MEAT & LIVESTOCK
AUSTRALIA

on farm

Managing woodlands: developing sustainable beef production systems for northern

Project number NAP3.205
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Abstract

Eucalypt woodlands provide most of the pasture for cattle in northern Queensland and good grazing management is the key to keeping these pasture lands productive and healthy. This project sought to understand how these pastures respond to grazing, spelling and fire and from this understanding develop practical grazing management options to either maintain pastures in good condition or to recover deteriorated pastures. Working on five commercial properties in north-east Queensland we were able to demonstrate the value of either conservative grazing or wet season spelling followed by moderate grazing levels as the key strategies in maintaining productive, perennial pastures. These strategies are increasingly being adopted by the grazing industry in the north, especially recommendations relating to the use of wet season spelling. This management option in particular has been well accepted by industry because it leads to rapid recovery of pastures and provides more flexibility than continuous conservative stocking. The project has also influenced perceptions of grazing management through demonstrating the close linkages between land condition, pasture productivity and enterprise economics.

Executive Summary

Most of the pasture grazed by cattle in northern Queensland is found in the understorey of various types of Eucalypt woodlands (forest country). This understorey is made up mainly of native pastures. A highly variable climate means that forage supply varies greatly from year to year and this coupled with relatively infertile soils creates an environment where perennial grasses, the key component of production and landscape health, are susceptible to over utilisation. The only practical management options available to producers to manage perennial grasses are grazing, spelling and fire. With this in mind Meat and Livestock Australia initiated the ECOGRAZE project in 1992 to improve our understanding of the effects of grazing, spelling, fire and climate on the condition and productivity of open eucalypt woodlands in north-eastern Queensland with the following objectives:

1. Develop management guidelines on the use of stocking rate, fire and strategic spelling to encourage deteriorated native pasture back to a more desirable state and to prevent decline of pastures presently in good condition.

2. Transfer management recommendations from Objective 1 into a range of extension activities, including property management planning modules, small group activities, landcare groups, training workshops.

3. Assess the economic benefits and costs of various grazing management strategies.

The focus of the ECOGRAZE project was to understand how pastures in different condition respond to grazing, spelling and fire and from this understanding develop grazing management options. Grazing plots were established on each of three land types in the region with land in either good condition (dominated by native tussock perennial grasses) or a deteriorated condition (perennial grasses still present but annual grasses and forbs and undesirable perennial grasses common).

At each site and in each land condition three different utilisation rates were imposed; 25%, 50% and 75%. Utilisation means the percentage of forage grown in a year that is consumed eg. for 25% utilisation, one-quarter of the forage grown in that year is consumed. The utilisation treatments aimed to achieve a wide range of grazing pressures from conservative to very high. In addition to these continuous grazing treatments wet season spelling treatments were included. Wet season spelling was imposed following the first significant rainfall event (>50 mm over two days) from November onwards. Paddocks were spelled for eight weeks and then the grazing treatments were reimposed. Each year measurements were made of pasture composition, forage availability, grazing preferences, and soil condition. Grazing commenced in 1992 and the study concluded in 2001.

The ECOGRAZE study has proven to be a successful long-term study which has developed innovative management options to enhance the condition of grazing lands in the open eucalypt woodlands of northern Australia. An important aspect of the research has been its location on five commercial grazing properties on different country types in north-east Queensland. This has allowed extrapolation of the results to a wide area across northern Australia. Another important part of the research was to be able to communicate concepts of land condition and this was successfully achieved by using a simple framework to explain land condition states and the factors (grazing, climate, fire) that drives the transitions between states.

The key findings of the field research and the economic modelling have been:

- Grazing management, not climate, is the key driver of land condition and pasture health

- Land was maintained in good condition by continuous stocking at 25% utilization or early wet season spelling followed by 50% utilization

- As perennial grasses are lost through overgrazing, rainfall effectiveness declines, pasture productivity is reduced and the system becomes desertified

- Continuous stocking at 25% utilization or early wet season spelling followed by 50% utilization recovers native tussock perennial grasses in poor condition pastures, even during drought years

- The value of wet season spelling is enormous and where a wet season spelling regime can be implemented it can provide increased flexibility to enterprise management

- Wet season spelling can be implemented using fairly simple two, three or four paddock grazing systems

- Cash flows between good and deteriorated pasture condition were on average not greatly different but pastures in a deteriorated condition gave more variable returns and there were more years in which losses occurred. If deteriorated pastures become degraded, the loss of productivity and increased supplementation costs can lead to huge financial losses

- Where wet season spelling is introduced and overall utilisation rates can be sustainably increased then cash flows can be improved even allowing for the capital costs of infrastructure developments such as water and fencing

These recommendations are increasingly being adopted by the grazing industry in the north, especially recommendations relating to the use of wet season spelling. This management option in particular has been well accepted by industry because it leads to rapid recovery of pastures and provides more flexibility than continuous conservative stocking. The ECOGRAZE findings have been promoted through producer field days, Meat Profit Days organized by Meat and Livestock Australia, brochures and their inclusion in QDPI Future Profit courses. More recently, the ECOGRAZE results have been incorporated into a major Grazing Land Education package developed specifically for producers in northern Australia.

ECOGRAZE has raised awareness of the interaction between grazing and land condition in the savannas of northern Australia. It has been particularly successful at demonstrating that grazing management rather than climate is the major determinant of pasture condition and health. This change in attitude amongst producers has led to an acceptance that more attention needs to be made to grazing management and this is now being observed in changed management practices. Another area where ECOGRAZE has influenced perceptions is through the linking of grazing management, land condition and enterprise economics. The field study results appear to have much more credibility when they are put in the context of enterprise economics using realistic case study properties. Because the ECOGRAZE study ran for eight years during which both severe drought and good seasons were experienced, producers have confidence that the results are relevant to their situation.

Near the start of the project an evaluation of four producer groups using a focus group approach was undertaken to document current grazing management practices and sources of information on grazing management. These focus groups will be reassessed over the next six months to determine in amore formal evaluation what impact the grazing research has had on producer awareness, attitudinal changes and adoption of grazing management principles flowing from the research.

The research work undertaken in this project was at the scale of small paddocks. Future work needs to examine how the grazing management recommendations from the research influence land condition and production outcomes at the scale of commercial paddocks and properties. The grazing management recommendations need to be assessed at this scale in combination with other advances in fire management, weed control, supplementation, genetics ie. a whole enterprise approach to grazing management.

Main Research Report

1. Background

Most of the pasture grazed by cattle in northern Queensland is found in the understorey of various types of Eucalypt woodlands (forest country). This understorey is made up mainly of native pastures. While some exotic legumes and grasses have been introduced to increase livestock production they account for less than 10% of the grazed lands. In general, the main improvements, other than pasture development, are water points and fencing.

Eucalypt woodlands dominate the catchments of the Burdekin, Gilbert, Mitchell and upper Herbert Rivers. They cover approximately 15 million ha and support about a million head of cattle. They are, therefore, an important natural and economic asset. Keeping these pasture lands productive and healthy demands good management. However, getting the right balance between stock numbers and the forage resource is a considerable challenge for management. Short-term economic pressures can force an increase in stock numbers that leads to an imbalance between forage supply and demand. The complexity of the management task is increased by the fact that highly variable rainfall results in a pasture supply that fluctuates greatly from year to year.

As a consequence of short-term economic pressures and generally over-optimistic expectations of good rains in the future, stocking rates often err on the high side. Over the last twenty years this has led to a decline in the condition of grazing lands in northern Queensland. Fortunately, improved grazing management and a better understanding of climate variability can reverse much of this deterioration in condition.

With this in mind, in 1992, Meat and Livestock Australia initiated the ECOGRAZE project. The project was designed to improve our understanding of the effects of grazing, spelling, fire and climate on the condition and productivity of open eucalypt woodlands in north-eastern Queensland. From this improved understanding, guidelines to better manage grazing country are being developed.

2. Project Objectives

1. Develop management guidelines on the use of stocking rate, fire and strategic spelling to encourage deteriorated native pasture back to a more desirable state and to prevent decline of pastures presently in good condition (1996-2001)

2. Develop a predictive understanding of the effect of trees on pasture production to aid management decisions on the extent of tree clearing, the optimal frequency of regrowth control and the use of fire to manage woody species (1996-1997).

3. Assess the economic benefits and costs of various grazing management strategies (1998-2001).

3. Methodology

Practically speaking, the only means of manipulating pasture composition are grazing, spelling and fire. The ECOGRAZE study, initiated in 1992, looked at how these factors could be used to improve the condition of deteriorated pastures and to prevent pastures in good condition from degrading. The focus of the project has been to understand how pastures in different conditions respond to grazing, spelling and fire and, from this understanding, develop grazing management options.

Pasture types vary considerably across the region and the region also experiences great variation in annual rainfall. Because of these regional characteristics, the study included a number of country types and was run over a number of years to experience a wide range of seasons.

Land condition and vegetation change – a simple framework

Changes in grazing land condition can occur gradually, like the steady loss of perennial grasses, or rapidly in response to a major disturbance, like a flood event introducing a weed species and providing good conditions for its establishment. Sometimes changes in vegetation occur gradually until some threshold is crossed, at which point change becomes rapid. An example of this would be the gradual loss of perennial tussock grasses in response to overgrazing, followed by a rapid invasion of Indian couch.

'State-and-transition' models provide a framework for describing these gradual and rapid changes. The models use a series of vegetation 'states', with transitions between the states being driven by grazing, climate, fire and weeds. An example of a state and transition model for the open eucalypt woodlands of north-eastern Queensland is shown in Figure 1.

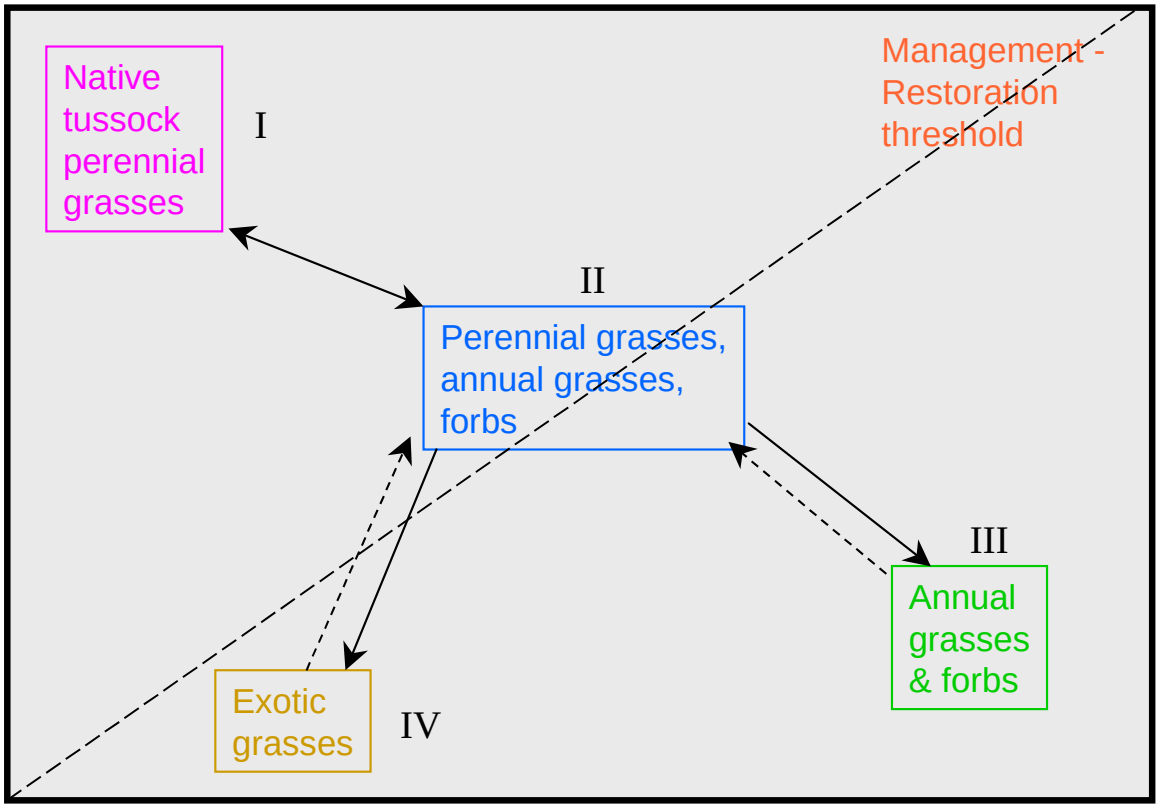

Figure 1. A state and transition framework of vegetation dynamics for the grassy layer in open eucalypt woodlands in north-eastern Queensland.

Location

Study sites were established on three important land types identified in north-east Queensland; the infertile red and yellow earths (Lakeview/Allan Hills), the moderate fertility Goldfields country (Cardigan) and the fertile red basalt soils (Hillgrove/Eumara Springs). A map of the study sites is shown in Figure 2.

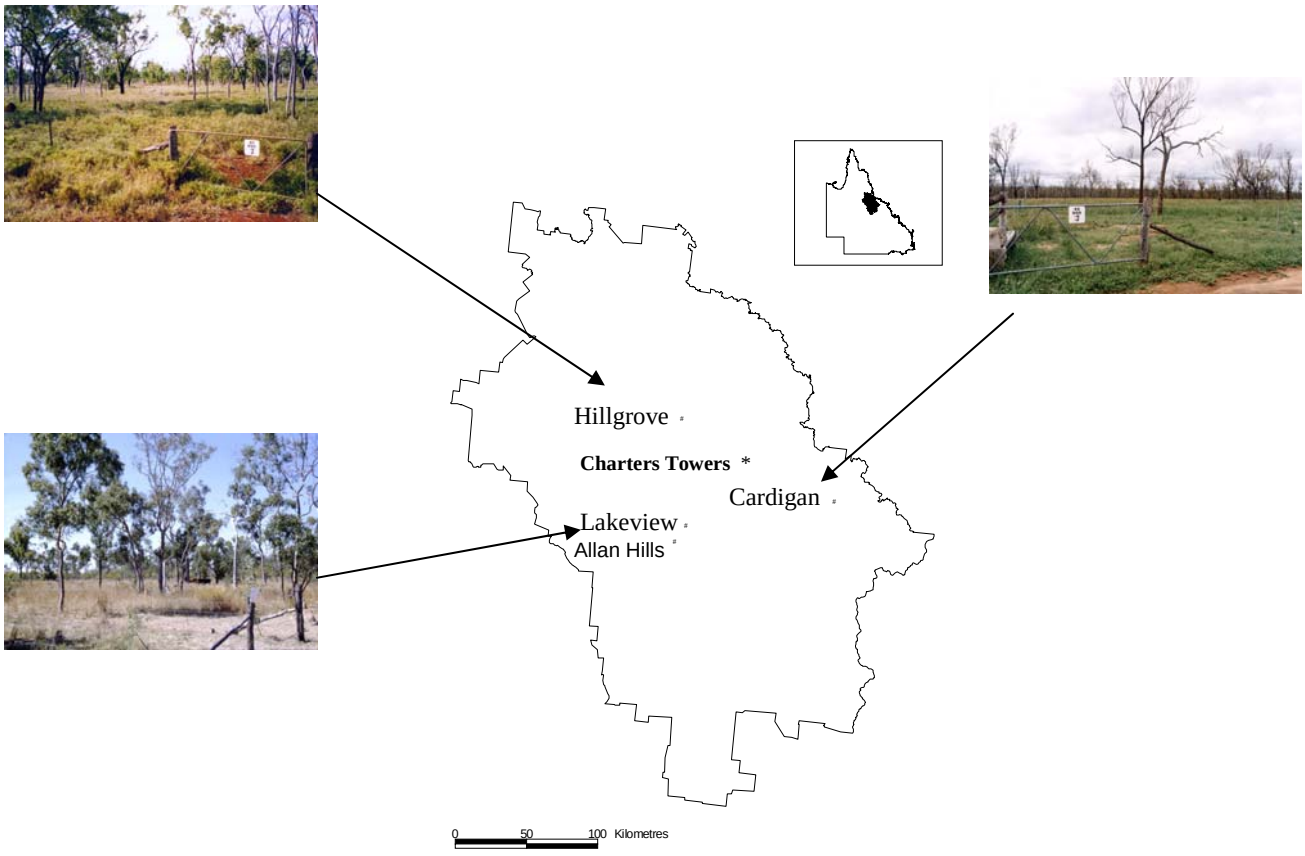

Figure 2. Location of the three ECOGRAZE study sites in the Charters Towers region

Grazing treatments

Grazing plots were established on each of the three land types with land in condition States I and II. State I (good condition) was dominated by palatable, perennial and productive (3P) grasses, such as black spear grass, desert mitchell grass, kangaroo grass and Queensland blue grass. State II (deteriorated condition) still had 3P grasses present but there were more increaser perennial grasses, such as wire grass, and annual grasses such as fairy grass and button grass. State I tended to have a continuous cover of grass, while in State II there were significant bare patches and scalds.

States I and II were chosen by selecting commercial paddocks near each other that had different grazing histories but were otherwise similar in land type. State I land had received low grazing pressure in the preceding decade relative to State II land. State II showed significant loss of 3P grass species but was still responsive to "improvement" via grazing management. At the three locations State I was separated from State II by up to 10 km. This was not ideal because of potential differences in rainfall between States I and II but was the most practical way of achieving differing land condition states on the same soil/vegetation type.

At each site and in each land condition state three different utilisation rates were imposed: 25% (low); 50% (medium); and 75% (high). (Utilisation means the percentage of forage grown in a year that is consumed - eg. if one-quarter of the forage grown in a year is consumed the utilisation rate is 25%.) The above rates represented conservative to very high grazing pressures. To achieve these different rates, paddock sizes were varied – eg. 75% utilisation paddocks were 1/3 the size of 25% utilisation paddocks (Figure 3). Because the amount of forage growth varied from year to year, the number of stock in each treatment was adjusted from time to time to maintain target utilisation rates in above- and below-average seasons.

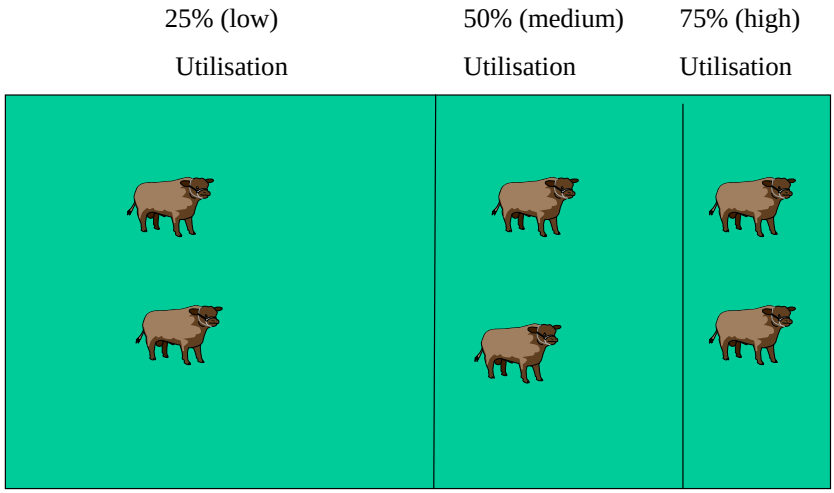

Figure 3. Illustration of the way paddock sizes were altered to achieve different utilisation rates

Wet season spelling started after the first significant rainfall event (>50 mm over two days) from November onwards. Paddocks were spelled for eight weeks and then the cattle were reintroduced.

Individual paddocks varied in size from about 1 ha to 5 ha. This paddock scale was good for studying pasture composition and soils, yet cost effective in establishment and maintenance. Brahman or Brahman-cross steers were used to graze the paddocks.

Measurements

All pastures were sampled at the end of each growing season (April-May) and at the end of each dry season. Full botanical surveys were conducted in each paddock. The data were collected by measuring vegetation in fifty to eighty (the number used depended on paddock size) 50cm x 50cm metal quadrats spread throughout each paddock. Measurements included:

- a record of all species encountered in each quadrat (species abundance)
- relative amount of each species in each quadrat (species composition)
- the amount of pasture on offer (standing crop)
- the relative amount of grazing of each species in each quadrat (defoliation)
- the percentage of ground occupied by the crown of perennial grasses (perennial grass basal area)
- percentage groundcover

In addition to these annual measurements, video data were collected from the paddocks at the Cardigan site in 1996. Video cameras mounted in a light aircraft were used to collect these data at a pixel resolution of 20cm and 50cm. These data provided information on vegetation type and cover at the whole paddock scale, which allowed us to examine spatial patterns in the vegetation and to see how “leaky” the landscapes were under a range of grazing treatments. (A “leaky” landscape is one that has insufficient grass and/or litter cover to prevent significant loss of water and nutrients from the system).

Soil samples were also collected to understand how soil nutrients differed between grazing treatments and to better quantify the role of perennial grass tussocks in the cycling of nutrients and carbon in the landscape.

4. Results and Discussion

Climate

Severe drought was experienced for the first four years of the study (1992-96) and this extended dry period coincided with persistent El Nino conditions. This sequence of dry years was the worst in recorded history and the extent of the drought was evident by the widespread death of eucalypts throughout the region (Table 1). These drought years were followed by an “average” year and then three good wet seasons (1998-2000), which were consistent with La Nina conditions in the Pacific Ocean. The sequence of dry and wet years that occurred during the study provided a good contrast for evaluating different grazing management strategies (Figure 4).

Table 1. Frequency of extended droughts (>24 months) at Charters Towers from 1882-2000 (adapted from Rainman).

Drought	Period	Duration (months)	Total rainfall (mm)	Average SOI
1	Feb 1883 to Mar 1886	38	1219	-3.4
2	Apr 1887 to Mar 1889	24	781	-6.5
3	Jan 1901 to Dec 1905	60	2294	-2.1
4	Jan 1914 to Jan 1916	25	844	-5.2
5	Mar 1918 to Mar 1920	25	739	-5.4
6	Feb 1925 to Mar 1927	26	1008	-1.7
7	Feb 1930 to Jan 1933	36	1136	-0.4
8	Feb 1934 to Jan 1936	24	768	0.8
9	Jan 1951 to Dec 1952	24	799	-1.5
10	Mar 1991 to Jan 1997	71	2007	-6.3

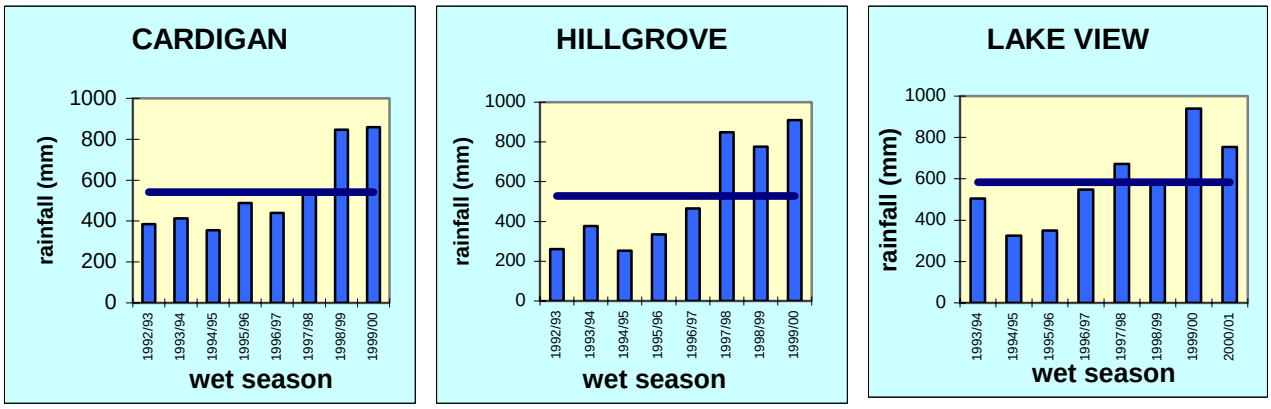

Figure 4. Wet season rainfall (Nov-April) recorded at the study sites.

Maintaining 3P grasses in good condition pastures

For land that was in good condition (State I) at the start of the study, there were two grazing strategies that were able to maintain the dominance of 3P grasses. These were:

1. Continuous stocking at 25% utilization

2. Spelling the pasture for the first 6-8 weeks of the wet season and then utilizing 50% or less of the pasture

Despite severe drought conditions for the first four years of the study, 3P grasses remained dominant in these grazing treatments (Figure 5). However, the vigour of 3P grasses declined during the drought (as evidenced by the rapid decline in basal area of perennial grasses), recovering only with the wetter period experienced towards the end of the study (Figure 6).

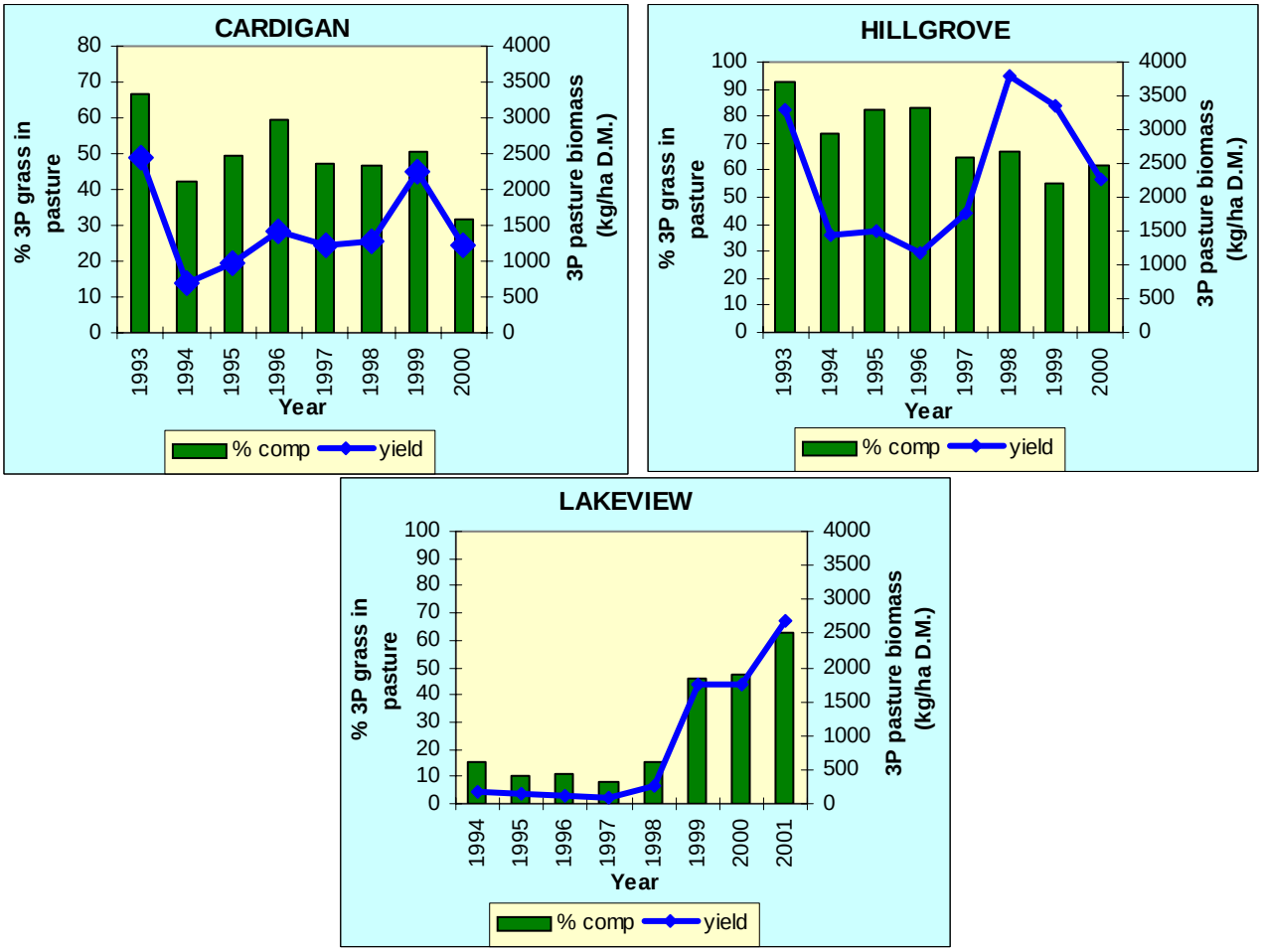

Figure 5. Percentage composition (bars) and pasture biomass (lines) of 3P grasses in State I condition land in response to 25% utilization.

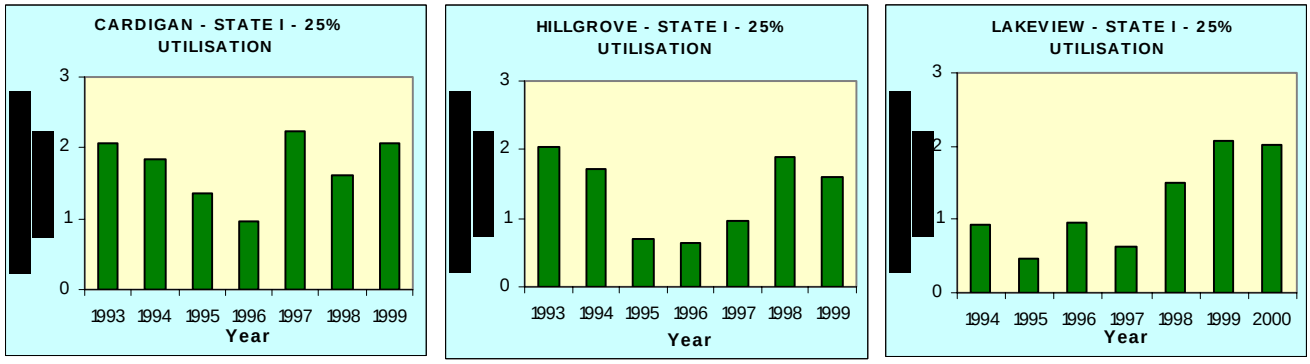

Figure 6. Effects of climate on the vigour of perennial grasses as measured by basal area of the tussocks.

Based on previous studies in the region we expected the continuous stocking at 25% utilization grazing strategy to be sufficiently conservative to maintain the 3P grasses. However, the wet season spelling regime followed by moderate utilization (strategy 2 above) proved to be surprisingly effective at

maintaining 3P grasses (Figure 7). This strategy provides some good opportunities to increase productivity whilst maintaining pasture health.

The challenge for managers is to design and implement a wet season spelling program into their grazing operation. This is likely to require additional paddocks and a greater degree of management intervention and pasture monitoring. While a short rest every year might not be practical for all operations, a rest for the whole of the wet season every three or four years might be a feasible and effective alternative. What is clear, however, is that adequately resting pastures during the wet season is an important strategy in maintaining 3P grasses.

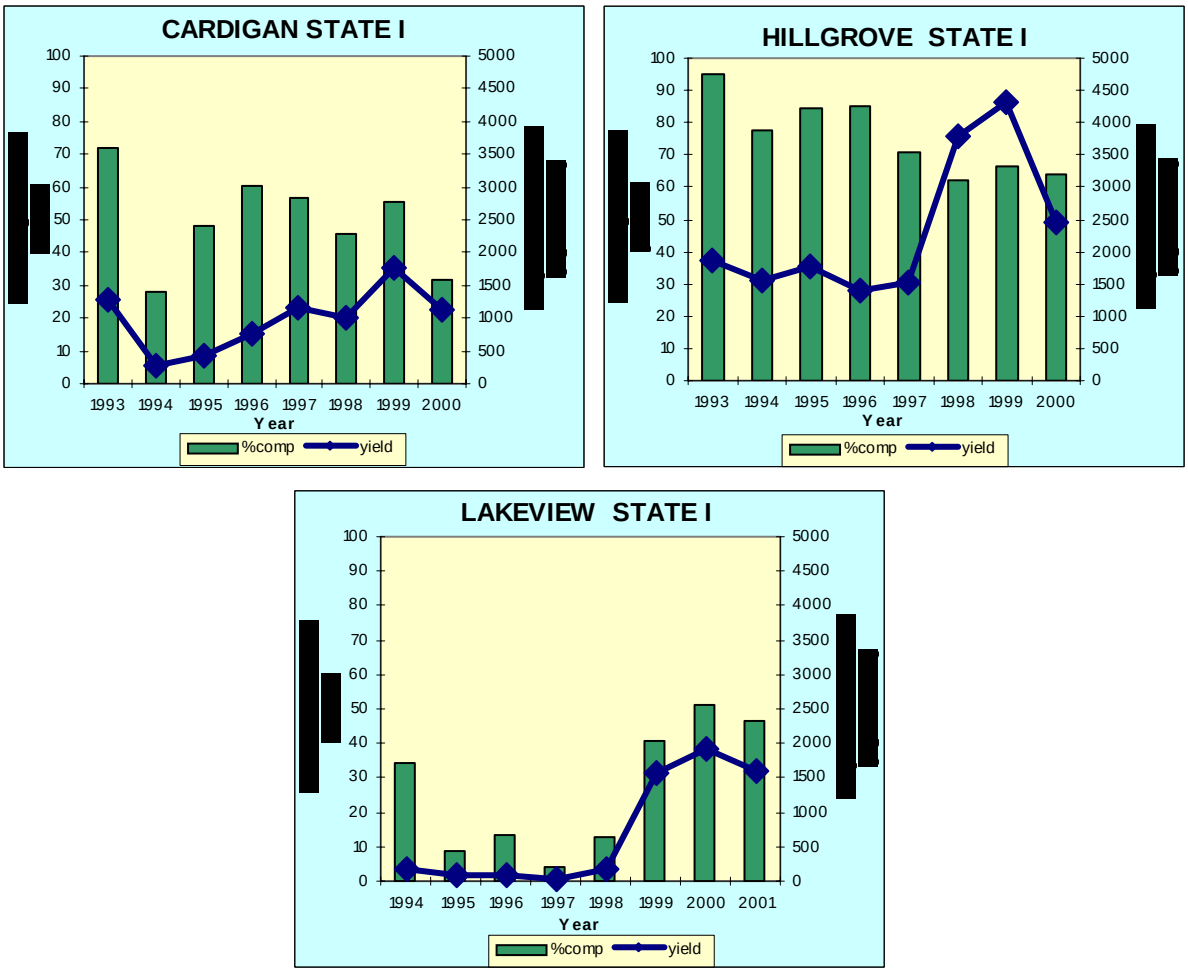

Figure 7. Percentage composition (bars) and pasture biomass (lines) of 3P grasses in State I condition land in response to 50% utilization plus wet season spelling.

Invasion by exotic grasses

At Cardigan and Hillgrove the percentage of 3P grasses in the pasture actually declined in the wet period following the drought, even though production of these grasses increased. This decrease in the proportion of 3P grasses was attributable to the invasion of exotic pasture grasses. Indian couch (Bothriochloa pertusa) at Cardigan and Buffel grass (Cenchrus ciliaris) at Hillgrove) in the wet years following the drought (Figure 8). The decline in vigour of 3P grasses during the drought was such that seed of the exotic grasses was able to germinate and plants became established in the ensuing wet seasons before the natives had time to recover and out-compete the exotics.

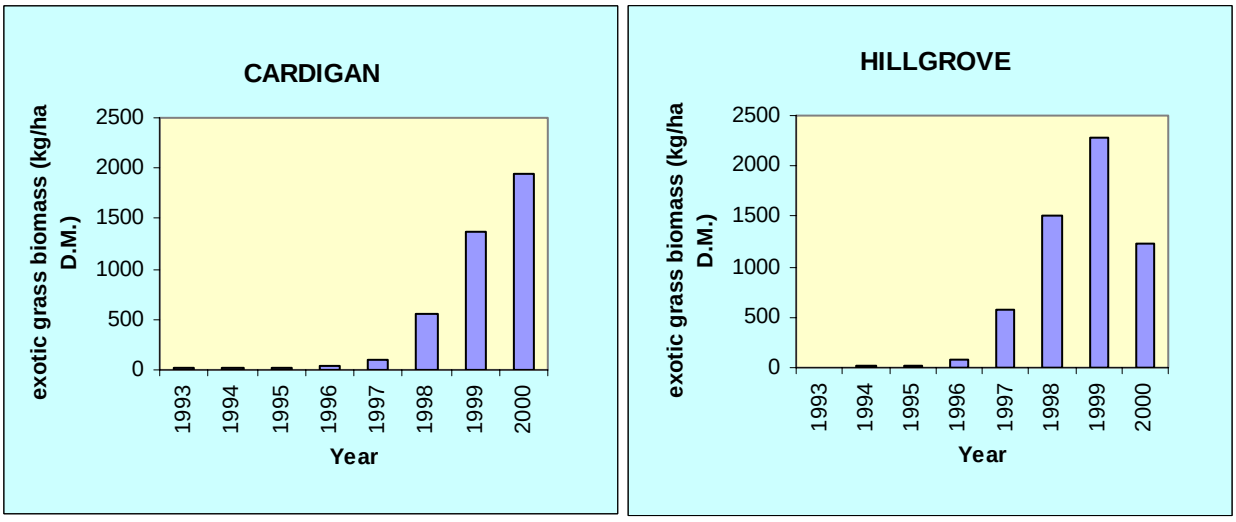

Figure 8. Increase in exotic grasses in the State I 25% utilization treatments at Hillgrove and Cardigan, which highlights their increase in the good seasons following drought.

This interaction between natives and exotics has implications for managing pasture condition. For example, maintenance of a healthy *native* pasture may not be possible if exotics are present locally and there is a viable seed bank to take advantage of the weakened native perennials during extended droughts. Alternatively, where the aim of management is to establish introduced grasses in native pasture, there may be a window of opportunity at the end of a lengthy drought. Introduced grasses are difficult to establish without soil cultivation because of the competition provided by native grasses but, as indicated above, the native perennials may not provide much competition if they have been weakened by drought.

Loss of 3P Grasses

3P grasses, which dominated pastures in good condition at the start of the study, were greatly reduced under continuing high levels of utilization (75%). Initially, 3P grasses were resistant to this grazing pressure but after a couple of years their populations declined dramatically (Figure 9). At Hillgrove, which is a high fertility basalt soil, the 3P grasses recovered well when good seasons returned in the late 1990s. To a lesser extent, there was also some recovery at the Lakeview site. However, there was no such recovery at Cardigan and, by the end of the study, there were no 3P grasses remaining in the 75% utilization treatments at this site. The different result between sites highlights the role of soil fertility and soil condition in pasture systems. At Hillgrove the pastures suffered as a result of high grazing pressure, but the soil remained in good condition. As a result, pastures had the opportunity to recover in good seasons. Indeed, during these good seasons pasture growth was such that it was difficult to achieve 75% utilization -. the pasture kept “getting away” from the cattle. However, at Cardigan, because both pasture and soil were degraded by heavy grazing, there was little chance for 3P grasses to recover even when, towards the end of the study, climatic conditions were more favourable.

As 3P grasses are lost the productivity of pasture declines because the 3P grasses are initially replaced by less productive annual grasses and forbs. More importantly, the loss of tussocks and groundcover results in much higher run-off and low infiltration rates, which effectively “desertifies” the soil-pasture system. This is highlighted by pasture production data which show the relative pasture productivity in the 75% utilization paddocks compared with the 25% utilization paddocks at the Cardigan site (Figure 10).

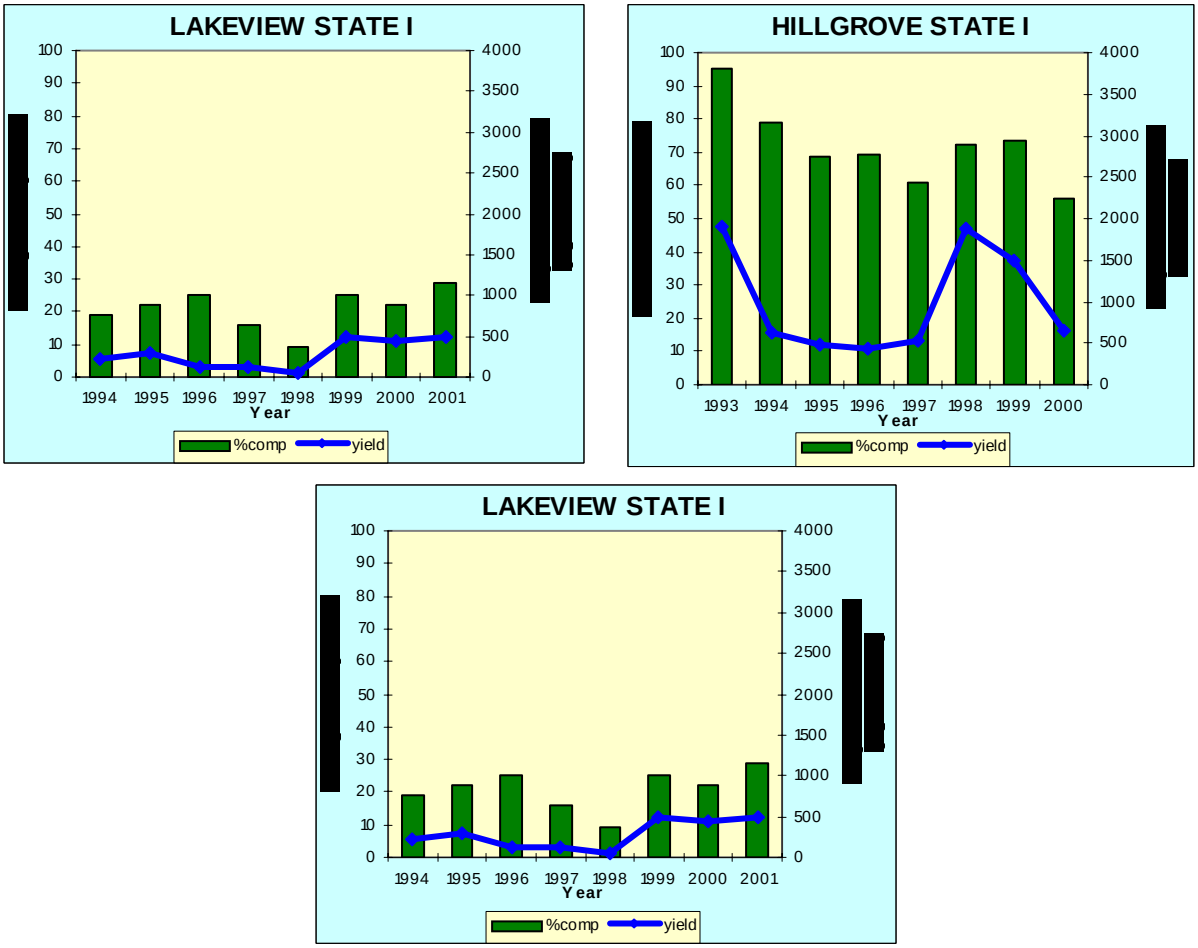

Figure 9. Decline in 3P grasses in State I in response to high utilisation rates.

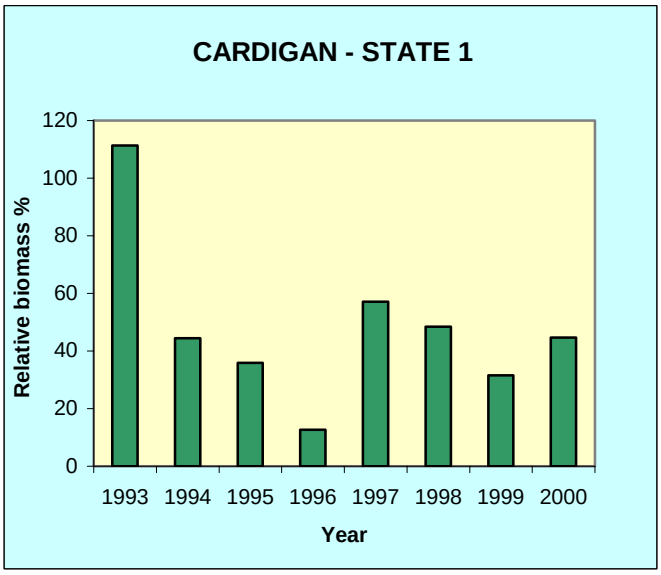

Figure 10. Relative pasture growth of 75% utilization paddocks compared with 25% utilization paddocks at the Cardigan site.

The result of this declining productivity is that it takes fewer and fewer stock to maintain high utilization rates. This was noticeable in the grazing study, where the number of grazing days needed to achieve 75% utilization became less each year relative to the 25% utilization treatment (Table 2).

Despite the return of better seasons commencing in 1996/97, pasture productivity in the 75% treatments at Cardigan and Lakeview did not recover to match that of the 25% utilisation treatments. This highlights that a decline in land condition is not a short-term effect and that pastures generally cannot "bounce-back" immediately upon the return of good seasons. Where a decline in land condition also results in soil deterioration it can take some time for the water and nutrient cycles to be restored. At Hillgrove, where the basalt soil is much more resilient, pasture productivity did recover in the good seasons following drought. This outcome further illustrates the role of soil condition in maintaining healthy productive pastures.

Table 2. Number of grazing days in each year for Cardigan site 25% and 75% utilization treatments. Paddocks were designed so that the 25% and 75% utilization treatments would have the same number of grazing days to achieve their target utilization if they had the same pasture productivity

Year	Grazing days 25%U	Grazing days 75%U
1993	165	165
1994	137	110
1995	128	100
1996	110	64
1997	137	92
1998	183	128
1999	198	135
2000	275	183

Another reason for the rapid disappearance of 3P grasses under high grazing pressure is that cattle like to eat them. Cattle show strong preferences for 3P grasses particularly during the early part of the wet season (Figure 11). Unfortunately, this time coincides with the period when the 3P grasses are most vulnerable to grazing.

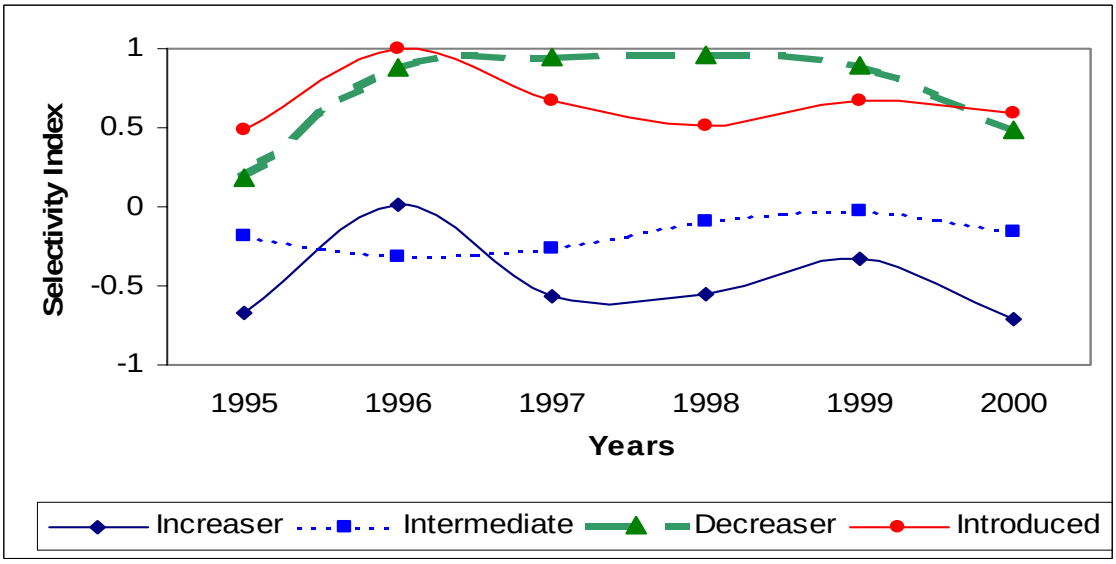

Figure 11. Preference of different plant functional groups at the Cardigan site over the life of the study. Selectivity index values above zero indicate increasing preference for that plant group while values below zero indicate relative avoidance.

Recovering deteriorated pastures

Recovery of 3P grasses in pastures that were in poor condition at the start of ECOGRAZE in 1992 was achieved with the same grazing strategies that *maintained* 3P grasses in good condition land, ie. conservative stocking (25% utilization) or wet season spelling followed by a higher level of utilization (50%) (Figure 12).

The recovery of 3P grasses was significant even during the drought years of 1992-96. This highlights the fact that grazing management, not climate, is the most important determinant of both pasture condition and the level of retention of 3P grasses. Climate markedly influences the amount of pasture grown from year to year and the vigor of individual plants, but it is grazing pressure that largely determines pasture composition.

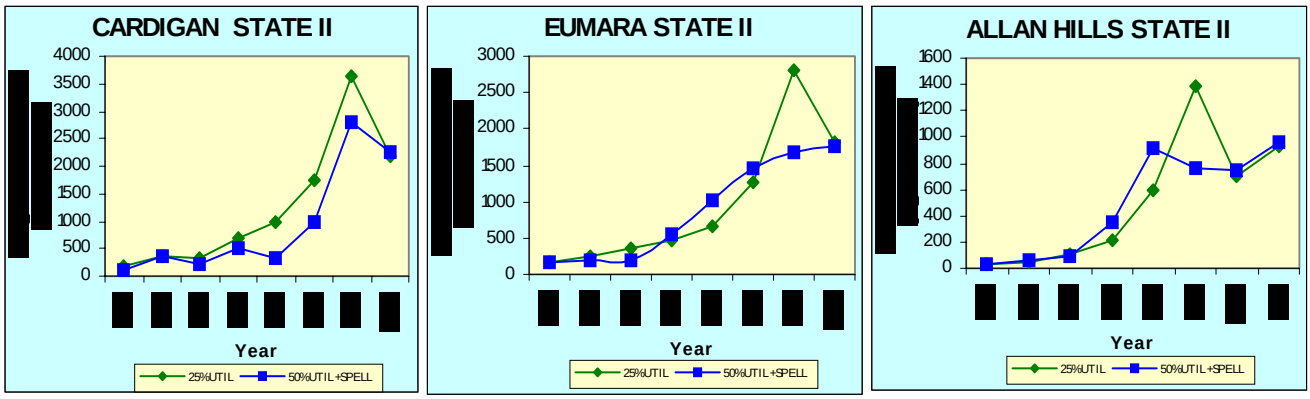

Figure 12. Recovery of 3P grasses with the 25% utilization and 50% utilization with spelling treatments in paddocks that were in poor condition at the start of the study.

After five years of either 25% utilization or 50% utilization with wet season spelling there appeared to be full recovery of forage biomass and pasture composition at the paddock scale.

Although the paddocks had recovered in terms of overall productivity and composition, they appeared to be very patchy compared with State I good condition pastures (Figure 13). The patches were distinct in that there were areas, 5-20m across, where very large perennial grass tussocks were separated by large scalded areas supporting short annual grasses.

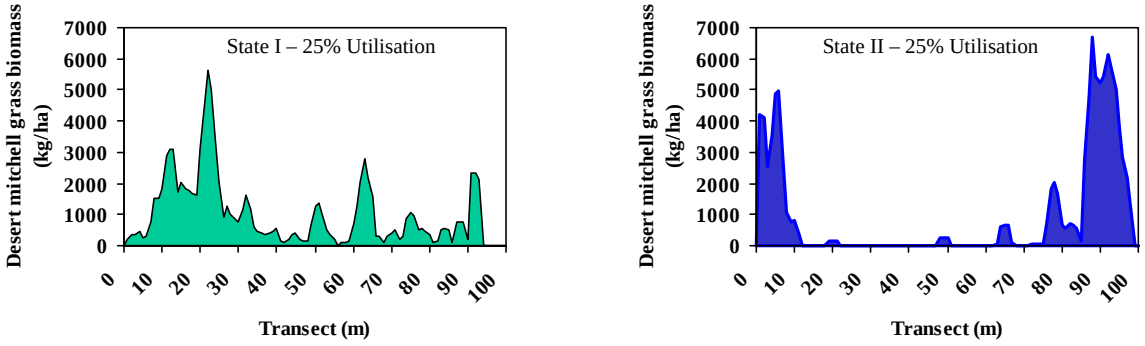

Figure 13. Illustration of the patchy recovery of 3P grasses. The figure on the left (green) shows the relatively even distribution of desert mitchell grass along a 100 m transect in a 25% utilization paddock in State I. The figure on the right (blue) shows the patchy distribution of desert mitchell grass along a similar transect but in a 25% utilization paddock in State II after a number of years of recovery. Both transects had the same total biomass of desert mitchell grass.

Animal selectivity appeared to reinforce this patchiness, with cattle concentrating much of their grazing in the short annual grass patches and leaving ungrazed many of the vigorous but rank perennial grass patches.

It is likely that these bare patches shed water and nutrients that are captured down-slope by the tussock grass-dominated patches.

Where perennial grasses have been greatly reduced and there are few tussocks, the loss of ground cover means that water, sediments and nutrients leak from the pasture. This results in a loss of pasture productivity because rainfall is not used effectively. When the pasture has partially recovered there is no system leakiness, but there is still significant movement of sediments and nutrients between bare areas and dense vegetation patches.

Videography data from the Cardigan site demonstrate the distribution of perennial grasses at the paddock scale when the pasture-soil system is in degraded, partially recovered or stable states (Figure 14).

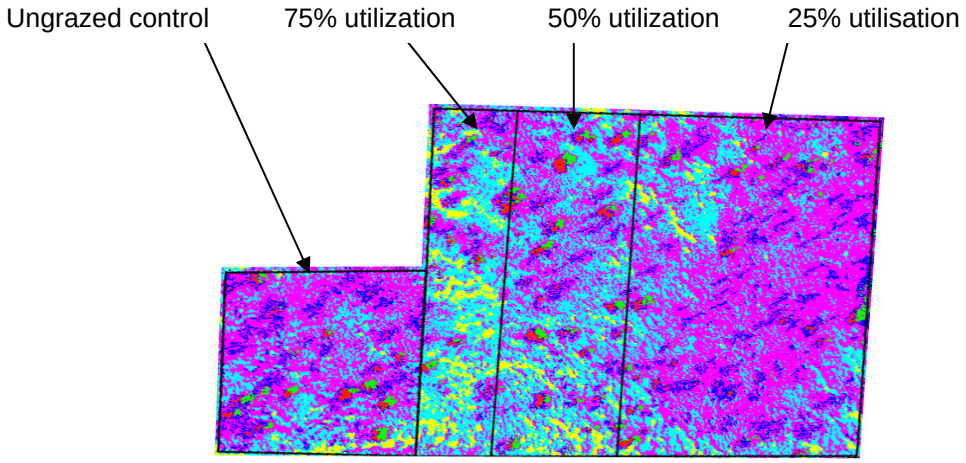

Figure 14. Patterns of vegetation at the paddock scale highlighting the patchiness. Red = shadow, green = trees & shrubs, yellow = bare soil, crimson = perennial grasses, dark blue = *Heteropogon contortus* and light blue = annuals and litter.

It is likely that the pasture will make the transition from patchy recovery to full recovery either very slowly (through gradual expansion of the dense perennial grass patches) or more rapidly (if there are very favourable climatic conditions that allow perennial grasses to germinate and establish despite the unfriendly soil environment associated with large bare patches). Such favourable climatic conditions were experienced from 1998-2000, when the wet seasons were good not only in terms of total amount of rainfall but also in terms of their long duration. The resulting good soil moisture conditions enabled newly germinated perennial grasses to persist. This is highlighted by data that show a large increase in presence or abundance of key perennial grasses in those years (Figure 15).

The story of recovery from State II to State I over the eight years of the study demonstrates the fact that good grazing management can bring about recovery of 3P grasses, ensuring that the pasture is productive and no longer leaks valuable water and nutrients. However, for the soil to fully recover, with perennial grasses establishing on even scalded patches, there may need to be a sequence of *very* favourable years.

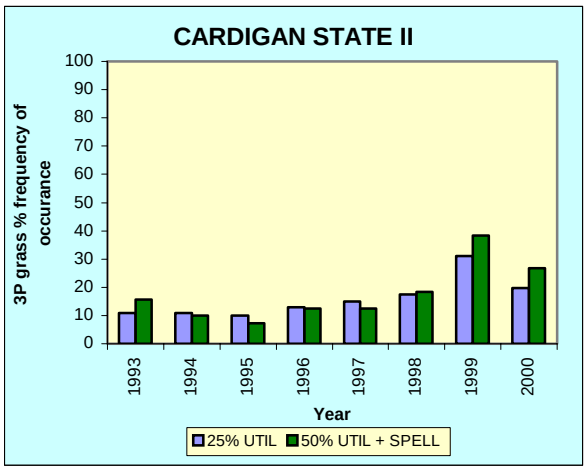

Figure 15. Frequency of occurrence of 3P grasses in the 25% utilization and 50% + spelling treatments that were initially in poor condition. Note the large increase in abundance does not occur until 1998.

Grazing and species diversity

The importance of developing grazing strategies that help conserve biodiversity, is increasingly being recognised. Biodiversity is the variety of all living organisms and the ecosystems to which they belong. Some plant and animal species are sensitive to grazing and it is important to understand how species respond to grazing so that management strategies that protect the sensitive species can be developed. The small size of our experimental paddocks in the ECOGRAZE study made them unsuitable for comprehensive biodiversity studies but we were able to measure the effects of grazing on herbaceous plant species diversity, which is one component of biodiversity.

At the Hillgrove and Lakeview sites grazing had little effect on species diversity in paddocks that were initially in good condition and grazed heavily (75% utilization). Even though the abundance of 3P grasses was greatly reduced in these treatments, nearly all of the species remained in the paddocks (Figure 16). However, at the Cardigan site there was a significant reduction in diversity of 3P grasses as a result of heavy utilization.

The relatively minor effect of heavy grazing on species diversity after eight years is not that surprising. The reduction in biomass and abundance of 3P grasses in response to heavy grazing creates gaps for new plants. As a result, there is often little early change in diversity. Indeed, it is not uncommon for plant diversity to *increase* in the short term in response to grazing. However, prolonged heavy utilization can lead to a loss of plant species. This is highlighted in the results for the heavily grazed paddocks that were in poor condition at the start of the study. At all three sites, plant species diversity was significantly reduced. Legumes, forbs and 3P grasses accounted for most of the reduction in plant diversity. As it is not uncommon for native legumes and forbs to decrease as perennial grasses decline, keeping 3P grasses abundant in pastures helps maintain the presence of minor species like forbs and native legumes.

There were interesting site differences in plant species diversity with an inverse trend between soil fertility and plant diversity; the low fertility site (Lakeview/Allan Hills) had the greatest diversity and the fertile basalt soils at Hillgrove/Eumara had the lowest diversity.

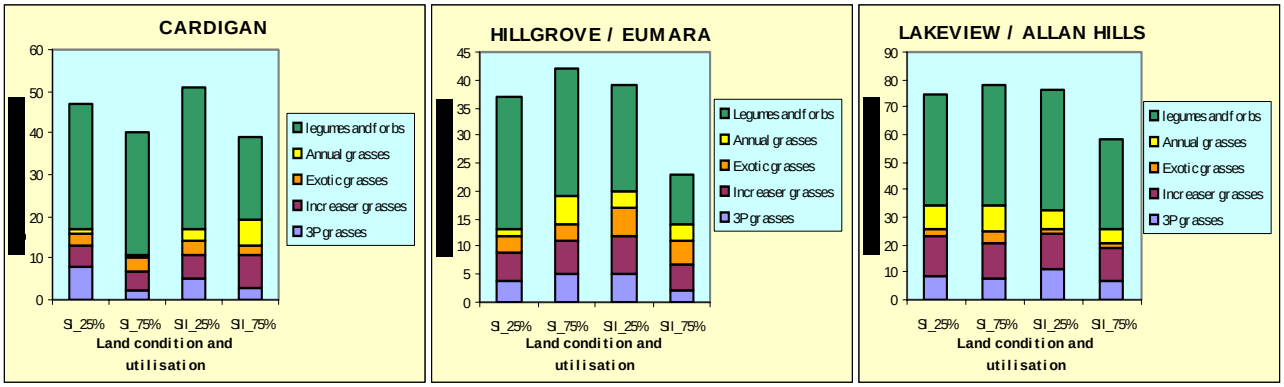

Figure 16. Species diversity in plant functional groups at the three study sites. The numbers represent species per paddock and are the average of 1999-2000 for Hillgrove and Cardigan and 2000-01 at Lakeview/Allan Hills. S1 = State 1, S2 = State 2, 25 = 25% utilization, 75 = 75% utilization.

Grazing management and the storage of carbon

The tropical savannas of northern Australia store about one third of Australia's terrestrial carbon. Good management of this carbon store could be important in limiting Australia's greenhouse gas emissions. Trees are the highly visible form of carbon storage and they receive a lot of attention. However, perennial grasses are also important in terms of carbon storage because their roots and associated organic matter make a valuable contribution to soil organic carbon.

To understand how grazing affects soil carbon through changes in pasture composition we sampled the soil in a number of the grazing treatments at the Cardigan site. The results showed that most of the soil organic carbon is found beneath perennial grass tussocks and that the amount declines rapidly with increasing distance from the tussock (Figure 17). When pasture is in good condition, there is much carbon beneath each tussock and, because tussocks are reasonably close together, the decline in organic carbon in the inter-tussock space is not great. However, when perennial grasses have been weakened through overgrazing there is a significant decline in soil carbon. In such situations, the amount of carbon beneath tussocks is lower and there are large gaps between tussocks with little carbon in the inter-tussock space.

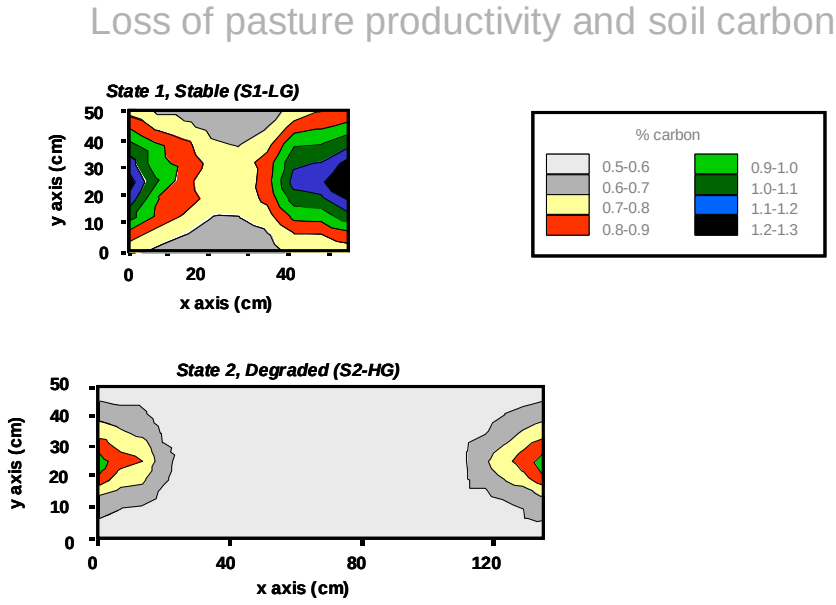

Figure 17. Illustration of the distribution of soil carbon in the top 10cm of soil between good condition State I (top figure) and poor condition State II (bottom figure).

At the paddock scale, overgrazing greatly reduces soil carbon reserves. Managing pasture condition to maintain 3P grasses has the added benefit of maintaining soil carbon reserves. If carbon trading increases in importance there may be some opportunities for producers to become involved and to receive additional returns (incentives, premium on beef etc) from good grazing management practices that generate public benefits.

Land condition, grazing strategies and economics

If producers are to adopt grazing management recommendations that sustain the native pasture resource it is important we assess the financial consequences of such recommendations.

We have assessed the economic implications of managing land in various land condition states by linking a pasture production model (GRASP) to a spreadsheet model of farm economics. In GRASP we used 100 years of historical climate data for Charters Towers to predict annual pasture and animal production for land in various conditions. This production data was used to drive branding and mortality rates and sales in a spreadsheet model of enterprise economics. For all of the scenarios presented in this section our "test" property was 28,000 ha in size and on moderate fertility soils. The assumptions associated with this property are shown in Box 1. The key outputs from this spreadsheet model are gross margin per head and per hectare, farm cash flow and return on capital. In the model, costs and prices of beef were based on an average of ABARE data from 1996-2000.

Box 1. The test beef enterprise used in the modeling scenarios

Property size: 28,000 ha
Country type: Moderate fertility, eg. Goldfields country, with intact woodland
Average rainfall: 650 mm
Useable area of property for grazing: 24,000 ha
Land value: $70/ha
Improvements: $400,000
Overhead Costs: $150,000 per annum
Non-cattle income: $15,000 per annum
Non-family labour: $32,000 per annum

Herd management
Bull/breeder ratio: 3%
Target steer/bullock weight: 580kg
Target weight of surplus heifers: 350kg
Weaning weight: 170 kg
Cow culling age: 6 or 7 years depending on season
Supplementary feeding: Initially M8U but in extended dry spells fortified molasses

Land condition and enterprise economics

In the first series of simulations we assumed that land condition remained constant for the 100 years in each of three land condition states – that is, the land was in State I (good condition), or State II (deteriorated condition) or State III (degraded condition) for the entire 100 year period and didn't change from one state to another.

In our model herd we tried to maintain around 3,600 head, if branding percentages and mortality rates permitted. The results for these first series of simulations are shown in Table 3.

Table 3. Land condition and farm economic performance

	State I	State II	State III
% perennials in pasture	90	70	32
Pasture growth (kg/ha/year)	1,730	1,462	938
Soil loss (kg/ha/year)	590	1,060	2,310
Herd number	3,600	3,410	1,910
Cattle sold per year	662	709	281
Supplement costs $/year	$17,000	$64,800	$72,800
Cash return $/year	$38,000	$35,000	-$95,000
% years –ve cash flow	17	25	58

While State I is considerably more productive than State II in terms of pasture growth, the difference is not as great in animal production or economic performance. This is because the greater proportion of annual grasses and forbs in State II affords a higher diet quality. Consequently, when seasons are good and forage is not limiting, animal production and cash flow is relatively high. However, in poorer seasons in State II forage quantity can be more limiting, leading to high supplementary feed costs and reduced economic performance. State II experiences a higher percentage of negative cash flow years and faces much greater enterprise risk. However, the main disadvantage of State II condition land is that, with further inappropriate management, it can shift to State III, a State that is highly unproductive and unprofitable.

In summary, State I is financially the most stable of the three States. While State II can be profitable, the level of profit is more variable and there is considerable risk of moving to a highly unprofitable, degraded land condition.

Are rotational grazing systems cost-effective?

We compared continuous grazing with rotational grazing in 100 year simulations using what appeared to be ‘safe’ utilisation rates based on the ECOGRAZE findings. (a long-term average 25% for continuous grazing and an average of 35% utilisation for rotational grazing with a wet season spelling regime). The feedback effects of grazing on perennial grasses was included so that the long-term sustainability of the grazing systems could be tested.

The rotational grazing system used in the simulations was the simple three paddock system. Under this system, one paddock was rested from November to the end of April, then all paddocks were grazed over the dry season, and then the second paddock rested in the following wet season and so on, with the full cycle taking three years.

The stocking rates were:

(a) Continuous stocking at 25% utilisation (one cow/7 ha)

(b) Continuous stocking at 35% utilisation (one cow/5ha)

(b) Wet season spelling regime with an average utilisation of 25% (one cow/7ha)

(c) Wet season spelling regime with an average utilisation of 35% (one cow/5ha)

It was assumed that $100,000 would need to be spent on fencing and water in order to implement the rotational grazing system on our 28,000 ha case study property. This $100,000 was borrowed from the bank at an interest rate of 10%.

The financial performance of the various stocking strategies is shown in Table 4.

Table 4. Financial performance of continuous grazing and wet season spelling strategies.

	Continuous grazing – 25% utilisation	**Continuous grazing – 35% utilisation**	**Wet season spelling –25% utilisation**	**Wet season spelling – 35% utilisation**
Pasture growth (kg/ha/year)	1,730	1,195	1,765	1,683
Soil loss (kg/ha/year)	590	2,291	548	861
Herd number	3,600	4,200	3,600	5,000
Cattle sold per year	662	688	675	892
Supplement costs $/year	$17,000	$128,000	$12,000	$61,000
Cash return $/year	$38,000	-$114,000	$37,000	$57,000

At the long-term safe utilization of 25%, continuous grazing is more profitable than rotational grazing because of the loan repayments associated with latter. However, the continuous stocking strategy is not sustainable if average utilization is increased to 35%. This is because there are sequences of years when utilisation rates are high and the pasture deteriorates to the point where it does not recover in subsequent years. The result is a crash in financial performance as a result of the loss of 3P grasses from the system.

In contrast, the rotational grazing system at 35% utilization *is* sustainable because the rest provided to paddocks every third wet season allows recovery of 3P grasses. Soil loss is higher with this grazing strategy but the amount lost is still low. Because more animals are carried there is a greater reliance on supplementary feeds. The result is that this rotational grazing system is more profitable than continuous grazing at 25% utilization, although both systems return reasonable cash flows.

The results of the ECOGRAZE study indicate that a wet season spelling regime can support higher utilisation rates without damaging the key perennial grasses than can continuous grazing. However, for most enterprises, the introduction of a rotational grazing system that incorporates a wet season spelling regime is likely to involve some infrastructure development in the form of fencing and new waterpoints. Also, higher utilization rates will lead to reduced individual animal performance, which may affect the ability of cattle to reach target market specifications.

Based on simulation studies, rotational grazing systems that incorporate wet season spelling can be more profitable than continuous grazing. However, because rotational grazing systems require more management effort and may require some capital expenditure on infrastructure, to be successful they need to be well planned and management needs to be flexible.

5. Success in achieving objectives

Objective 1. Develop management guidelines on the use of stocking rate, fire and strategic spelling to encourage deteriorated native pasture back to a more desirable state and to prevent decline of pastures presently in good condition

The results and discussion section above clearly demonstrates that through our research we have developed management guidelines on how to recover deteriorated pastures and how to maintain the health and vigour of pastures in good condition. These strategies were first described in an ECOGRAZE brochure produced in 1998 (Appendix A). This brochure was successful in describing the project and communicating the initial results and over 1000 copies have been distributed across northern Australia.

Because of the importance strategic spelling plays in managing perennial grass composition we saw the need to examine ways in which strategic spelling could be incorporated into practical grazing systems. These grazing systems are described in the ECOGRAZE manual, included in this report as Appendix B. This further highlights the success in achieving this objective through taking research findings and translating them into practical management guidelines. Peer review reports are included in Appendix C and scientific publications coming out of the research are attached as Appendix D.

Objective 2. Develop a predictive understanding of the effect of trees on pasture production to aid management decisions on the extent of tree clearing, the optimal frequency of regrowth control and the use of fire to manage woody species

This objective was largely undertaken in the first phase of the project (1992-96) with some final experimental work being completed in 1997. This work was largely reported in the 1996 final report and a peer review report in 1997/98. In summary, the work showed that tree water use is fairly homogenous within a woodland community and that there is little difference in use under trees versus outside canopy areas. In cleared and regrowth paddocks soil moisture depletion was more rapid in the top 30cm than in intact woodland paddocks. The results of the work were successfully incorporated into the forage production model GRASP.

Objective 3. Benefits and costs of various grazing management strategies

Through linking the forage production model GRASP to a spreadsheet model of herd dynamics and farm economics we were successfully able to assess the influence of land condition and different grazing strategies on enterprise economics. The development of the dynamical herd model that responds to different season types and land condition status has been a major breakthrough within the project. The model requires some further development but it will prove to be an invaluable tool in assessing the economic implications of a whole range of grazing management strategies.

This linking of the pasture dynamics to herd dynamics and financial performance has been instrumental in producer acceptance of the implications of the grazing management recommendations that came out of the ECOGRAZE field trials.

Impact on Meat and Livestock Industry

At the commencement of the ECOGRAZE study there was little awareness (Appendix E) of the main issues surrounding sustainable grazing management of open eucalypt woodlands in northern Queensland and only a few producers were actively managing their enterprises to maintain perennial grass composition and pasture health. Over the course of the ECOGRAZE study we have witnessed, first a major change in awareness of the issues followed by a noticeable change in management practices. We believe awareness raising of sustainable grazing management issues was achieved through the ECOGRAZE brochure, through well attended and successful field days at the research sites and through presentations at general beef events such as Meat Profit Days. To some extent it was easy to attract the attention of producers because of the crippling effect of the severe drought in the early to mid-1990s. The deteriorating condition of land during this drought persuaded producers to examine their grazing management practices and look for more sustainable alternatives.

The relevance of the research to industry is also demonstrated in the ECOGRAZE research being included in FutureProfit courses that have been conducted in north-east Queensland over the last few years. The key findings of the research have reached a considerable number of producers through this means. The research findings also form an important part of the new Grazing Land Management education package being developed by MLA so it is envisaged that the research will continue to have an important impact over the next five years.

A change in practice in the industry is now evident through the widespread adoption of wet season spelling, which was a key management practice recommended as a result of the ECOGRAZE research. We believe the ECOGRAZE study has been a significant contributor to the adoption of this management practice. We hope to quantify this with a follow-up survey of the same producer groups that contributed to the initial survey reported in Appendix E.

Conclusions

The ECOGRAZE study has been a successful long-term study which has developed innovative management options to enhance the condition of grazing lands in the open eucalypt woodlands of northern Australia. It has focused on developing grazing management guidelines that can be used by industry to recover land that has deteriorated through overuse or prevent degradation of pastures

currently in good condition. An important aspect of the research has been its location on five commercial grazing properties on different country types in north-east Queensland. This has allowed extrapolation of the results to a wide area across northern Australia. Another important part of the research was to be able to communicate concepts of land condition and this was successfully achieved by using a simple framework to explain land condition states and the factors (grazing, climate, fire) that drives the transitions between states.

The key findings of the research have been:

- Grazing management, not climate, is the key driver of land condition and pasture health
- Land was maintained in good condition by continuous stocking at 25% utilization or early wet season spelling followed by 50% utilization
- As perennial grasses are lost through overgrazing, rainfall effectiveness declines, pasture productivity is reduced and the system becomes desertified
- Continuous stocking at 25% utilization or early wet season spelling followed by 50% utilization recovers native tussock perennial grasses in poor condition pastures, even during drought years
- The value of wet season spelling is enormous and where a wet season spelling regime can be implemented it can provide increased flexibility to enterprise management
- Wet season spelling can be implemented using fairly simple two, three or four paddock grazing systems
- Cash flows between good and deteriorated pasture condition were on average not greatly different but pastures in a deteriorated condition gave more variable returns and there were more years in which losses occurred. If deteriorated pastures become degraded, the loss of productivity and increased supplementation costs can lead to huge financial losses
- Where wet season spelling is introduced and overall utilisation rates can be sustainably increased then cash flows can be improved even allowing for the capital costs of infrastructure developments such as water and fencing.

Recommendations

While all of the research in ECOGRAZE was carried out on commercial beef properties, the trial paddocks were small and not representative of large, heterogeneous paddocks which are typically 2000-5000 ha in size. The grazing management recommendations coming out of ECOGRAZE assume fairly even grazing distribution. Clearly distribution of grazing in commercial paddocks is not always even because of mix of land types and distance to water points. The utilisation and spelling recommendations need to be evaluated at these commercial scales to ensure they are robust and deliver the same resource management benefits as the trial paddocks. Larger scale evaluations should be accompanied by detailed on-ground economic analyses.

The run of drought years experienced during ECOGRAZE did not allow a proper evaluation of the role of fire in manipulating pasture composition. This area of work needs to be carried on, possibly in the broader context of fire and woody-grass dynamics.

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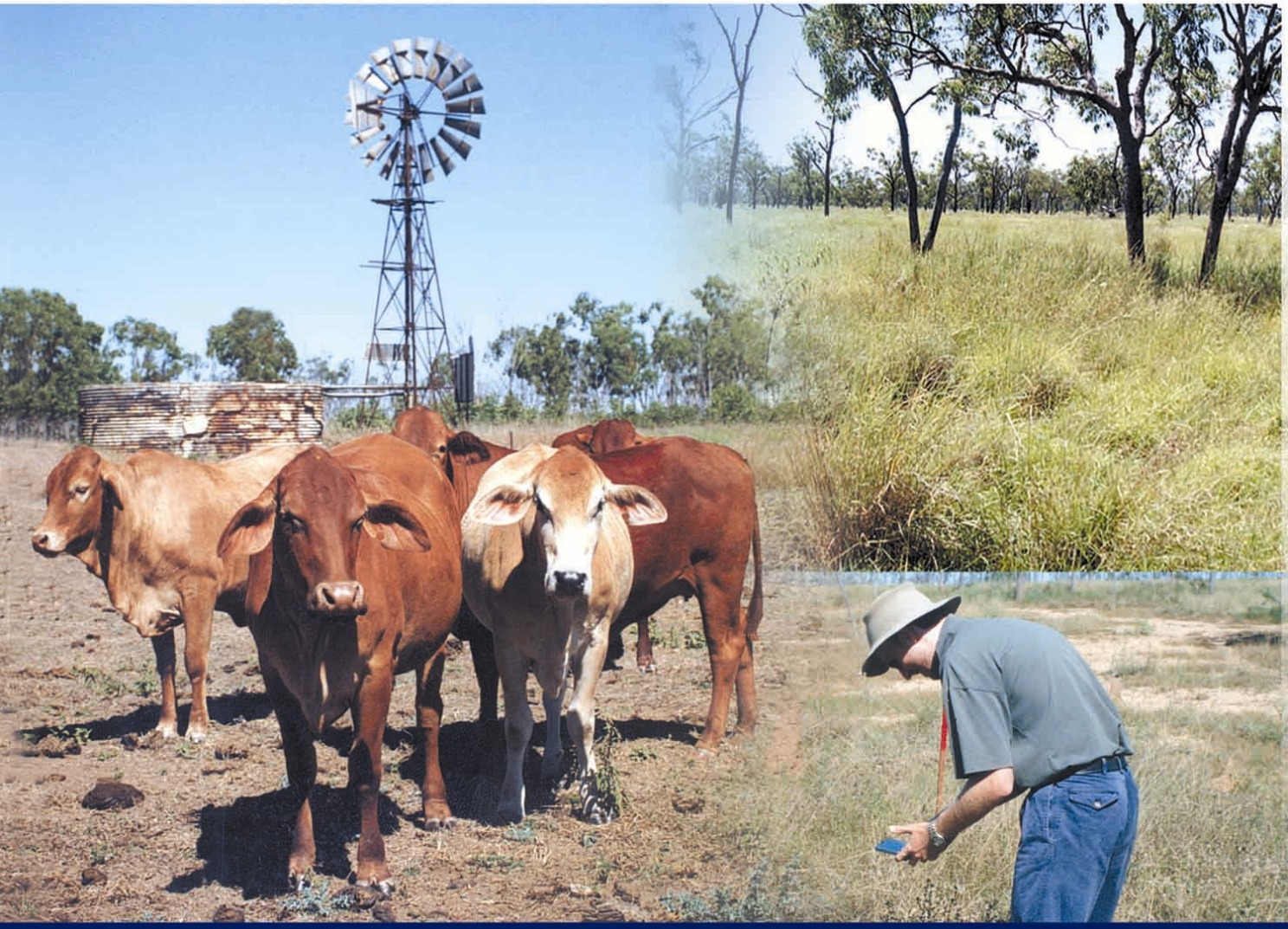
Appendix A – ECOGRAZE brochure produced in 1998



The Ecograze Project

developing guidelines to better manage grazing country

Appendix B – Pre-print copy of the ECOGRAZE manual which is being sent to all producers in the Dalrymple Shire and State and Territory agency staff across northern Australia

Appendix C – Peer review reports 1997-2000

Managing Woodlands: Developing sustainable beef production systems for northern Australia

MRC Project: NAP3.205
Project Duration: 1 July 1996 – 30 June 2001
Milestone Report Date: 1 July 1997

Project Objectives:

1. Develop management guidelines on the use of stocking rate, fire and strategic spelling to encourage deteriorated native pasture back to a more desirable state and to prevent decline of pastures presently in good condition.
2. Develop a predictive understanding of the effect of trees on pasture production to aid management decisions on the extent of tree clearing, the optimal frequency of regrowth control and the use of fire to manage woody species.
3. Assess the economic benefits and costs of various grazing management strategies.

Project Summary:

This project aims to (a) develop management guidelines (fire, grazing, strategic spelling) to manipulate native pasture composition, and (b) quantify soil water use by trees and grasses for improved prediction of forage production in topical woodland environments. Grazing studies and tree-grass interactions are being conducted on three commercial properties in Dalrymple Shire.

The results to date show that significant recovery of run-down pastures can be achieved with either light stocking without spelling or with heavier stocking and wet season spelling. However, while forage yields and botanical composition appear to have recovered at two of the three sites with either of these two grazing strategies, the recovery until the has been achieved through regeneration of existing plants with little recruitment of new plants.

Modelling studies using historical climate records indicate that in comparison with good condition pasture, deteriorated pasture has animal production that is more variable, there are more years where there is a predicted weight loss (therefore requiring additional supplementation), and soil loss is considerably higher.

Background and methodology

The condition of tropical tallgrass grazing lands has declined significantly over the last 20 years in response to greatly increased grazing pressure. Tothill and Gillies (1992) estimated that approximately 45% of these grazing lands had suffered some deleterious changes which were reversible by management. Severe drought conditions have prevailed since that survey and it is apparent that the condition of these grazing lands has declined further.

In the first phase of this MRC project (1992-1996) a number of field experiments and modelling studies were initiated to understand the management actions and environmental requirements necessary to manipulate vegetation in tropical tallgrass pastures and to maintain grass legume balance in pastures oversown with *Stylosanthes* species.

The second phase of this project is concentrating on native pastures with experimental work proceeding to (a) develop management guidelines for manipulating pasture composition and (b) quantify soil water use by trees and grasses for improved prediction of forage production. This work is being carried out on three soil types of contrasting fertilities in north-east Queensland: Hillgrove/Eumara Springs -

euchrozem; Cardigan - neutral red duplex; Allan Hills/Lakeview - yellow earth. The work is being carried out using pastures which initially were in contrasting condition i.e. State I - good condition pasture dominated by desirable perennial grasses and State II - deteriorated pasture dominated by less palatable perennial grasses with annual grasses and forbs much more prevalent.

Additionally, in this phase strong emphasis is being placed on improved adoption of research through linking management recommendations into a range of extension activities (property management planning modules, group activities such as LCD groups and landcare groups) and by providing some economic evaluation of different management scenarios.

Results

Rainfall at the experimental sites

Rainfall in 1996/97 at the three sites was close to average for the first time since the project commenced in 1992 (Table 1).

Table 1. Wet season rainfall (mm) at the three experimental sites (October-May)

	1992/93	1993/94	1994/95	1995/96	1996/97	Average
Cardigan	187	320	327	306	441	538
Hillgrove/Eumara	213	332	172	292	428	468
Allan Hills/Lakeview	225	433	267	220	514	519

Preventing loss of desirable perennial grasses from "State I" condition pastures

The grazing study is showing that either low grazing pressures (25% utilisation) or a higher grazing pressure (50% utilisation) with wet season spelling is necessary to maintain the palatable perennial grasses in these pastures. Fig. 1 shows that with either of these grazing strategies perennial grasses can be maintained though there is large inter-annual variability due to climate-grazing interactions.

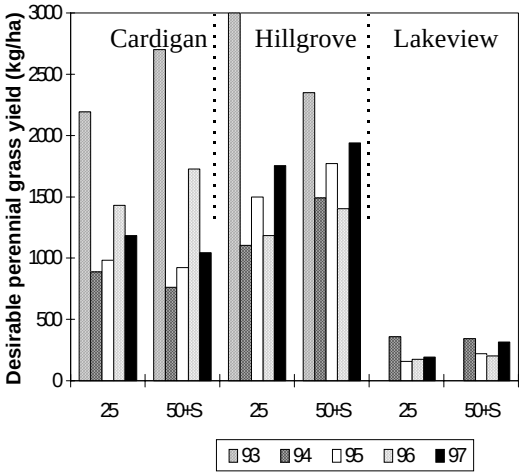


Figure 1. Yield of desirable perennial grasses in State I pastures with either light grazing (25% utilisation) or moderate grazing (50% utilisation) with spelling.

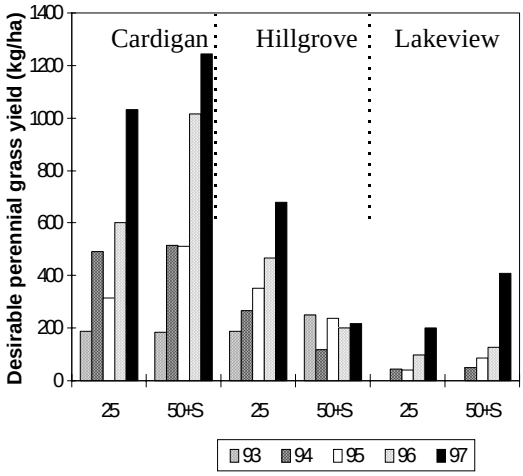


Figure 2. Recovery of desirable perennial grasses in State II pastures with either light grazing (25% utilisation) or moderate grazing (50% utilisation) with spelling.

Encouraging recovery of desirable perennial grasses in "State II" pastures

Recovery of perennial grasses in pastures that have suffered losses through previous overgrazing has been partially achieved with the same grazing strategies that prevent loss of perennial grasses from State I i.e. light stocking or more moderate stocking but with a wet season spelling regime (Fig. 2). This recovery has been achieved in a period of well below average rainfall.

Perennial grass decline and recovery: different processes and different time scales

A comparison of the yield and botanical composition of "recovered" State II pastures and State I pastures grazed lightly (25% utilisation) to maintain a desirable perennial grass mix suggests that recovery is almost "complete" at Cardigan and Allan Hills, though not at Eumara Springs where particularly bad seasons has limited pasture growth (Fig. 3).

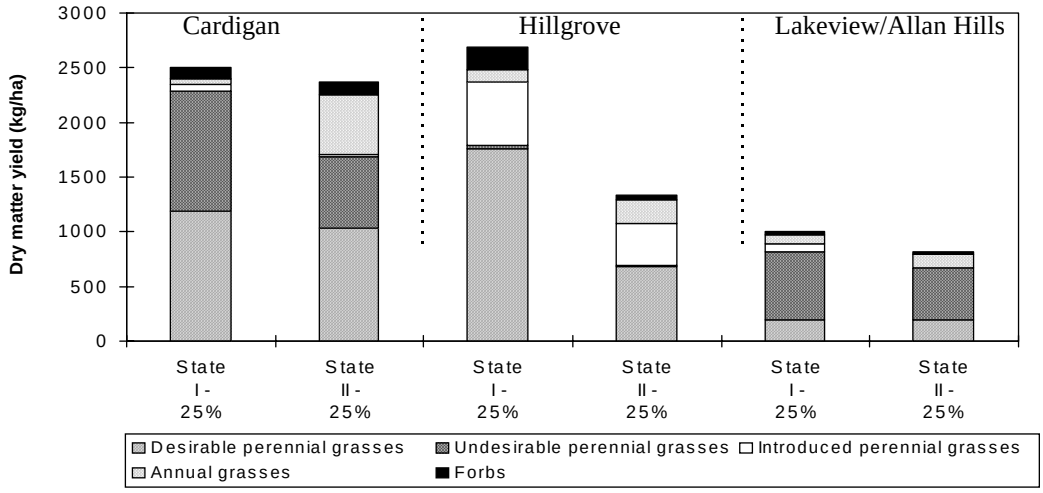


Figure 3. Comparison of yield and composition of State I and II pastures after 5 years of grazing at 25% utilisation.

However, at all three sites there is still a visible difference between State I and II pastures though mean paddock composition does not reflect this difference. State II pasture is very patchy with large bare areas interspersed with stands of grass denser than can be found in State I pastures. We believe that species recovery has been through expansion of existing individuals rather than through recruitment of new plants. Bare patches have low water infiltration rates and are low in nutrients, organic matter and microbial biomass, making it difficult for perennial grasses to germinate and establish. The percentage area of a paddock with a species present is a better indication of decline and recovery than just the total amount (yield) of that species in the paddock. This percentage area of a species presence is referred to as frequency percentage. Our frequency data shows that while yields of desirable perennial grasses have recovered in lightly grazed State II pastures, frequency distribution of plants has not increased greatly over the five years of the experiment (Table 2). In contrast heavy grazing of State I pasture has resulted in a large decline in perennial grass frequency i.e. the rate of recovery of perennial grasses is much slower than the rate of decline. The patchy nature of recovered pasture makes it more susceptible to overgrazing as all the resources are concentrated in a relatively small percentage of the total paddock area. Soil seed bank results show that there is still almost no germinable perennial grass seed in State II pastures. Seed banks are dominated by annual grasses and forbs. These results have important implications for the grazing management of "recovering" State II pastures and further stresses the importance of maintaining pastures in good condition rather than relying on them to "bounce back" in good seasons.

Table 2. Change in frequency percentage and yield of *Bothriochloa ewartiana* under different grazing strategies (75% utilisation vs 25% utilisation + spelling) at the Cardigan site.

		1993	1994	1995	1996	1997
State I - 75%	Yield (kg/ha)	613	272	254	163	80
	Frequency (%)	26	23	21	16	10
State II - 25% + S	Yield (kg/ha)	66	77	251	226	598
	Frequency (%)	15	10	12	17	15

Spread of introduced perennial grasses

In the past, we have observed that introduced perennial grasses (Buffel grass, Urochloa, Indian couch) only spread into native pastures after heavy grazing has created gaps between native perennials for the exotics to exploit. However, the drought of 1991-96 resulted in such a decline in basal area of native perennial grasses, even under light grazing, that large enough gaps developed for introduced perennial grasses to invade. At Hillgrove, this has resulted in a large increase in buffel grass in lightly grazed native pasture paddocks (Fig. 4). Now established, buffel grass is unlikely to be outcompeted by native grasses and will probably spread further in the future after each drought event. This will be a desirable outcome for beef production but maybe a problem where there is unwanted spread. In contrast, Indian couch can be "pushed out" with a combination of light grazing and better seasons.

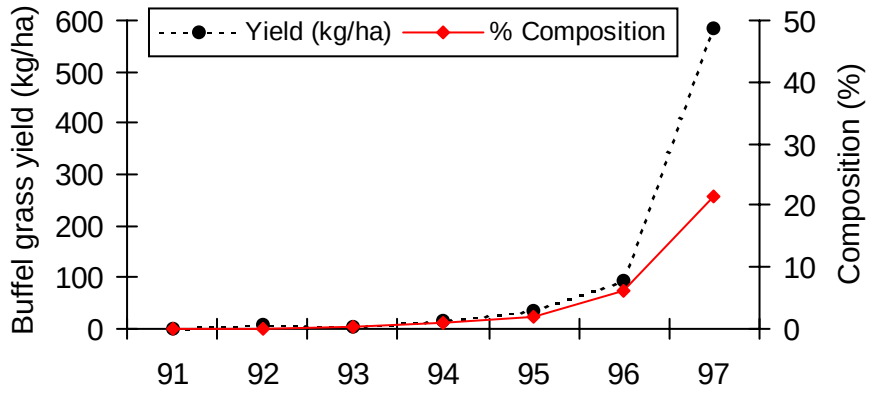


Figure 4. Spread of buffel grass into lightly grazed pasture (25% utilisation) at Hillgrove (State I).

Managing Woodlands: Developing sustainable beef production systems for northern Australia

MRC Project: NAP3.205 **Project Duration:** 1/7/96–30/6/2001 **Report Date:** 1/7/98

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Project Objectives:

1. Develop management guidelines on the use of stocking rate, fire and strategic spelling to encourage deteriorated native pasture back to a more desirable state and to prevent decline of pastures presently in good condition.
2. Develop a predictive understanding of the effect of trees on pasture production to aid management decisions on the extent of tree clearing, the optimal frequency of regrowth control and the use of fire to manage woody species.
3. Assess the economic benefits and costs of various grazing management strategies.

Project Summary:

This project aims to (a) develop management guidelines (fire, grazing, strategic spelling) to manipulate native pasture composition, and (b) quantify soil water use by trees and grasses for improved prediction of forage production in tropical woodland environments. The research is located in the Dalrymple Shire on five commercial properties representative of three of the major soil types/fertilities in the region.

During 1993-1997 the results showed that significant recovery of run-down pastures could be achieved with either light stocking without spelling or with heavier stocking and wet season spelling but that this recovery was mainly through growth of existing plants rather than recruitment of new plants. Large bare patches and surface soil scalds were still apparent in recovering pastures compared with long-term conservatively grazed paddocks. However, during 1997/98, the first season since the experiment commenced in which growing weeks were well above average, some recovery occurred in these bare patches. At sites where introduced perennial grasses are in the vicinity of treatment paddocks, spread of these grasses into treatments has been significant, more so where native grasses have been reduced by heavy utilisation. The dry seasons of 1993-1996 caused such a reduction in basal area of native perennial grasses that invasion by introduced perennial grasses into even lightly stocked paddocks has occurred, disproving the hypothesis that lightly grazed pastures will resist invasion.

The experimental component of the tree-grass water use study has been completed and the results are currently being analysed. Initial findings show that tree water use is fairly homogenous within a woodland community and that there is little difference in use under versus outside canopy areas. In cleared and regrowth paddocks soil moisture depletion was more rapid in the top 30cm than in intact woodland paddocks. Results are being incorporated into the forage production model GRASP.

Results and achievements

Background and methodology

The condition of north Queensland's grazing lands (mainly tropical woodlands and open savannas) has declined significantly over the last 20 years in response to greatly increased grazing pressure. Tothill and Gillies (1992) estimated that approximately 45% of these grazing lands had suffered some deleterious changes which were reversible by management. Severe drought conditions have prevailed since that survey and it is apparent that the condition of these grazing lands has declined further.

In the first phase of this MRC project (1992-1996) a number of field experiments and modelling studies were initiated to understand the management actions and environmental requirements necessary to manipulate vegetation in tropical tallgrass.

The second phase of this project is concentrating on native pastures with experimental work proceeding to (a) develop management guidelines for manipulating pasture composition and (b) quantify soil water use by trees and grasses for improved prediction of forage production. This work is being carried out on three soil types of contrasting fertilities in north-east Queensland: Hillgrove/Eumara Springs - euchrozem; Cardigan - neutral red duplex; Allan Hills/Lakeview - yellow earth. On each land type, we are testing management options (stocking pressure, spelling, fire) on native pastures that were initially in either good condition (State I - pasture dominated by desirable perennial grasses) or fair condition (State II - pasture dominated by less palatable perennial grasses and with annual grasses and forbs much more prevalent).

Additionally, in this phase strong emphasis is being placed on improved adoption of research through linking management recommendations into a range of extension activities (property management planning modules, group activities such as LCD groups and landcare groups).

Results

Rainfall at the experimental sites

Rainfall in 1997/98 was well above average at Hillgrove/Eumara and Allan Hills/Lakeview and average at Cardigan. However, good distribution of rain meant that growing weeks were above average at all three sites (Table 1) for the first time since the study commenced in late 1992.

Table 1. Wet season rainfall (mm) at the three experimental sites (October-May)

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	Long term average
Cardigan	187	320	327	306	441	538	538
Hillgrove/Eumara	213	332	172	292	428	845	468
Allan Hills/Lakeview	225	433	267	220	514	645	519

Preventing loss of desirable perennial grasses from "State I" condition pastures

The grazing study is continuing to show that either low grazing pressures (25% utilisation) or a higher grazing pressure (50% utilisation) combined with wet season spelling is necessary to maintain the palatable perennial grasses in these pastures (Fig. 1). High utilisation rates (50% and especially 75%) have resulted in significant losses of desirable perennial grasses. Despite good growth conditions during 1997/98, high utilisation treatments at Cardigan and Lakeview did not produce enough growth to "get away" from the animals. However, at the high fertility site at Hillgrove, growth exceeded demand and by the end of the season there was significant standing crop, even in the 75% utilisation treatment.

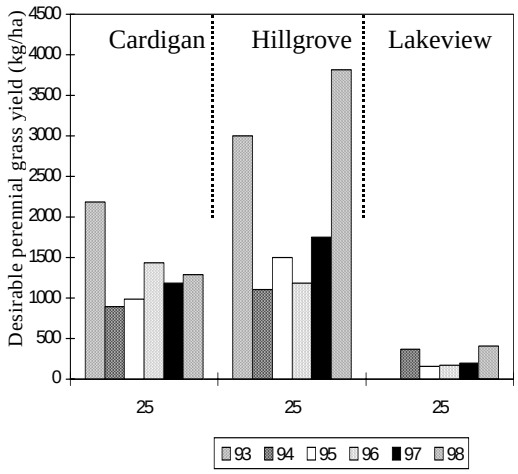

Figure 1. Yield of desirable perennial grasses in State I pastures with light grazing (25% utilisation).

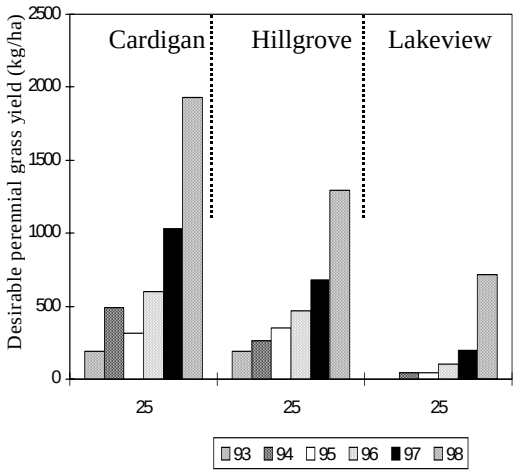

Figure 2. Recovery of desirable perennial grasses in State II pastures with light grazing (25% utilisation).

Encouraging recovery of desirable perennial grasses in "State II" pastures

Recovery of perennial grasses in pastures that have suffered losses through previous overgrazing has been partially achieved with the same grazing strategies that prevent loss of perennial grasses from State I ie. light stocking or more moderate stocking but with a wet season spelling regime (Fig. 2). This recovery has been achieved over 6 years, the first four of which were very dry.

Previous annual reports have demonstrated that recovery of State II pastures has been in overall paddock yield and composition but within paddocks this recovery has been very patchy with little recruitment of new plants (existing ones just becoming extremely large) and extensive bare patches persisting. Animal selectivity appeared to be exacerbating this patchiness with cattle concentrating much of their grazing in the short annual grass patches and leaving many of the tussock dominated patches ungrazed. This patchy recovery was supported by plant frequency data which showed that while yields of desirable perennial grasses had recovered in lightly grazed State II pastures by 1997, frequency distribution of plants had not increased greatly over the five years of the experiment (Table 2). In contrast, heavy grazing of State I pasture had resulted in a large decline in perennial grass frequency i.e. the rate of recovery of perennial grasses is much slower than the rate of decline.

Table 2. Change in frequency percentage and yield of *Bothriochloa ewartiana* under different grazing strategies (75% utilisation vs 25% utilisation + spelling) at the Cardigan site.

		1993	1994	1995	1996	1997	1998
State I - 75%	Yield (kg/ha)	613	272	254	163	80	78
	Frequency (%)	26	23	21	16	10	10
State II - 25% + S	Yield (kg/ha)	66	77	251	226	598	1428
	Frequency (%)	15	10	12	17	15	28

However, the well-above average wet season in 1997/98, allowed many of the bare patches to remain moist for extended periods which permitted germination and establishment of new perennial plants. Many of the previous bare patches have filled in with new perennial grass plants and the frequency data of desirable perennial grasses now indicates that much of the patchiness has disappeared (Table 2). At the Eumara Springs site (State II) bare patches have filled in with the introduced perennial grass *Urochloa mosambicensis* rather than native perennial grasses.

Spread of introduced perennial grasses

In the past, we have observed that introduced perennial grasses (Buffel grass, Urochloa, Indian couch) only spread into native pastures after heavy grazing has created gaps between native perennials for the exotics to exploit. However, the drought of 1991-96 resulted in such a decline in basal area of native grasses, even in lightly grazed paddocks, that large enough gaps developed for introduced perennial grasses to invade. Last year we reported that this had resulted in a large increase in buffel grass in lightly grazed native pasture paddocks at Hillgrove and that once established, this trend of increasing buffel grass was likely to continue and the data supports this trend (Fig. 3). Under heavy grazing, the gaps necessary for establishment of introduced perennial grasses will be more pronounced thereby increasing both the probability of invasion occurring and the rate of spread once established. This has proven to be the case in 75% utilisation paddocks at Cardigan State I. Interestingly, at this site one rep has been invaded by Indian couch (*Bothriochloa pertusa*) and the second by urochloa (*Urochloa mosambicensis*). Spread of introduced perennial grasses across a paddock occurs via an invasion front suggesting that spread occurs from neighbouring seed producing plants rather than by other broader scale dispersal mechanisms such as wind or water (Fig. 4).

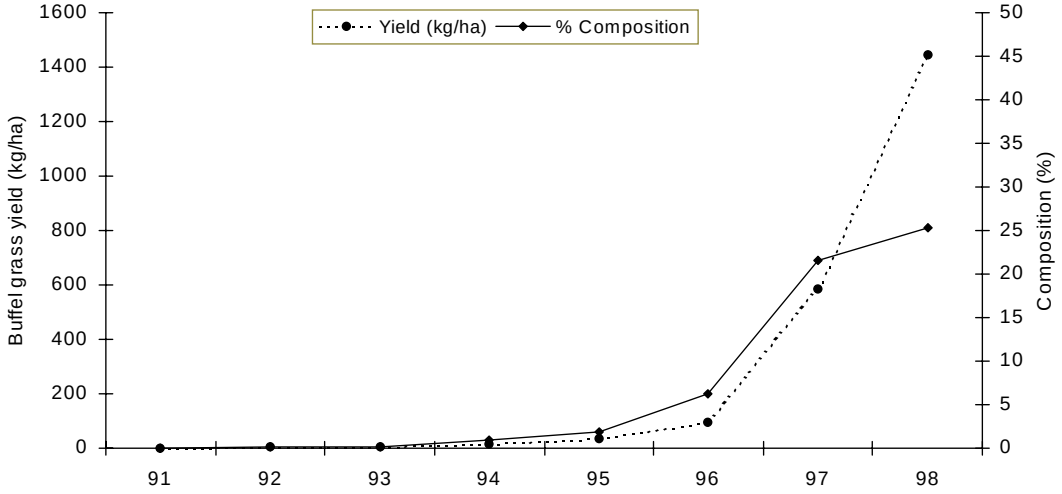

Figure 3. Spread of buffel grass into lightly grazed (25% utilisation) State I pasture at Hillgrove.

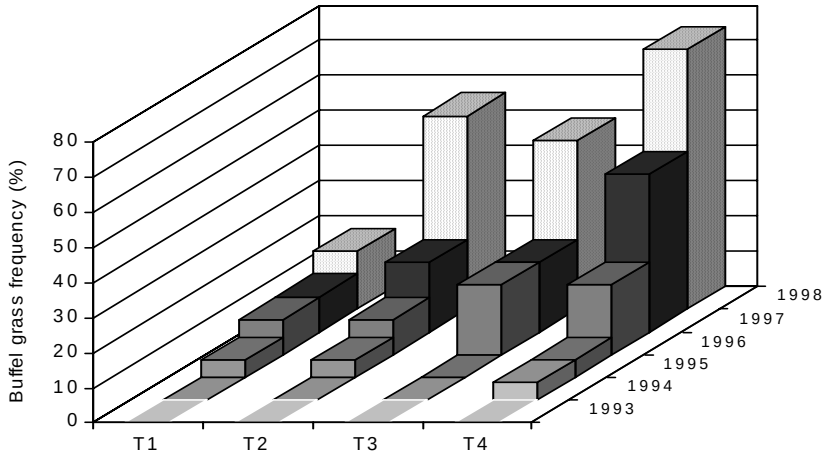

Figure 4. Spatial spread of buffel grass across a lightly grazed (25% utilisation) State I pasture at Hillgrove. The floor of the graph represents the paddock with the right-hand fence line next to transect 4 (T4) marking the separation with a neighbouring paddock sown to buffel grass.

Communication activities

- Evaluation of four producer groups using a focus group approach has commenced to document current grazing management practices and sources of information on grazing management. These focus groups will be reassessed over the next three years to determine what impact the grazing research has had on producer awareness, attitudinal changes and adoption of grazing management principles flowing from the research.

- A four page A4 brochure describing the research project and basic ecological principles of grazing management (using project research results as examples) has been prepared and will be printed in July 1998 when the new MLA logo is available.

- A field day planned for June at Hillgrove has been postponed until August. The 1997/98 wet season at Hillgrove was so good that excessive pasture growth has disguised? treatment differences. These differences should be apparent again by August.

- Research results and grazing management principles have been incorporated into Future Profit courses and during 1997/98 five of these courses was held in the region with a total of about 45 properties being represented. In addition, pasture management workshops, incorporating many of this project's findings, have been held at 6 locations throughout the region, with a total of about 60 properties in attendance.

- The grazing study sites continue to receive a steady flow of visitors including local producers, industry groups and committees (eg NABRC visited the Cardigan site in February), extension staff and local and international scientists.

Planned activities

- Write and submit a paper for journal publication on the tree-grass interactions work
- Hold a major field day in August at Hillgrove and another at Lakeview/Allan Hills in April 1999
- Visit major QDPI regional offices in the north to discuss research results and deliver training in grazing ecology.
- Write and submit a paper on grazing influences on soil characteristics

Publications

Holt, J.A. (1997). Grazing pressure and soil carbon, microbial biomass and enzyme activities in semi-arid northeastern Australia. *Applied Soil Ecology* **5**: 143-149.

Dias, C. (1997). Quantifying land degradation in semi-arid environments using FIST (Fine-scale Image Sampling Technique). Honours Thesis, Department of Tropical Environmental Sciences and Geography, James Cook University of North Queensland, Townsville.

Submitted

Northup, B.K., Brown, J.R., Dias, C.D., Skelly, W.C. and Radford, B. (1998). Developing techniques for near-ground remote sensing of vegetation characteristics. Submitted to Tropical Grasslands.

Northup, B.K. and Brown, J.R. (1998). Grazing-induced changes in a tropical woodland: micro- and meso-scale patches. Submitted to TAG Editorial Panel prior to being submitted to Journal of Vegetation Science.

Managing Woodlands: Developing sustainable beef production systems for northern Australia

MRC Project: NAP3.205 **Project Duration:** 1/7/96–30/6/2001 **Report Date:** 17/9/99

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Project Objectives:

1. Develop management guidelines on the use of stocking rate, fire and strategic spelling to encourage deteriorated native pasture back to a more desirable state and to prevent decline of pastures presently in good condition.
2. Develop a predictive understanding of the effect of trees on pasture production to aid management decisions on the extent of tree clearing, the optimal frequency of regrowth control and the use of fire to manage woody species.
3. Assess the economic benefits and costs of various grazing management strategies.

Project Summary:

This project aims to (a) develop management guidelines (fire, grazing, strategic spelling) to manipulate native pasture composition, and (b) quantify soil water use by trees and grasses for improved prediction of forage production in tropical woodland environments. The research is located in the Dalrymple Shire on five commercial properties representative of three of the major soil types/fertilities in the region.

During 1993-1997 the results showed that recovery of run-down pastures could be achieved with either light stocking without spelling or with heavier stocking and wet season spelling but that this recovery was mainly through growth of existing plants rather than recruitment of new plants. Large surface soil scalds were still apparent in recovering pastures compared with long-term conservatively grazed paddocks. However, during the above average wet seasons of 1997/98 and 1998/99, many of these bare patches have disappeared. Heavily utilised paddocks, initially in good condition, continue to use rainfall ineffectively with resultant low net primary productivity, despite recent invasion by exotic perennial grasses. Overall, the experiment is demonstrating that the palatable tussock perennial grasses are the best indicators of degradation but soil condition is the best indicator of restoration of ecosystem processes.

The forage production model GRASP has been linked to a whole farm economics model to show the economic implications of managing land in different condition states and how planning horizons and rates of degradation can influence the choice of stocking rate.

A four page colour brochure on the project has been produced and distributed, which has resulted in much follow-up interest in the project and its findings. Three landcare groups in the region have been interviewed to provide a baseline of current understanding of grazing management issues and sources of information. These same groups will be interviewed at the conclusion of the project to gain some measure of research impact.

Results and achievements

(a) Background and methodology

In the first phase of this project (1992-1996) a number of field experiments and modelling studies were initiated to understand the management actions and environmental requirements necessary to manipulate vegetation, both native and sown pastures, in tropical tallgrass. The second phase of this project is concentrating on native pastures with experimental work proceeding to (a) develop management guidelines for manipulating pasture composition. This work is being carried out on three soil types of contrasting fertilities in north-east Queensland: Hillgrove/Eumara Springs - euchrozem; Cardigan - neutral red duplex; Allan Hills/Lakeview - yellow earth. On each land type, we are testing management options (stocking pressure, spelling, fire) on native pastures that were initially in either good condition (State I - pasture dominated by desirable perennial grasses) or fair condition (State II - pasture dominated by less palatable perennial grasses and with annual grasses and forbs much more prevalent).

Additionally, in this phase strong emphasis is being placed on examining economic implications of various grazing management strategies and improved adoption of research through linking management recommendations into a range of extension activities (property management planning modules, group activities such as LCD groups and landcare groups).

(b) Results

(i) Rainfall at the experimental sites

Rainfall in 1998/99 was above average at Hillgrove/Eumara and Cardigan and average at Lakeview/Allan Hills (Table 1). Good distribution of rain meant that growing weeks were above average at all three sites.

Table 1. Wet season rainfall (mm) at the three experimental sites (October-May)

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	Long term ave.
Cardigan	187	320	327	306	441	538	703	538
Hillgrove/Eumara	213	332	172	292	428	845	652	468
Allan Hills/Lakeview	225	433	267	220	514	645	519	519

(ii) Preventing loss of desirable perennial grasses from “State I” condition pastures

The grazing study is continuing to show that either low grazing pressures (25% utilisation) or a higher grazing pressure (50% utilisation) combined with wet season spelling is necessary to maintain the palatable perennial grasses in these pastures (Table 2).

Table 2. Effect of different grazing treatments on standing crop (kg DM/ha) of decreaser perennial grasses (averaged across all three sites) and relative primary pasture production of heavily grazed (75%) vs lightly grazed (25%) pastures at the Cardigan site.

	1993	1994	1995	1996	1997	1998	1999
State I – 25% utilisation	1729	786	881	928	1041	1841	2449
State I – 50% utilisation + spelling	1684	864	970	1109	1098	1741	2558
State I – 75% utilisation	1146	630	459	282	264	680	663
Relative primary pasture production (%) – 75% vs 25%	107	44	34	13	52	50	

High utilisation rates (50% and especially 75%) have resulted in significant losses of desirable perennial grasses. The net primary productivity, as measured in exclosure cages which are moved each year, in the

75% utilisation paddocks continues to be about only 50% of that measured in conservatively grazed paddocks (Table 2). This clearly demonstrates the low efficiency with which rainfall is used to produce forage in degraded pastures.

(iii) Encouraging recovery of desirable perennial grasses in "State II" pastures

Recovery of perennial grasses in pastures that have suffered losses through previous overgrazing has been achieved with the same grazing strategies that prevent loss of perennial grasses from State I ie. light stocking or more moderate stocking but with a wet season spelling regime. This recovery has been achieved over seven years, the first five of which were very dry.

Recovery of forage biomass and pasture composition was achieved at the paddock scale after five years. However it was noticeable at that stage that the recovery was very patchy with large bare scalds interspersed with patches of very vigorous pasture. Animal selectivity appeared to be exacerbating this patchiness with cattle concentrating much of their grazing in the short annual grass patches and leaving many of the tussock dominated patches ungrazed. This patchy recovery was supported by plant frequency data which showed that while yields of desirable perennial grasses had recovered in lightly grazed State II pastures by 1997, frequency distribution of plants had not increased greatly over the five years of the experiment. However, the well-above average wet seasons in the last two years has allowed good recruitment and establishment of perennial grasses into these previously bare patches. Frequency data of desirable perennial grasses now indicates that much of the patchiness has disappeared. Overall, the experiment is demonstrating that the palatable tussock perennial grasses are the best indicators of degradation but soil condition is the best indicator of restoration of ecosystem processes.

(iv) Land condition and economics

If producers are to adopt grazing management recommendations to help sustain the native pasture resource it is important we assess the consequences of such recommendations for enterprise economics.

We have assessed the economic implications of managing land in various land condition classes by linking the forage production model GRASP to a spreadsheet model of farm economics. In GRASP we used 100 years of historical climate data for Charters Towers to predict annual variation in pasture and animal production for land in various condition classes. This production data was used to drive branding and mortality rates and sales in the herd dynamics/economics spreadsheet. The output from this economic spreadsheet is gross margin per head and per hectare, farm cash flow and return on capital.

In the first series of simulations we assumed that land condition remained constant for the 100 years in each of three land condition states: State I - dominated by palatable perennial grasses; State II - less palatable perennial grasses, annual grasses and forbs dominate; and State III – dominated by annual grasses and forbs. In the model herd we tried to maintain around 4400 head, if branding percentages and mortality rates permitted. The output for these first series of simulations is shown in Table 3.

While State I is considerably more productive than State II in terms of pasture growth, there is little difference between the two States in cash flow. This is because the greater proportion of annual grasses and forbs in State II affords a higher diet quality and when seasons are good and forage is not limiting, animal production and cash flow is greater. However, in poorer seasons forage quantity can be more limiting in State II and economic performance suffers. This results in a higher percentage of years in State II when cash flow is negative. But the main disadvantage of State II condition land is that with further inappropriate management it can shift to State III, which is highly unproductive and uneconomic.

Table 3. Land condition and farm economic performance

	State I	State II	State III
Herd no. (AE)	4429	4425	3137
Pre-tax cash flow ($)	$121,557	$125, 587	$-227,605
% years –ve cash flow	23	33	72
Soil loss (kg/ha)	1024	2228	4341

In the second series of simulations we assumed that land condition is dynamic and responds either positively or negatively to the feedback effects of grazing. Three stocking rates were imposed (low - 0.10, moderate – 0.15, and high – 0.2 AE/ha) and in each of the simulations land condition was initially State I, as described previously.

To assess how planning horizons affect the perceived value of these different stocking strategies we imposed two time scales (5 years and 25 years). In the 5 year planning horizon, land condition was reset to State I every 5 years during the 100 year simulation ie. grazing decisions discounted the future possibility of irreversible degradation. In the 25 year simulations, land condition was reset to State I every 25 years. During this 25 year period the feedback effects of grazing could result in a decline in land condition ie. no discounting of the future. The 25 year period was chosen on the basis that this reflects a "management generation".

Table 4 shows the results for these scenarios. With a short-term planning horizon of 5 years, the high stocking rate strategy is clearly the most profitable. Because 5 years is not long enough for the feedback effects of grazing to degrade the system, exploitation of the pasture resource is clearly the most economic approach to grazing management, particularly if there is a sizeable debt to service (80% equity) and/or if beef prices are very low. However, with the 25 year view is taken, a moderate stocking rate is more profitable because at high stocking rates there is time for excessive grazing pressure to degrade the pasture and soil resource which ultimately impacts negatively on animal production and cash flow.

Table 4. Planning horizons and economics of different stocking strategies.

	5 year planning horizon			25 year planning horizon		
Stocking Rate	Low	Moderate	High	Low	Moderate	High
Herd no. (AE)	2946	4429	5922	2948	4432	6145
Cash flow ($)						
100% equity	$52,273	$121,557	$162,262	$37,459	$103,143	$-126,437
80% equity	$-34,913	$20,015	$47,039	$-49,332	$2298	$-235,754
Soil loss (kg/ha)	842	1024	1278	760	923	2504

Communication activities

(a) Communication plan evaluation

As part of an evaluation of the project communication plan, a baseline study of producer groups to document current grazing management practices and sources of information on grazing management has been completed by Dr Alison Cottrell, Tropical Environmental Studies and Geography Department at James Cook University. These focus groups will be reassessed at the end of the project to determine what impact the grazing research has had on producer awareness, attitudinal changes and adoption of grazing management principles flowing from the research.

The baseline evaluation is summarised below. A full baseline establishment report has been written and will be sent to the producer groups involved.

(i) Background

This evaluation determines the impact of the communication plan of this project through qualitative assessments of the extent of land managers demand for information, their knowledge about the material presented by the communication plan and their reported changes in behaviour.

(ii) Aims of the Evaluation of the Communication Plan

- To identify the most favoured sources and formats for communicating with land managers.
- To assess changes in demand for information on the grazing management strategies identified in the communication plan.
- To detect change in land managers' behaviour as a result of information provided by the research projects NAP3.205&NAP3.206.
- To distinguish the changes in land managers' behaviour that can be attributed to the two projects as opposed to other sources of information.

(iii) Evaluation Methods

Both base-line (late 1998-early 1999) and follow up evaluation (late 2000 – early 2001) of the project are best conducted in focus groups. Focus groups are favoured in this type of circumstance because they are more efficient for data collection because they take advantage of a situation where land managers are together at the one location. For land managers, the three local best practice groups are the most appropriate starting point.

(iv) Baseline Outcomes

Focus group sessions were conducted with three land manager groups: Three Rivers, 70 Mile Range, and Birdbush-Basalt Groups.

- The most favoured sources and formats for communicating with land managers have been identified.
- The baseline for information sought by land managers about grazing management strategies has been identified.
- The baseline to detect change in land managers' behaviour as a result of information provided by the research projects NAP3.205&NAP3.206 has been established.
- The baseline too distinguish the changes in land managers' behaviour that can be attributed to the two projects as opposed to other sources of information has been established.

At this stage of the evaluation it can be said that few land managers have a clear perception or acceptance that grazing levels can impact adversely on land condition. There is a tendency to assess land condition through the condition of their animals. There is also a tendency to suggest that there is not the economic flexibility in the enterprise to adopt more sustainable practices which are seen to be more costly.

Specifically, few land managers are able to identify plant species which might help them assess land condition in a more appropriate manner.

(b) Project brochure

A four-page colour brochure was produced in late 1999 and has been widely distributed through the region. There has been considerable follow-up interest and feedback from the brochure, which has highlighted the need for a full write-up of the project, its results and its recommendations in a form suitable for producers.

(c) Visitors to the research sites

There have been a wide range of visitors to the research sites, including various producers and producer groups, the CRC for Tropical Savannas Board and Consultative Committee, and about 180 delegates from the International Rangeland Congress.

(d) Publications

Ash, A.J., Corfield, J.P. and Brown, J.R. (1999) Patterns and processes in loss and recovery of perennial grasses in grazed woodlands of semi-arid tropical Australia. In: People and Rangelands Building the Future – Proceedings of the VI International Rangeland Congress, Eds. D. Eldridge and D. Freudenberger, pp. 229-230. Organising Committee of the VI International Rangeland Congress, Townsville, Australia.

Northup, B.K. and Brown, J.R. (1999) Spatial distribution of soil carbon in grazed woodlands of dry tropical Australia: tussock and inter-tussock scales. In: People and Rangelands Building the Future – Proceedings of the VI International Rangeland Congress, Eds. D. Eldridge and D. Freudenberger, pp. 120-121. Organising Committee of the VI International Rangeland Congress, Townsville, Australia.

Northup, B.K. and Brown, J.R. (1999) Spatial distribution of soil carbon in grazed woodlands of dry tropical Australia: meso-patch to community scales. In: People and Rangelands Building the Future – Proceedings of the VI International Rangeland Congress, Eds. D. Eldridge and D. Freudenberger, pp. 121-122. Organising Committee of the VI International Rangeland Congress, Townsville, Australia.

Managing Woodlands: Developing sustainable beef production systems for northern Australia (ECOGRAZE project)

MLA Project: NAP3.205 **Project Duration:** 1/7/96–30/6/2001 **Report Date:** 11/10/00

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Project Objectives:

1. Develop management guidelines on the use of stocking rate, fire and strategic spelling to encourage deteriorated native pasture back to a more desirable state and to prevent decline of pastures presently in good condition.
2. Develop a predictive understanding of the effect of trees on pasture production to aid management decisions on the extent of tree clearing, the optimal frequency of regrowth control and the use of fire to manage woody species.
3. Assess the economic benefits and costs of various grazing management strategies.

Project Summary:

Sampling was completed at the Hillgrove/Eumara and Cardigan sites in August 2000 and these sites are now being decommissioned. These two experimental sites have been in operation since 1982 and used for the current MLA project since 1992. The Allan Hills and Lakeview sites will stay in operation until the end of the project in June 2001. The closure of two of the sites has freed up technical resources so that the huge task of data analysis and interpretation can be given proper attention.

Paddocks which were in a deteriorated condition (State II) at the start of the project and subjected to either continuous grazing at conservative levels or heavier grazing with a wet season spelling regime have now fully recovered their desirable perennial grass populations and their patch structure. Biomass of desirable perennial grasses in these grazing treatments declined over the last year and this probably reflects increased detachment and decomposition of standing dead material following two good wet seasons.

Lightly grazed paddocks which were in good condition at the commencement of the project (State I) continue to show an increased presence of exotic perennial grasses. It would appear that the drought from 1992-1997 was severe enough to create gaps large enough between native perennial grass tussocks for the exotics to establish and then increase in subsequent good seasons.

There were two field days during the last year, one at Virginia Park and one at Allan Hills/Lakeview at which the ECOGRAZE project's results and achievements were highlighted. Many of the results of ECOGRAZE project are now being incorporated into educational material (MLA Grazing Land Education project and the Savannas CRC Burdekin Management Study). There is also good anecdotal evidence that wet season spelling is being increasingly adopted as a means of improving pasture condition.

Results and achievements

(a) Background and methodology

In the first phase of this project (1992-1996) a number of field experiments and modelling studies were initiated to understand the management actions and environmental requirements necessary to manipulate vegetation, both native and sown pastures, in tropical tallgrass. The second phase of this project is concentrating on native pastures with experimental work proceeding to (a) develop management guidelines for manipulating pasture composition. This work is being carried out on three soil types of contrasting fertilities in north-east Queensland: Hillgrove/Eumara Springs - euchrozem; Cardigan - neutral red duplex; Allan Hills/Lakeview - yellow earth. On each land type, we are testing management options (stocking pressure, spelling, fire) on native pastures that were initially in either good condition (State I - pasture dominated by desirable perennial grasses) or fair condition (State II - pasture dominated by less palatable perennial grasses and with annual grasses and forbs much more prevalent).

Additionally, in this phase strong emphasis is being placed on examining economic implications of various grazing management strategies and improved adoption of research through linking management recommendations into a range of extension activities (property management planning modules, group activities such as LCD groups and landcare groups).

(b) Results

(i) Rainfall at the experimental sites

Rainfall in 1999/00 was well above average at all three sites and the best since the start of the study in 1993 (Table 1). Good distribution of rain meant that growing weeks were above average at all three sites.

Table 1. Wet season rainfall (mm) at the three experimental sites (October-May)

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	Long term ave.
Cardigan	187	320	327	306	441	538	703	818	538
Hillgrove	213	332	172	292	428	845	652	890	468
Allan Hills	225	433	267	220	514	645	519	864	519

(ii) Preventing loss of desirable perennial grasses from “State I” condition pastures

We have been reporting in past years that either low grazing pressures (25% utilisation) or a higher grazing pressure (50% utilisation) combined with wet season spelling is necessary to maintain the palatable perennial grasses in these pastures (Table 2). Certainly, desirable perennial grasses have not declined in these treatments over the experimental period. However, at both Cardigan and Hillgrove exotic perennial grasses have been invading these treatment paddocks in the last few above average wet seasons (Figure 1). It would appear that the drought from 1992-1997 was severe enough to create gaps large enough between native perennial grass tussocks for the exotics to establish and then increase in subsequent good seasons. At Hillgrove the exotic grass invading is buffel grass while at Cardigan Indian couch has been increasing rapidly. These grasses are both palatable and productive from a pastoral perspective and therefore likely to be of little concern to producers (indeed most producers would like more buffel grass) but such invasions do raise the issue of maintaining biodiversity in these systems.

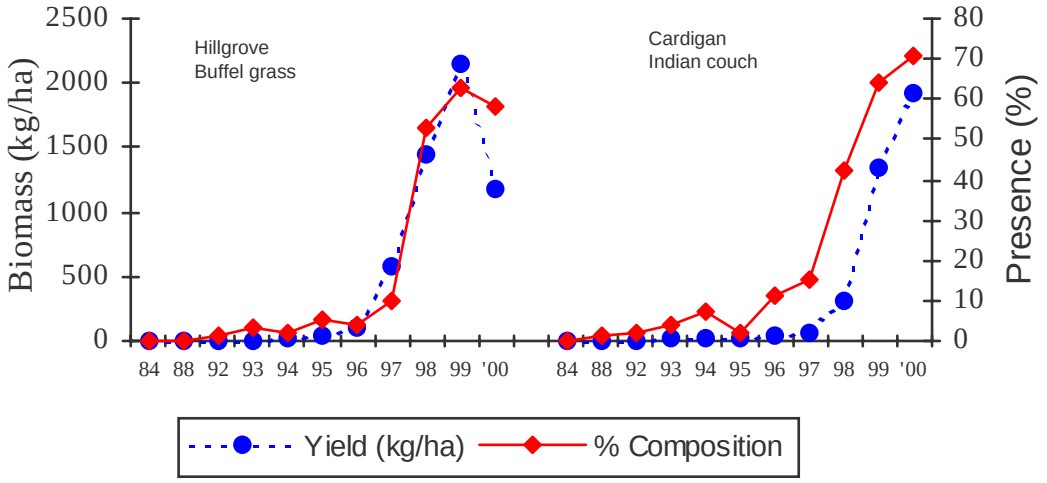

Figure 1. Increase in exotic perennial grasses in lightly grazed (25% utilisation) native pasture at the Hillgrove and Cardigan sites.

Table 2. Effect of different grazing treatments on standing crop (kg DM/ha) of decreaser perennial grasses (averaged across all three sites) and relative primary pasture production of heavily grazed (75%) vs lightly grazed (25%) pastures at the Cardigan site.

	1993	1994	1995	1996	1997	1998	1999	2000
State I – 25% utilisation	1729	786	881	928	1041	1841	2449	1749
State I – 50% utilisation + spelling	1684	864	970	1109	1098	1741	2558	1828
State I – 75% utilisation	1146	630	459	282	264	680	663	371
State II – 25% utilisation	137	268	252	398	707	1466	2710	1859
State II – 50% utilisation + spelling	190	301	334	538	723	1244	2384	1925
Relative primary pasture production (%) – 75% vs 25%	107	44	34	13	52	50	72	74

High utilisation rates (50% and especially 75%) have resulted in significant losses of desirable perennial grasses. The net primary productivity, as measured in exclosure cages which are moved each year, in the 75% utilisation paddocks continues to be about only 50% of that measured in conservatively grazed paddocks (Table 2). This clearly demonstrates the low efficiency with which rainfall is used to produce forage in degraded pastures.

(iii) Encouraging recovery of desirable perennial grasses in "State II" pastures

As mentioned in the report last year recovery of perennial grasses in pastures that have suffered losses through previous overgrazing has been achieved with the same grazing strategies that prevent loss of perennial grasses from State I ie. light stocking or more moderate stocking but with a wet season spelling regime (Table 2). This recovery has taken seven years, the first five of which were very dry. For the first time since the experiment commenced desirable native perennial grasses in these treatments did not increase in biomass over the last year which further indicates that the system has fully recovered. Indeed biomass declined significantly and this probably reflects increased detachment and decomposition of standing dead material following two good wet seasons.

(iv) Grazing management and carbon sequestration

Detailed sampling of soils beneath perennial grass tussocks and in intertussock spaces has shown that perennial grasses are strong controllers of soil organic carbon. Soil carbon levels are highest beneath tussocks and lowest in intertussock spaces (Figure 2). In addition, soil carbon is greater under tussocks in healthy pastures than under less vigorous tussocks typical of deteriorated pastures. Intertussock distances are much greater in deteriorated pastures which means that paddock soil carbon is much lower than in healthy pastures. There is currently considerable interest in carbon as a tradeable commodity and these results show that grazing management practices that are desirable in terms of pasture condition and resource management also contribute significantly to sequestering carbon.

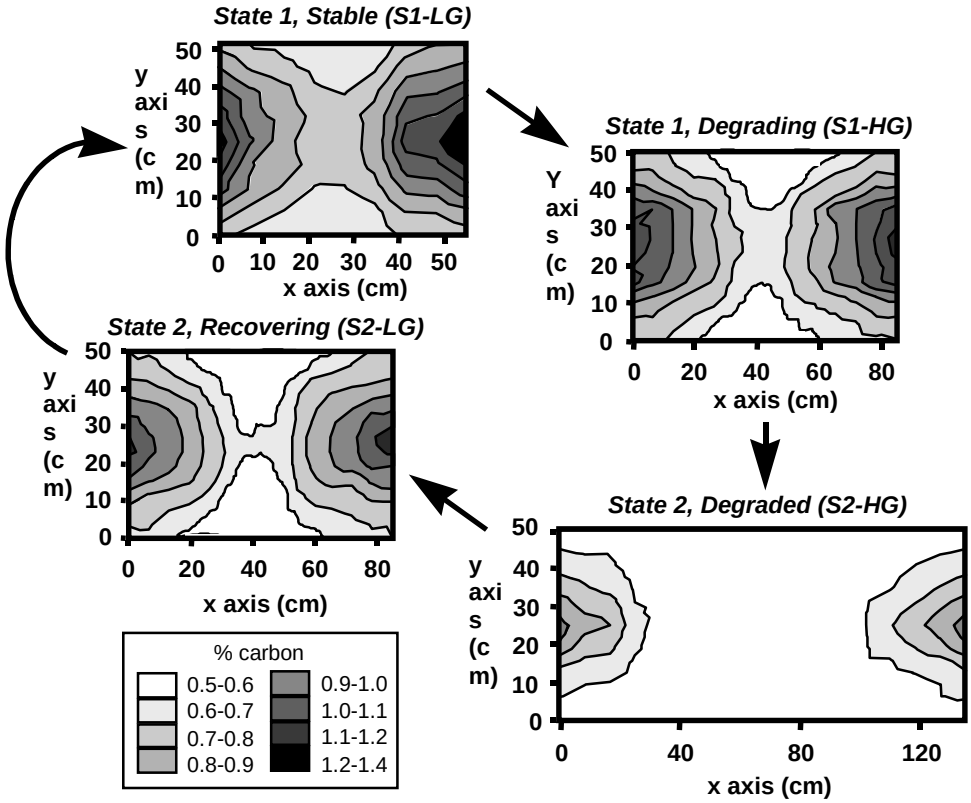

Figure 2. Changes in spatial distribution of soil carbon between neignbouring perennial grass tussocks in State I and State 2 condition land.

(v) Diet selection

We looked at species selection at the 3 locations (states 1 and 2) using a selection index based on relative defoliation of different plant species. Our results support the view that at conservative stocking, most increaser pasture species are avoided and many decreaser pasture species are preferred by free-ranging cattle. This was true especially for the Cardigan and Lakeview/Allan Hills sites. At Cardigan *Aristida calycina* was avoided and *Bothriochloa ewartiana* was preferred in both States 1 and 2. At Lakeview/Allan Hills, *Aristida calycina* and *A. jerechoensis* were also avoided. *Heteropogon contortus* and *Chrysopogon fallax* were the most preferred in states 1 and 2, respectively.

At Hillgrove, however, *Cenchrus ciliaris* and *Chrysopogon fallax* (considered by many as an intermediate species) were preferred in both States 1 and 2. All other species were less preferred, including *Bothriochloa ewartiana* and *Urochloa mosambicensis*.

(vi) Land condition and economics

If producers are to adopt grazing management recommendations to help sustain the native pasture resource it is important we assess the consequences of such recommendations for enterprise economics.

We have assessed the economic implications of managing land in various land condition classes by linking the forage production model GRASP to a spreadsheet model of farm economics. In GRASP we used 100 years of historical climate data for Charters Towers to predict annual variation in pasture and animal production for land in various condition classes. This production data was used to drive branding and mortality rates and sales in the herd dynamics/economics spreadsheet. The output from this economic spreadsheet is gross margin per head and per hectare, farm cash flow and return on capital.

Last year we presented results of the first set of economic simulations from this study. In the last year we have been further developing the economic spreadsheet model to interact more dynamically with changes in land condition due to grazing and climate. These developments are almost complete and we will be devoting effort during the remainder of the project to undertake a rigorous economic analysis.

Communication and adoption activities

(a) Incorporation of project findings into education and extension materials

Results from the ECOGRAZE project are now being incorporated into a range of educational and extension material. Key findings are contributing to learning outcomes in the new MLA funded Grazing Land Education project. Also, the Savannas CRC , as part of the Burdekin Management Study, are producing a book titled, “The Grazing Lands of the Upper Burdekin River Catchment: Ecological Functioning and Sustainable Management”, and ECOGRAZE results and conclusions are forming key components of chapters on sustainable grazing management of the Upper Burdekin grazing lands. The first draft of this book has been completed and it should be finalised in the next six months.

(b) Field days/Presentations

Two field days were held during the year, one at Virginia Park and one at Allan Hills and Lakeview. There was a very good attendance at the Virginia Park field day and a number of media articles and interviews resulted from this field day. A seminar on the ECOGRAZE experiment was presented at Trangie Research Centre and a visit to an SGS site associated with this seminar provided an opportunity to discuss the different approaches between southern Australia and northern Australia.

What is clear from talking to producers at these field days and at other meetings is that wet season spelling is increasingly being adopted as a grazing management practice to recover deteriorated pastures. Many producers are thinking about infrastructure developments required (fencing, waters) to further sub-divide paddocks to more effectively implement a wet season spelling program.

(c) Publications

Bastin, G., Ash, A., Corfield, J. and Abbott, B. (1999). Monitoring tropical tallgrass rangelands with aerial videography. In: People and Rangelands Building the Future – Proceedings of the VI International Rangeland Congress, Eds. D. Eldridge and D. Freudenberger, pp. 473-474. Organising Committee of the VI International Rangeland Congress, Townsville, Australia.

Northup, B.K., Brown, J.R. and Holt, J.A. (1999) Grazing impacts on the spatial distribution of soil microbial biomass around tussock grasses in a tropical grassland. *Applied Soil Ecology* **13**: 259-270.

Appendix D – Conference and scientific papers written during the course of the study. Further peer reviewed journal papers will be written over the next year.

Appendix E – Results of producers survey conducted in 1998

MANAGING WOODLANDS: DEVELOPING SUSTAINABLE BEEF PRODUCTION SYSTEMS IN NORTHERN AUSTRALIA

COMMUNICATION PLAN EVALUATION

Baseline Establishment

Dr Alison Cottrell
Tropical Environment Studies & Geography
James Cook University

MANAGING WOODLANDS: DEVELOPING SUSTAINABLE BEEF PRODUCTION SYSTEMS IN NORTHERN AUSTRALIA

COMMUNICATION PLAN EVALUATION

Baseline establishment

MRC PROJECT NAP3.205 and NAP3.206

Introduction

This evaluation is conducted in the context of a broader social environment which is requiring scientists, particularly agricultural and ecological scientists, to communicate the results of their research to a wider audience (Robertson and Pratley, 1998). However, we need to be mindful that communicating about research may not directly result in achieving behavioural change on the part of land managers because that behavioural change requires changes in culture, attitudes and behaviour, that may not occur over short periods of time (Robertson and Pratley, 1998). As well, favourable economic and legislative conditions may also be required to achieve behavioural change (Campbell, 1994; Lawrence, 1987). Consequently, this evaluation assumes that the impact of the communication plan of this project is best met through qualitative assessments of the extent of land managers demand for information, their knowledge about the material presented by the communication plan and their reported changes in behaviour.

Communication Plan Objectives

a) To stimulate demand for information on grazing management
b) Supply the principles and practices on which to base grazing management plans
c) Foster adoption of sustainable management practices

Aims of the Evaluation of the Communication Plan

- To identify the most favoured sources and formats for communicating with land managers.
- To assess changes in demand for information on the grazing management strategies identified in the communication plan.
- To detect change in land managers' behaviour as a result of information provided by the research projects NAP3.205&NAP3.206.
- To distinguish the changes in land managers' behaviour that can be attributed to the project as opposed to other sources of information.

Evaluation Methods

Objectives to be measured and the means of measuring were defined from consultations with project participants and the external evaluator. The design of the evaluation necessitates external involvement and it is preferable that the evaluations be conducted by personnel other than those running the project.

Physical evidence of receipt and implementation of the message could be gained from property observations. However previous research (Hinton, 1995) indicates that co-operation by land managers in providing economic data would be unlikely.

Changes in land management practice as a consequence of this particular project may be hard to detect because:

a) adoption of information may be a slow process; and
b) similar information is coming from different places.

Because of these problems, quantitative measures are not appropriately applied. Therefore, qualitative measures are required (Patton, 1987). The primary methods for obtaining pertinent qualitative data for the purposes of evaluation are face to face interviews, written semi-structured surveys, or focus groups. Focus groups are favoured in this type of circumstance because they are more efficient for data collection because they take advantage of a situation where land managers are together at the one location. Focus groups are also efficient for providing more detailed (ie "richer") data (Denzin & Lincoln, 1994; Krueger, 1994), particularly in the early phases of a project. Focus groups are becoming widely accepted as a means of obtaining specific types of information (Katcher, 1997; Hughes and DuMont, 1993; Morgan, 1996; Quible, 1998 and in a cost effective and flexible manner (Stewart and Shamdasani, 1990). The particular advantage of focus groups is that they provide insight into complex behaviours and motivations in a manner that is not evident from personal interviews. It is in this situation that the interaction of participants through queries and explanations of each other where focus groups are particularly productive (Morgan and Krueger, 1993). However, as Morgan (1996) suggests, it is necessary to structure discussions in focus groups to avoid their main pitfall of participants digressing from the issues of interest.

Both base-line (late 1998-early 1999) and follow up evaluation (late 2000 – early 2001) of the project are best conducted in focus groups. For land managers, the local landcare/catchment groups are the most appropriate starting point. During the planning phase for this evaluation three phases were considered that would occur every two years (1997, 1999, and 2001). However, the realities of time constraints placed on land managers and access to 'best practice groups' resulted in an evaluation based on a baseline and one follow up activity.

Baseline Focus Group Activity

Focus group sessions were conducted with three land manager groups: Three Rivers, 70 Mile Range, and Birdwood - Basalt Groups. These sessions took place when time was made available during landcare/catchment meetings. The moderator was a social scientist external to the projects being evaluated and there were two to three recorders at each session. At the end of each session participants were invited to request information from the chief researcher of the project. Subsequent to the meeting, notes from all people recording information were compared to ensure complete coverage of responses. The guide to questions for each of the sessions can be found in Appendix I.

The Three Rivers group was the first to be consulted. This group consisted of 11 participants. There were few spouses/partners at this group. Being the first group the session took nearly two hours to complete. It is quite common that the first of a series of focus groups sessions is longer because the moderator/s become familiarised with the responses to the issues. There was also a tendency for the group to return to the issue of economic constraints to agricultural production. The group response to the evaluation activity was quite positive.

The second focus session was with the 70 Mile Range group. Fifteen participants attended this session. There were several spouses and children at this session, with spouses actively participating. This was a highly interactive group and the session flowed quite well. A number of key insights about how land managers assess land condition became quite clear in this session. It lasted for approximately 1½ hours.

The last group was the Birdwood - Basalt group. This group was problematic in that there were only five participants. There was a field day on in the town that day to which some of them had already been and where other anticipated participants had obviously stayed. Despite this problem, some useful insights did arise.

Results

In presenting the results of this baseline study, the structure of the focus group sessions provides the structure for the discussion.

Information

From the first group it was found that obtaining information on both native pastures management and woody weeds could be considered as one issue. The most important consideration is that there is a

perception that information being received is conflicting. The perception of conflicting information coming from the scientific experts seems to relate to changes over time in the recommendations being made. In particular, changes in attitude towards recommended pasture species. Some species recommended in the past have not been successful in some areas, or have led to 'weed' problems in themselves. The overall perception is that the information is primarily verbal. The implications of this are to question the reliability of memories for the information transmitted. It also highlights the necessity of intermediate information providers having the information readily available.

Two issues relating to the reliability of information were raised. Being able to understand the information presented, particularly written information and the time available for people to read is limited. Long working days do not make it easy to sit down to read at night. It is also important to remember that land managers are still the lowest educated managers in Australia (SCARM, 1998).

Information Sources

Information comes from Queensland Department of Primary Industries, Department of Natural Resources, Charters Towers Weeds Research Centre, CSIRO EcoGraze plots: by one to one contact either in person but mostly a phonecall request on the part of the landholder. Media included the ABC, North Queensland Register, and Queensland Country Life. Other sources of information were group meetings, Landcare meetings, field days, bumping into a neighbour while out, neighbours, previous owners, other family members, and stock (animal) responses. Pamphlets from chemical companies and produce agencies also seemed to figure highly. Local experts also figured. If there was a particular problem to be addressed then they would consult the local expert, that is, the landholder who was considered to have had the most success in dealing with the problem. A few people mentioned the internet. There seems to be considerable faith in landholders' expertise, but there is some scepticism of scientific expertise which seems to relate to the issues discussed above. 'Trial and error', that is their own experimentation, was mentioned by a few people as their way of obtaining information. In general, *the best way to get information* to them was considered to be through Landcare groups, pamphlets, and personal contact.

Information required about managing native pastures included: **t**he viability of their use and management under situations of fluctuating economic/market circumstances; dealing with fluctuating climatic circumstances; how to use fire more effectively, and the interactions of fire and grazing. In the main, costs determined the extent of management. The question 'How extensive is the information?' tended to be read as 'how difficult to understand is the information' and is covered above.

Information required about Woody Weeds included: the detailed use of fire, use of chemicals, especially the appropriateness of a particular chemical for a particular situation, and the interaction between chemicals and biological control. They felt that most of the information about chemical control was already out there.

"In agencies it is not always easy to know who to contact to get information other than the old hands who you know."
"Agency staff aren't forthcoming with a lot of information – you have to drag it out of them."
"I tend to seek out practical people rather than those more qualified."
"Information is often too general or where it is specific it is for another area or slightly different situation."
"Even good information can't always be adopted because of a number of constraints or the financial position at the time."

Current Land Management Strategies and how they have changed over the last decade

Grazing management
In terms of carrying capacity, there is a tendency to carry an 'ideal' number in their heads, usually based on previous experience or the experience of previous owners. Personal experience, rainfall conditions, and finance influence the choice of numbers. Paddock spelling is more commonly used as a management strategy in recent times. Especially on larger properties, it was a natural consequence of the size of properties. There was a general feeling in the group that today they are more conscious of the need to spell paddocks. For some the last five years of drought has led to an increased awareness.

Dry season management strategies include early weaning, feeding, supplemetation, agistment, sale, and the use of riparian zones. *Extended drought strategies* include **always keeping stock**, especially breeding stock. Some suggested there was a greater likelihood of selling stock earlier, rather than holding out in the hope that the situation would improve. Agistment was seen by some to be less likely because of problems with being able to check on animals and the possibility that other cattle might be agisted as well. Supplementary feeding would depend on finances, Some suggested the use of Brahmns in the Three Rivers area. However, some mentioned a return to pre 1983 stocking levels if seasons allowed it.

Since the early 1980s changes include numbers of stock having been reduced by half and early weaning as a common practice. Paddock spelling varied between 5 and 30 years as a practice, but then we found that this was a strategy mainly used in the last 5 years. Supplementary feeding is used for the circumstances of a dry season that follows a poor wet season. *Drought stocking and grazing management strategies* are possible through drought relief subsidy, low interest loans, and rebates to allow stock to remain on the property. There was a suggestion of recognition that they push it to the limit. Changes in practices were triggered by the seasonal and economic circumstances.

All had received help from the QDPI. They used information from QDPI and their own trials to evaluate early weaning practices. Research does appear to be being used, people take what they want out of it and use it in terms of their economic circumstances.

Fire
Fire was quite commonly used prior to the current drought phase - up to 1992. Most indicated they wouldn't return to using fire as a normal practice. Some suggested that it depended on the type of country. Fire was considered useful for control of woody weeds. Reasons for not using fire included the sensitivity of introduced species such as seca stylo, loss of the forage resource and fencing improvements.

Woody weeds
Woody weed problems included rubber vine, parthenium, chinee apple, calotrope, bitter bark, and parkinsonia.

Strategies to control woody weeds included use of fire, chemicals, biological and mechanical methods. Strategies change regularly because there are better methods and more economical methods developing all the time. In particular, the newer poisons were reported to be more effective. Twenty years ago, some places didn't treat woody weeds. There appeared to be little acceptance of the view that increases in incidence of woody weeds might be related to land management strategies. The perception was that they came from somewhere else – down the river, in hay, with cattle brought in, with movement of birds and pigs, and infrastructure development such as telecommunications and roads.

"Now wary of over stocking because of recurrent droughts"
"People now look for good species in their pasture."
"Allow stocking rates to increase naturally in good seasons rather than buying in."
"Weather information is much better today and is used to make decisions."
"Stocking rates are much lower than in the 1970s and 1980s."

Land condition

Generally, good land condition was considered to be indicated by:

- lots of grass,
- buffel and introduced species in particular,
- native grasses on black soil, black speargrass and bluegrass.
- and a recognition that there is no erosion on well covered soils.

For some, land condition was considered to be very important to the enterprise, 'the heart of the property'. Land in good condition leads to fat cattle. Standards and expectations in terms of land condition have changed, now there is a tendency to look 20-30 years ahead. If you flog the land, your business suffers in the end. Economic circumstances, education, increased awareness, development of smaller properties were all seen to have contributed to changes.

Pasture monitoring workshops held by MLA and QDPI have contributed to changes and the development of grasscheck sites and pasture monitoring. The claim was made that most properties are now monitoring pastures.

"Spelling can be useful but is of little value in improving pasture condition if rain doesn't fall."
"It all depends on the season."
"It's all up to the guy upstairs who controls the weather."
"Good land condition is hard to define – as long as it's not washing down the creek."
"Depends on whether you are judging for cattle or the land. Good cattle condition, often bad land condition and vice versa."
"Good land condition indicated by buffel grass, desert blue grass, mixture of grasses and legumes."

The impression is that native pastures are viewed rather negatively and that if technically possible and economic, most managers would replace native pastures with improved exotic species such as buffel grass. There appear to be only a few land managers in each group who already accept the view that grazing management is of key importance to land condition and long term viability of the enterprise. Most land managers appear to be working through the ideas of grazing management but still do not seem to have grasped the concepts of key interest to this sustainable grazing project. There are a couple in each group for whom there appeared to be some resistance to the ideas, to the point where at some points in discussion they appeared to be attempting to be provocative.

Summary of Baseline Assessment

The summary of baseline assessment is best addressed in terms of the objectives of the evaluation. It is the first two aims that can be specifically addressed at this baseline stage.

The most favoured sources and formats for communicating with land managers have been identified as quite wide-ranging, but in terms of this sustainable grazing project, pamphlets and web pages would seem to be important starting points.

The demands for information on grazing management strategies have been identified by land managers as being related to detailed use of fire and chemicals for control of woody weeds, viability of pasture management strategies under fluctuating economic and climate conditions. From the responses to the question of what is indicative of good land condition it is evident that in the main, land managers still view the landscape through the condition and productivity of their animals, rather than 'reading the landscape'.

Issues for consideration in the second phase of the evaluation

There are a number of tasks required by the second phase of the evaluation to meet the aims of the evaluation.

It will be necessary to confirm the favoured sources and formats of information as identified at the baseline stage. In particular it will be pertinent to establish whether there has been any increase in

internet based information use. In addition, it will be necessary to identify the specific communication strategies employed by the NAP3.205 and NAP3.206 Projects to ascertain whether these have been used.
It will also be necessary to assess what types and level of sophistication of information are being sought to determine any changes that may relate to objectives of the overall Project.

To detect change in land managers' behaviour as a result of information provided by the NAP3.205 Project, it will be necessary to identify the key messages of the project and determine to what extent the various groups are able to re-communicate those messages. In particular, are they able to accurately represent the important components of the messages, are these components narrowly or widely understood within the group, and how extensive is the reported use of the strategies.

To distinguish the changes in land managers' behaviour that can be attributed to the two projects as opposed to other sources of information would most easily be determined by comparing information from the three groups contacted directly by the project with other groups not targeted by the project. As well, it would be appropriate to assess directly the level of exposure to specific items of information provided by the Project.

In essence, the follow-up phase of the evaluation will need to reassess all the information collected in the first phase as well as focusing on key messages identified in the communication strategy.

An example of how this might proceed can be taken from the glossy pamphlet *the EcoGraze project.*

- Identify the extent of exposure to the pamphlet and the research sites
- Identify the extent to which the key messages of the pamphlet are able to be re-commuicated by the groups – poor condition leads to low water retention, lower productivity and erosion; good coverage of 3P grasses is an indicator of good condition; 25-30% utilisation rates are optimal
- Identify level of acceptance of the message – do the groups report it as changing behaviour

Focus group sessions remain the most efficient and non-threatening way of collecting the information for the follow-up phase.

Conclusion

At this stage of the evaluation it can be said that few land managers have a clear perception or acceptance that grazing levels can impact adversely on land condition. There is a tendency to assess land condition through the condition of their animals. There is also a tendency to suggest that there is not the economic flexibility in the enterprise to adopt more sustainable practices which are seen to be more costly. Specifically, few land managers are able to identify plant species which might help them assess land condition in a more appropriate manner.

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Attachments

Appendix I: Focus group discussion guide.

Appendix I

COMMUNICATION PLAN EVALUATION
BASELINE

Focus Group
Discussion Guide

THANKS FOR LETTING US BREAK INTO YOUR MEETING. WE REALLY APPRECIATE BEING ABLE TO BE HERE.

INTRODUCTIONS. – MODERATOR AND OTHERS.

FROM THIS SESSION WE HOPE TO BE ABLE TO FIND OUT WAYS WE CAN IMPROVE ON OUR WORK ACTIVITIES AND AT THE SAME TIME PERHAPS BE OF HELP TO YOURSELVES.

THE TYPE OF WORK WE DO NEEDS TO TAKE INTO ACCOUNT TWO IMPORTANT ISSUES TO MAKE WHAT WE DO MORE RELEVANT AND THE INFORMATION WE PROVIDE MORE ACCESSIBLE.

THE FIRST THING WE NEED TO KNOW IS WHERE YOU GET YOUR INFORMATION.

THE SECOND THING WE NEED TO KNOW IS HOW LAND MANAGEMENT HAS CHANGED OVER THE LAST DECADE.

THEN WE WOULD LIKE TO FINISH THIS SESSION WITH YOU ASKING QUESTIONS OF US.

***ARE THERE ANY QUESTIONS BEFORE WE START*?**

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B DO NOT SUPPLY ANY RESPONSES TO QUESTIONS. ASK FOR INFORMATION, RECORD ANSWERS AND THEN PROBE.

- Okay then, let's start with where you get information (woody weeds & native pastures & land management).

What about information on management of grazing on native pastures and managing woody weeds.

Who provides the information? QDPI QDNR someone else?

Newspapers?

What form does it come in?

Is that by field day? Direct request? Meetings? Bumping into someone?

How extensive is the information?

Recipes? Pamphlets? Publications?

What would you like to know about managing native pastures?

Is there enough information available to you on either of these issues?

What problems so you have using the information
relevance, accessibility, ease of interpretation

What is the best way for you to get information?
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- Current Land Management Strategies and how they have changed over the last decade

Let's start with Grazing management

(a) **Is there an expectation that a paddock will carry a certain number of head in most years or do you have very flexible animal numbers from year to year?**

What influences the choice of numbers?

(b) **Is paddock spelling used as a grazing management tool**?

If so, to what extent?

(c) **Given that wet seasons often fail what preferred grazing management strategies do you practice to get through the dry season**?

market conditions ?

(d) **How do you cope with extended droughts in terms of your**
stocking strategies

grazing management strategies

(e) **Since the early 1980s has there been any change in the way that you deal with**

numbers

paddock spelling

grazing management in a dry season that follows a poor wet season

drought stocking and grazing management

(f) **What events triggered this change**?

(g) **How did you go about implementing this change and did you need any agency help?**

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ire

(a) **Is fire currently used as a grazing management tool?**

If so in what way?
If you don't use fire what are your reasons for not doing so?
What influences your decision to burn in any particular year?

(c) **Do you have any grazing management plan for paddocks after they are burnt?**

(d) **Since the early 1980s has there been any change in the way that you use or don't use fire?**

(e) **What events triggered this change?**

(f) **How did you go about implementing this change**

did you need any agency help? What kind?
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Woody weeds

(a) **What woody weeds are a problem on your property?**

(b) **Have you got a strategy to control woody weeds**?

If so, what is this strategy? (this may be different for different weeds)

(c) **Since the early 1980s has there been any change in the way that you manage your woody weed problem?**

(d) **What events triggered this change**?

(e) **How did you go about implementing this change and did you need any agency help?**

~~~~~~*L and condition*

(a) **What is your idea of good land condition in terms of the types of pasture species that might be around esp. grasses?**

(b) **What are the key things you look for to make an assessment about land condition?**

What kinds of grasses do you look for?

(c) **Do you alter grazing management strategies according to land condition** (not just amount of grass)?

(d) **How important is land condition to your enterprise**?

(e) **Has your view of what constitutes good or bad land condition changed in the last 10 years?**

(d) **What events triggered this change in view?**

(e) **If you have implemented a pasture monitoring scheme in the last 10 years how did you go about implementing this change**

(f) * **Does land condition have an impact on land value?**

THANK YOU FOR YOUR TIME AND YOUR COMMENTS THEY WILL BE VERY USEFUL TO US.
BEFORE WE FINISH, DO YOU HAVE ANY QUESTIONS YOU WOULD LIKE TO ASK?
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