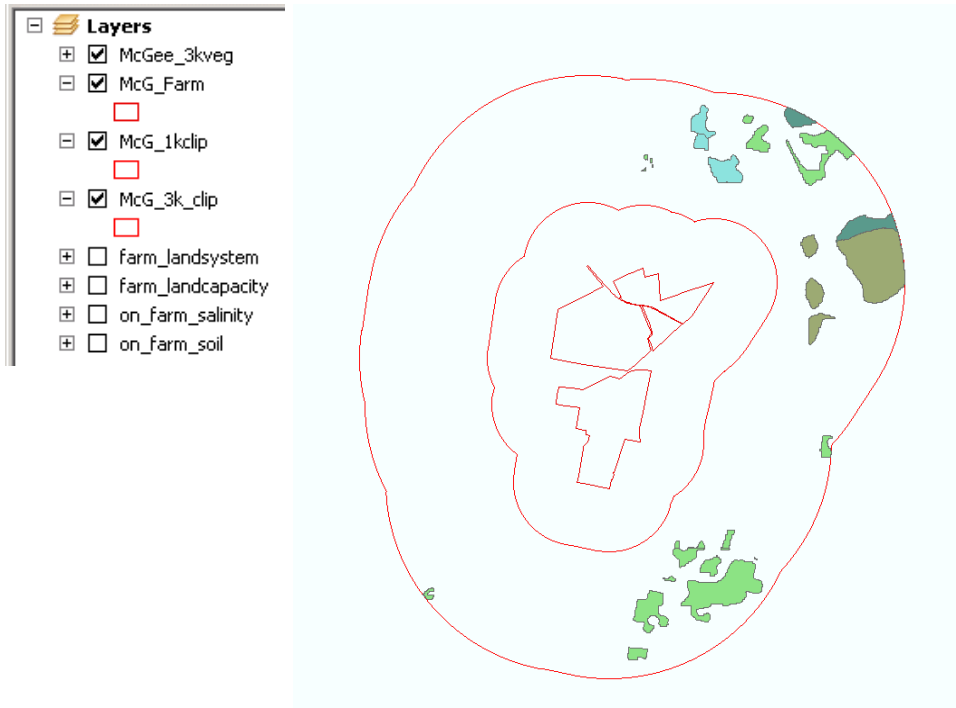


Figure 3. Example of farm and landscape scale measures of biodiversity for a mixed farm in the Cressy region.

The diagram shows the farm boundary and distances of 1 and 3 km from the boundary with native vegetation patches mapped.

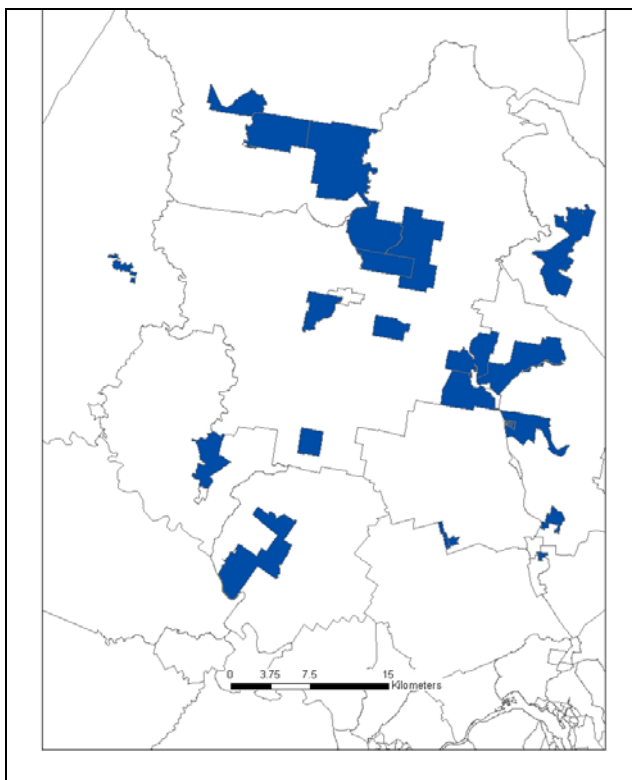


Figure 4. Location and extent of participating farms in the 1992 survey in the Southern Midlands region.

Other sources of digital data include ABARES datasets e.g. AgSurf and regional commodity outlooks. Unfortunately the data sets are incomplete for the time period 1993-2010. Figure 5 shows data for the area of irrigated grazing land and total irrigated area for Tasmanian mixed farms from 1992 to 2010. The small amount of data available for the early 1990s suggests a much closer link between irrigation and grazing than information for 2000 onwards. These trends are consistent with information provided by producers during the interviews and with the increase in irrigation identified by the DPIPWE land use change layer. Data for beef cattle (Figure 6) and sheep (Figure 7) demonstrate the impact of drought (2006-2008) on the number livestock sold from mixed farming systems.

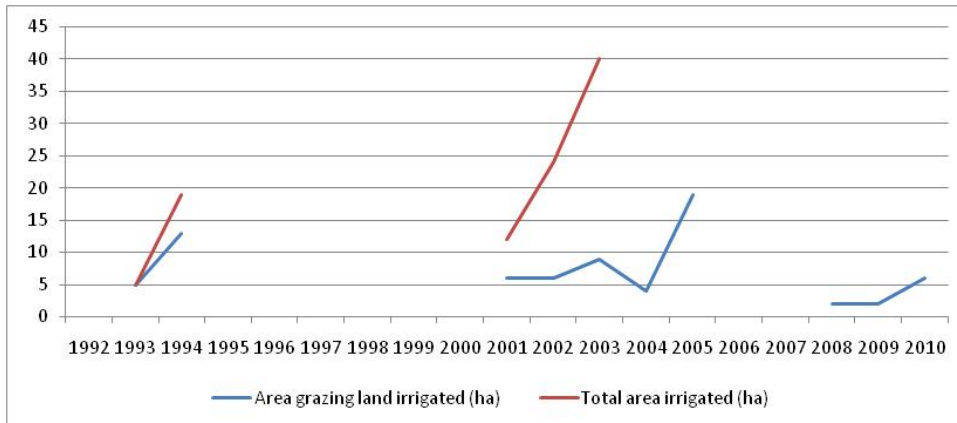


Figure 5. Average area of land under irrigation from 1992 to 2010 for a Tasmanian mixed farm. Source: AgSurf accessed 23/10/11.

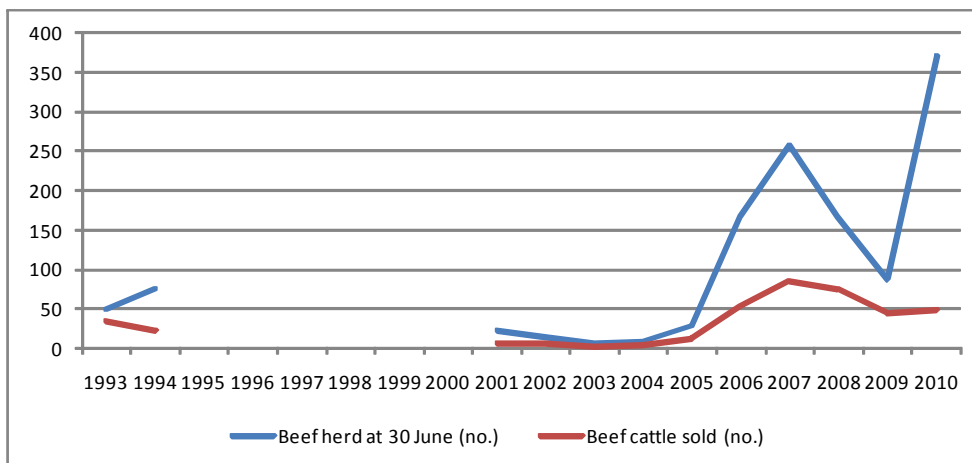


Figure 6. Average number of beef cattle from 1993 to 2010 for a Tasmanian mixed farm. Source: AgSurf accessed 23/10/11.

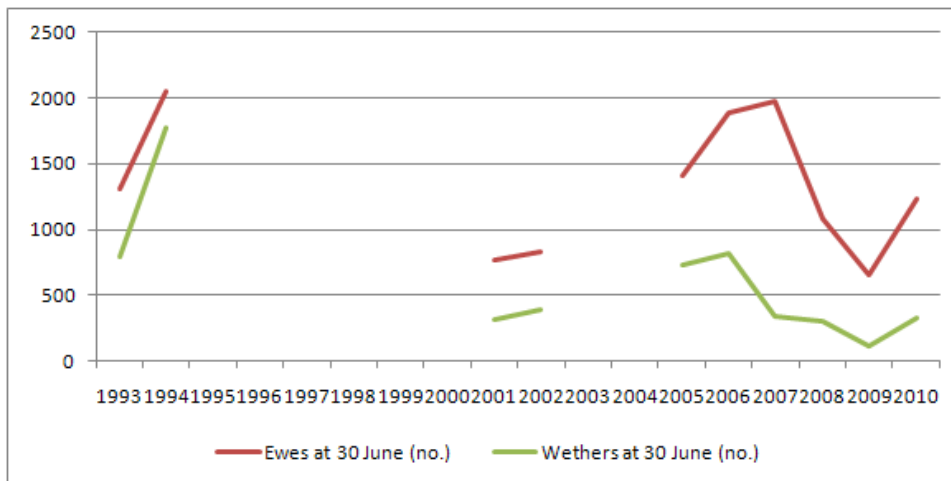


Figure 7. Average number of ewes and wethers from 1993 to 2010 for a Tasmanian mixed farm. Source: AgSurf accessed 23/10/11.

Conclusion and Recommendations

This pilot study has explored a range of approaches to determining the natural resource values of Tasmanian mixed farming properties. The regions of the Midlands and the Derwent Valley were originally selected in 1992 because they were the main wool producing regions in the State. The properties had sheep (wool and meat production) and/or cattle, as pastures were a dominant component of the farm enterprise. A combination of low wool prices and drought had led many to initiate or increase cropping activities on their properties, particularly irrigated cropping.

The project has focused on the 97 properties that were surveyed in 1992 to identify those properties still under family ownership. The reason for doing this was to ensure some continuity and provision of land use management information in order to reduce the number of variables that lead to change in natural resource condition over time. While 62 of the properties have stayed in the same family, many are now under the management of their children. The small number of interviews conducted via telephone highlights the increase in cropping activity on most farms, information that is supported by AgSurf data and the DPIPWE land use layer. One producer stated that he felt that he had had to reinvent the farm business every decade due to drought, commodity prices and with the advent of technological advances (e.g. pivot irrigators).

The telephone interviews and previous experience working with graziers have led to the assumption that paddock records for pastures are not well maintained. *It is highly unlikely that detailed paddock records exist for the majority of properties over the 20 year period, whether managed by the same family or not.* Statistical advice was sought from Dr Ross Corkrey (TIAR, pers. comm.) on the sample size needed to detect changes in pasture condition. He suggests that at least two thirds of the 354 sites would need to be resurveyed to reduce confidence intervals to 15%. Surveying only 50% of sites would increase confidence intervals to 20%. Given that 64% of all sites are under the same ownership and that it is unlikely that all 62 producers will allow access to their properties, or will have accurate paddock management records, it seems **reasonable to target as many of the original 97 properties as possible. This would increase statistical power and provide an extensive review of pastures across all regions, which can complement current MLA activities**

such as 'the pasture feed audit' in addition to TIAR's current pasture audit via roadside surveys.

We recommend that a more thorough desk-top based analysis of all 97 properties be carried out using DPIPWE's land use change layer as an appropriate starting point to detect trends in land use change. This assessment can be followed by farm based surveys to provide biophysical data to assess land use change in the context of the condition of natural resources and the farm enterprise mix. Therefore we can obtain a landscape scale overview of correlates between changes in land use change, particularly the proportion and type of livestock enterprise and cropping, and components of the natural resource base that were measured in 1992.

Maximising the data set, i.e. approaching all 97 landholders and triangulation of results from a range of sources (satellite imagery, producer interviews, ABARE data, on-ground pasture assessments) will increase our confidence in the research findings.

An assessment of pastures after 20 years allows us to determine the long-term sustainability of the enterprise. Information on ground cover including the ratio of perennial to annual species present will provide an indication of soil loss and pasture management. In sown pastures, information on the number of times a pasture has been sown or fertilised in the past 20 years will provide an indication of pasture management and long-term economic sustainability. In native pastures the ratio of native to introduced species, and the number of native species present will provide an indication of native pasture degradation.

Soil physical and nutrient tests will provide supporting information on the amount of fertiliser used, the relative acidity of the soil, compaction and soil carbon stores. Change in carbon stores over time may be difficult to detect due to a number of variables that affect carbon values, including soil type, rainfall and grazing management. However significant land use change has occurred across all regions with the expansion of cropping into previous pasture systems. This provides an excellent opportunity to measure change in soil carbon levels for selected land use types and to assess above ground carbon stores remotely (through native vegetation mapping).

In depth, face to face, land holder interviews will provide more detailed information on land management decisions and land use change over time, particularly the drivers of land use change. Records relating to crop area and yield are more likely to be kept than records of pasture management. This information will provide an indication of the length of time and proportion of income that cropping has provided to the farm enterprise, and diversification associated with this. ***What impact has intensification had on natural resource values? Has intensification led to increased meat production by the ability to irrigate pastures within a cropping rotation?***

Opportunities exist to explore future meat production at a range of scales: at the farm scale using farming systems approaches to explore the best use of resources to promote meat production within the context of irrigation development; and the paddock, farm and landscape level to assess changes in land use/enterprise mix on natural resources, particularly the perenniality and stability of the pasture resource, soil erosion potential and soil carbon storage and farm and landscape level biodiversity values. Positive outcomes linking grazing management (persistence of a perennial pasture base) to natural resource outcomes including carbon storage may help to offset negative images of the livestock industry in a carbon-focused world.

Acknowledgements

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the 20 producers who participated in the telephone interviews; Matthew Appleby (Bush Heritage Australia); Andrew Bailey, Ross Corkrey (TIAR); Andrew Cameron (Tasmanian Land Conservancy); Felicity Fawkner, Darren Kidd (DPIPWE); Eric Hutchinson (Roberts Limited); Leanne Sherriff (Macquarie-Franklin); Maria Weeding (Southern Midlands Council); and Rae and Lindsay Young (producers).

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Appendix 1 – Human Ethics Information Sheet (Logos removed)

PARTICIPANT INFORMATION SHEET SOCIAL SCIENCE/ HUMANITIES RESEARCH

Assessing changes to Tasmanian Pastures: Implications for NRM, climate change adaptation and red meat production.

Invitation

You are invited to participate in a feasibility study exploring the opportunity to resurvey 354 pastures that were last surveyed by Doug Friend, Robin Thompson and Peter Ball in 1992. We understand that your property was selected in the original 1992 survey, and we are contacting you to see if you would like to participate again.

The feasibility study is being conducted by Dr Kerry Bridle with assistance from Mr Peter Ball.

1. 'What is the purpose of this study?'

The purpose is to investigate whether it is possible to access the same properties that were surveyed in the 1992 pasture survey. We aim to contact all participants who have retained ownership of the property since 1992. It is important that the ownership is consistent as we would like to collect information on land management (grazing and cropping) over time.

2. 'Why have I been invited to participate in this study?'

You are eligible to participate in this study because pastures on your farm were surveyed in 1992, and your family have retained ownership of the farm since then.

4. 'What does this study involve?'

This feasibility study has identified which properties have stayed under the same ownership since 1992. We would like to contact (via telephone) a subset of farmers to ask questions about the type of information that might be available if the full project was funded. We would like to know the following:

- what land/paddock management information is available
- what production information is available for the paddock (e.g. kg/ha)
- what economic information is available (e.g. gross margins) and,
- what changes have occurred on farm and what prompted change.

This information will be collated into a report to Meat & Livestock Australia. They would like to know how many farmers are likely to participate in the study and what management information may be available before they decide whether or not to fund the pasture survey.

At this point we are not asking for detailed information from you, we only want to know what information is available and what form it might be in.

It is important that you understand that your involvement in this study is voluntary. While we would be pleased to have you participate, we respect your right to decline. There will be no consequences to you if you decide not to participate. If you decide to discontinue participation at any time, you may do so without providing an explanation. All information will be treated in a confidential manner, and your name will not be used in any publication arising out of the research. All of the research will

be kept in a locked cabinet in the office of Dr Kerry Bridle. The data will be kept for five years (as a research requirement) and will be destroyed after that time.

5. Are there any possible benefits from participation in this study?

Participation in this feasibility study will hopefully lead to MLA funding a new pasture survey to be undertaken in 2012. The results of this survey would be of interest to you because it will allow us to look at changes in pasture composition and a range of soil nutrients including soil carbon over a 20 year time period. Information relating to drivers of land use change on farm will inform MLA of potential future directions for livestock industries in the State.

6. Are there any possible risks from participation in this study?

There are no specific risks anticipated with participation in this study. However, we remind you that if you decide to discontinue participation at any time, you may do so without providing an explanation. You may request for your information to be withdrawn from the project at any time.

7. What if I have questions about this research?

If you would like to discuss any aspect of this study please feel free to contact Kerry Bridle on 0427846050 or on email Kerry.Bridle@utas.edu.au. I would be happy to discuss any aspect of the research with you. Once we have analysed the information we will be mailing / emailing you a summary of our findings. You are welcome to contact us at that time to discuss any issue relating to the research study.

This study has been approved by the Tasmanian Social Science Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study should contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. You will need to quote project number H12070.

If you would like to be involved in this project then please phone Kerry Bridle on 0427846050 or email Kerry.Bridle@utas.edu.au

Thank you for taking the time to consider this study.

Appendix 2 – Letter of invitation – telephone surveys (logos removed)

Dear ***

Over the spring and summer of 1992/1993 your farm took part in a state-wide survey of pasture composition and condition. This survey was sponsored by the Australian Wool Secretariat and provided invaluable industry information on Tasmania's pasture resource. This was the first time such information had been collected on a large scale.

In the intervening 19 years there have been extensive changes across the agricultural landscape with drought, irrigation, new species, new weeds and different land uses all affecting the pastures resource.

We now have an opportunity to apply for funding through MLA to revisit the 1992 pasture sites, to look at changes in pasture composition, soil nutrient levels and land management. However, before securing the funds to do this we have been asked to collate information on land management changes over the past 19 years. We would also like to know what you perceive to be the impacts of change on your enterprise and determine what information you have available if we are able to revisit the surveyed sites.

We would like to survey as many of the original properties as possible, and are seeking your assistance in completing this feasibility survey.

For the feasibility study we have been asked to collate the availability of the following information:

- a description of farm enterprise mix and their relative contributions (%) to farm income
- production per enterprise in kg/ha/product per year
- indicative financial information such as return on assets managed and/or gross margins (ranges rather than actual figures)
- description of changes in land use and management since 1992 affecting the survey areas
- identification of drivers affecting decision making since 1992
- observations of climatic variability over time

Initially involvement in this feasibility study will take the form of a short telephone survey to determine the above. If funding is successful, the field data collection will be undertaken in spring 2012 and will consist of one day on the property revisiting pasture sites and approximately 1 hour spent with you, identifying the pastures previously visited and asking you about current management and changes to management.

We would like to contact you shortly to provide you with an opportunity to seek further information or clarification about this project, and to see if you are willing to be involved with this study. We have approval for this project from the Human Ethics board at UTAS (see attached document).

Please be assured that all information will be treated confidentially. Responses will be grouped across all participants; therefore your personal responses cannot be identified in the final report. If funding is secured for the pasture survey, we will then contact you again to see if you would like to be involved.

We look forward to the opportunity of working with you to provide this valuable industry development information.

Yours sincerely

Kerry Bridle
Chief investigator
MLA Pasture Survey 2011-2012.

Revised Project Proposal

LIVESTOCK PRODUCTION R&D PROJECT APPLICATIONS

PROJECT APPLICATION FORM

Project Title (Maximum of Fifteen Words)

Assessing changes to Tasmanian pastures: Implications for NRM, climate change adaptation and red meat production.

Organisation(s) Conducting the Research

Tasmanian Institute of Agriculture

Associated Organisation(s) (eg: joint ventures, body corporate, etc)

**Department of Primary Industries, Parks, Water and Environment (Tas).
Potential for AWI involvement.**

Administration Contact Details

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Principal Investigator(s) Contact Details

Title/First Name/Last Name	Dr Kerry Bridle
Mailing Address	TIAR, Private Bag 98, Hobart 7001 Tasmania
Phone Number	03 62 262837
Facsimile Number	
Email Address	Kerry@utas.edu.au

Location of Research Work

Improved and native pastures in the Midlands and the Derwent Valley. Eastern Tasmania

Description and Background of Research Work

This project will address the impact of land use change on natural resources under red meat production at a paddock, farm and landscape scale. Data from 97 farms (354 sites) will form the basis of a study combining quantitative and qualitative data to quantify the current status of the pasture resource and change associated with land use and management over the past 20 years.

This project has three main aims:

1. To explore the impact of land use change due to changing enterprise mix on natural resources, particularly pasture composition, soil carbon and the extent of native vegetation in the prime store production (cattle and lamb) and lamb finishing regions of Tasmania's red meat industry:
2. To assess the relative contribution of the top 20% of producers to natural

resource management (NRM) and to identify opportunities to improve NRM outcomes, while retaining livestock production at a farm and regional scale.

3. To use a farming systems modelling approach to identify potential climate adaptation options that deliver production **and environmental** outcomes on grazing properties.

Since the early 1990s, Tasmanian producers have experienced some of the warmest years on record, prolonged periods of dry weather and developments in irrigation infrastructure. Changes in herd and flock dynamics have resulted from producers adapting to internal and external drivers. Shifts from wool to meat sheep breeds, including 'exotic' breeds, a reduction in livestock numbers due to drought, and an increase in the geographical extent of dairy enterprises facilitated by irrigation developments, have or will all impacted on grazing industries in the State. Further changes to enterprise mixes are expected with new Tasmanian specific climate projections, and with the planned irrigation development schemes, particularly in the Midlands region, the traditional strong-hold of extensive grazing enterprises.

The extent to which individual businesses can adapt to external pressures, including climate change, is currently under investigation by two Tasmanian based DAFF funded climate adaptation projects. The DAFF funded projects focus on the climate impact on current production systems and potential for change in enterprise mix and crop and pasture management practices in addition to identifying the perceived values, needs and risks of the individual when considering change on farm. The primary focus of the of the climate adaptation projects is production, *and not the impact of potential changes on natural resources*. Results will also inform other State based pasture audits such as DPIPWE/TIAR's currently active roadside pasture audit and MLA's feed base audit.

Plant and soil surveys, including soil carbon, of native and improved pastures were undertaken across 354 sites on 97 farms in eastern Tasmania in the spring/summer of 1992-1993 (Friend et al 1997). This survey provided important bench-marking dataset for Tasmanian livestock industries, particularly with respect to the condition of the natural resource base at the paddock scale. This data set provides an excellent opportunity for a longitudinal study of change in land use and pasture condition across the predominant land-classes within Tasmania's extensive grazing enterprises.

This project will add considerable value to existing projects by addressing the potential impact of management decisions on natural resources at a farm and landscape scale and quantify the current status of the resource being managed. It is timely to revisit past survey sites to determine what land use changes have occurred, how this has affected the red meat industry, and what might be the potential land use into the future. The condition of natural resources, including soil carbon stores, under these changes can also be assessed.

As producers move to more intensive systems, there are implications for natural resource management outcomes including biodiversity (Bridle et al 2009). Data from a benchmarking survey of Reid et al (2003) suggested that the area of native pasture on farms belonging to the top 20% of producers was less than the mean for all farms surveyed, but that the area of 'bush' (woody native vegetation) on these high performance properties was similar to the average for all farms. The mean area of native pasture decreased while improved pasture increased over the two years of the study (2000-2001, 2001-2002). While these data are limited, it is highly likely that the top 20% are the 'early adopters', signalling the direction of potential changes to future management. If producers are under pressure to intensify in order to increase

production, then we need to ask what implications are there of such a decisions on natural resources. The likelihood of meeting the goal of increasing production whilst maintaining environmental standards needs to be investigated, and can be done so retrospectively using long-term data sets.

Digital spatial layers are available at 1:25,000 scale on the extent of native vegetation (TasVeg) and presence of threatened species (DPIPWE, Natural Values Atlas) across Tasmania. These data sets will be used in conjunction with property boundaries to determine the amount of native vegetation on and around all 97 farms. Change in land use from 1995 to 2010 will also be available in early 2012, providing information on changes to the relative proportions of crop, pasture and native vegetation over a 15 year period.

This project will use a combination of data sources: 1) farmer surveys will assist in identifying the top 20% of farmers for selected farms in the project; 2) pasture surveys will provide paddock level information on the change in natural resources over time; and 3) existing electronic resources can be used to identify measures of biodiversity for each farm (e.g. amount and type of native vegetation).

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Objective/s and Outcomes of Project

Project objectives

1. By July 2013 to have assessed the land use, pasture composition (species) and soil carbon in all sites that are accessible from the 354 pasture sites that were previously assessed in 1992.
2. By July 2013 to have a detailed description of management practices over the period 1992- 2011 that may have impacted on pasture composition, and soil carbon
3. By December 2013 to have modelled soil carbon stores from the subset of sites to determine soil carbon dynamics over time under prevailing climatic conditions and different pasture conditions.
4. By July 2014 to have determined what correlations exist in terms of the impact of land use change, enterprise mix and management practices on pasture condition and soil carbon.
5. By December 2014 to identify potential climate adaptation options that deliver production and environmental outcomes on grazing properties, particularly for the top 20% of producers.

Outcomes

1. Improvement of NRM outcomes for all livestock producers, particularly the top 20%.
2. Increased knowledge of soil carbon stores under changed land management

conditions, particularly land utilised for red meat production.

3. Future directions for the red meat industry in Tasmania with positive production and NRM outcomes.

Outputs

1. A final report on the status of the pasture resource across grazing enterprises in eastern Tasmania
2. At least three articles submitted to relevant A1 journals (e.g. Animal Production Science, Agriculture, Ecosystems and Environment)
3. Data provided to the Tasmanian node of the national program investigating soil properties for carbon accounting purposes under the DAFF – Climate Change Research Program. Updated information on the state of the pasture feedbase to ML A and the State Government. The soil carbon data will be compatible with FullCAM and the national SCarP project.

What are the Benefits to Red Meat Producers?

This project will inform red meat producers of the condition of their natural resource base and long term sustainability, particularly through assessments of the perennality of pastures and measurement and modelling of soil carbon stores under different pasture types at the paddock and farm scale. It will enable the top 20% to further develop their performance delivering triple bottom line outcomes. The project will add to producers' understanding of their environmental performance, which is under increasing scrutiny in the market place.

Brief Project Design and Methods

A feasibility study (Bridle and Ball 2011) has indicated that agricultural land use in Tasmania has undergone a transformation to more intensive production systems through the adoption of cropping and irrigation across properties. We hypothesise that the documented increase in irrigation and cropping development on mixed farms will impact on natural values, particularly the composition of the pasture resource, perennial ground cover and changes in soil carbon. We will test this hypothesis using a number of techniques.

This project consists of two phases. The first phase consists of a desk-top assessment of land use change and repeat interviews with the 97 land holders who were surveyed in 1992.

The desk-top analysis of land use change using existing spatial data layers (DPIPWE's land use change layer) will identify changes in area of pasture, crop and native vegetation at the property level from 1995 to 2010. Broad-scale land use change has already been detected for a proportion of the 354 sites surveyed in 1992 (Bridle and Ball 2011). The addition of the DPIPWE land use change layer, available in early 2012 will allow us to cross-check our interpretation of the 2010 SPOT imagery. In addition, landscape scale assessments of biodiversity assets using existing digital spatial layers (e.g. vegetation layers, threatened species locations) will also be used to assess the relative contribution of each property to broader natural resource management objectives. Data will be collated on a range of other variables such as rainfall, market prices for major commodities (meat, wool, crops), fluctuations in the Australian dollar and production of meat (sheep and cattle).

Interviews with the 97 producers will take the form of a farming systems approach, asking for information on how producers have adapted their enterprise mix over time in response to a number of variables such as variable climatic conditions; commodity

prices; technological developments and government and industry initiatives. Information on ROAM and production (kg/ha/enterprise) will allow us to rank producers in terms of production and profit to identify the top 20% in the survey group. Comparisons between the farm scale environmental (biodiversity) performance of top 20% of producers can be compared to the other 80% to determine whether there is any significant difference in native vegetation cover on high performing and low performing businesses.

In-depth interviews provide an opportunity to relate management decisions with internal and external drivers, providing greater understanding of the complexity of decision making on farms. In-depth interviews also allow the interviewer to develop a rapport with the producer which should result in a greater understanding of the complexity of management decisions for a particular farm. This information in conjunction with the spatial analyses will provide insights on land use change, land management change and the drivers for change from 1992 to 2011. Information gathered from a preliminary study suggests that producers are willing to share information about their farm enterprises, land use change and land management (Bridle and Ball 2011).

The second phase of the project has the following aims: 1) to reassess the condition of a range of pasture types (native and improved) in eastern Tasmania; and 2) to monitor and model soil carbon levels across a range of pasture types.

The experimental design for sampling within paddocks will include subsets of land use classes defined by change in land use from 1992 to 2011, i.e. to compare changes within land uses (e.g. native pasture to native pasture) and between land uses (e.g. native pasture to sown pasture). Responses to 'treatments' (pasture 'type') with farms as blocks and sites within farms as plots, will be tested for a range of environmental variables such as soil C and ground cover. These can be partitioned into properties within a region that are still under the same family ownership (62 of the 97) and those that are not. In this way we can assess whether there is any significant difference in NRM outcomes on continuously owned farms to those that have changed hands relatively recently.

The pasture survey will repeat the original methods at the site locations given in the report (Friend et al 1997). Perennial ground cover will be used as an indicator for soil conservation. Plant species richness and abundance of perennial species will be used as an indicator of site stability and long-term sustainability. Change in soil carbon over time under different land uses will be used as one indicator of soil health. The 1992 data indicated relatively high soil organic carbon levels (4.7-6.3%) for a range of native pastures. Pasture based interviews will include a repeat of the 1992 questions on pasture management (inputs) for the target paddocks.

Soil scientists within TIAR are already collaborating on the CSIRO led national SCaRP project, collecting and analysing soil samples across a range of agricultural enterprises and land uses to determine soil organic carbon content. In this project we will visit a subset of the 227 sites held by the same owners to resample surface soils (0-10 cm deep) for carbon content. Within each site, soil carbon sampling will include a repeat of the 1992 survey method (Walkley Black), plus the SCaRP method (dry combustion). Soil carbon budgets will be prepared across the subset of sites using 'Black Magic', a Tasmanian specific soil carbon model developed with the 'RothC' model as its framework, which in turn underpins Fullcam. Available climate data will be collated for all years from 1992 to present from the nearest stations. Modelling of these data will provide a summary of the soil carbon dynamics and potentially the drivers for the end point soil carbon values. The resulting data will be relevant at

state and national levels with the data being fed into the national database for carbon accounting using FullCAM.

Information will be fed into existing farming systems models to build on datasets compiled under two currently operating DAFF funded projects. Potential changes to enterprise mixes into the future can be explored with reference to both production and environmental outcomes. This information will be delivered back to livestock producers through existing networks (e.g. SheepConnect).

R&D Adoption/Commercial pathways (if relevant)

This project will feed into the existing DAFF funded climate impact modelling projects and the national SCaRP database. Existing adoption pathways include producer extension networks such as SheepConnect, Making More from Sheep and More Beef from Pastures programs.

Overall Preliminary Budget (All budgets are recorded exclusive of GST, however, MLA will pay GST in addition to this budget.)

	Previous expenditure	2012-13 \$	2013-014 \$	2014-2015 \$	TOTAL 2012-2014
Salaries and on costs		144726	134915	70541	350182
Travel		28600	10816		39416
Operating Capital (equipment)		122644*	2542		125186
TOTAL BUDGET (excl. GST)		295970	148273	70541	514784

- This amount includes \$100,000 to undertake the SCaRP methodology for soil carbon measures (see below for project justification)

Funding Breakdown

MLA		514784
Other Contributors		
Research & Other Organisations (in kind)		520518

Proposed start date: 01/07/2012

Proposed project duration: 31/12/2014

Budget justification

Project budget includes the following: Dr Kerry Bridle (50% fte – 70% recovery – project management, pasture surveys, producer interviews report writing), Mr Peter Ball (15% fte, pasture surveys, extension activities), Dr Bill Cotching (10% fte, soil carbon modelling), Dr Ross Corkrey (10% fte, biometrician), Graduate research assistant (50% fte, data entry, GIS capability, farming systems analyses), and casual field assistance (soil and pasture surveys).

Collecting soil carbon data as per the national SCaRP methodology is expensive (approx. \$200-\$300 per sample/paddock, Garth Oliver TIAR pers. comm.) depending on whether the soil scientist associated with the SCaRP project travels with the pasture survey team or independently. The budget for this component would only cover 30-45 paddocks from the 227 that are owned by the same families. The sampling strategy for this component would have to be carefully thought out to cover the range of pastures within regions and current land use types on different soil types. The project has already sampled 300 sites in Tasmania and some of the properties sampled overlap with the 97 target farms. Soil carbon modelling will still be undertaken by Cotching even if the SCaRP component is not funded.

The operating costs in 2012-2013 also include soil nutrient analyses by CSBP for each paddock sampled and casual field assistance for both soil and pasture surveys. The travel budget is based on visiting each of the 97 farms at least once and spending the equivalent of a day there collecting soil samples, doing pasture surveys (at least 3 sites per farm) and conducting the in-depth producer interviews. The current hire rate for a University 4wd is \$150/day. The budget allocation includes up to two vehicles at peak times as Cotching is based in Burnie and would need to travel separately. Accommodation expenses are estimated for 2 people for 25 nights. Travel expenses have been allocated to the project team in the second year to assist with extension activities once results are finalised. These include farm based activities and travel to a national conference to deliver research findings towards the end of the project. The travel allocation also covers project team meetings.