

The North Australia Program

1997 Review of
Improving Resource
Management
Projects

Edited by Barry Walker
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NAP Occasional Publication No. 2



Meat
Research
Corporation

Index

	Page
Preface	1
Part I. The NORTH AUSTRALIA PROGRAM (NAP3)	3
1.1 Introduction	3
1.2 NAP3 objectives	3
1.3 NAP3 Sub-programs	4
1.4 Improving Resource Management (IRM)	4
1.4.1 Background	4
1.4.2 Review of NAP2 grazing management projects seeking progression to NAP3	5
1.4.3 NAP outputs	9
1.4.4 Future directions	10
1.4.5 References	10
Part 2. Review of Improving Resource Management projects	11
2.1 Workshop details	11
2.1.1 Introduction	11
2.1.2 Meeting details	11
2.1.3 Meeting format	11
2.2 Annual progress milestone reports for on-going projects	11
Effects of stocking rate, legume augmentation, supplements and fire on animal production and stability of native pastures – W.H. Burrows	13
Restoring the condition of degraded black speargrass pastures in the southern speargrass zone – C. Paton	19
Enhancing pasture stability and profitability for producers in the <i>Aristida/Bothriochloa</i> woodlands – R.G. Silcock	27
Managing woodlands: Developing sustainable beef production systems for northern Australia – J. Brown and A. Ash	35
Grazing systems and grazing management guides for Kimberley rangelands – P. Novelly	43
Woodland management and woody weed control for Queensland's beef pastures – W.H. Burrows	51
Managing tropical woodlands to control exotic woody weeds – J. Brown and A. Grice	57
Developing sustainable grazing management systems for the semi arid tropics of the Northern Territory – R. Dyer	63
Biodiversity workshops in northern Australia – J. Lambert	73
Soil acidification research in the semi arid tropics – A.D. Noble	81

Sustainable beef production on tropical tallgrass using the LBP approach – J. Kernot	85
BEEFPLAN – An ‘holistic’ approach to property management – S. Blakeley	91
Determining the productive capability of your land to develop sustainable management practices – S. Walsh, R. Landsberg and C. Rodgers	99
Overview of catchment management, water quality and nutrient flows – R. Hook	103
Part 3. Peer review workshop evaluation	109
Comments on the NAP3 IRM sub-program review – W. Mason	111
Comments on the NAP3 IRM sub-program review – S. McIntyre	117
Workshop evaluation	121
APPENDICES	127
I. NAP IRM Workshops and Conferences	129
II. Final Reports of NAP IRM Project reports since July 1991	131
III. Reports of producer case studies and LBP activities	133
IV. Publications related to NAP projects, activities and workshops	137
V. Meeting program for the annual review of NAP Improving Resource Management projects	151
VI. Guidelines for milestone reporting	154
VII. List of participants and their e-mail and fax numbers	155

Disclaimer

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PREFACE

The aim of the NAP Improving Resource Management sub program is to assist landholders to better manage their properties and especially the vegetation and soil resource, through the application of improved knowledge and understanding gained from research and development. The sub program emphasises practical outcomes and developing effective links between property managers, extension and research staff and agri-business.

Within the North Australia Program Phase 3 (1996-2001) the reporting and monitoring of projects has changed from each project having a number of detailed milestone reports, to a brief annual report and a peer review process. The review process is via a brief presentation of the objectives, methods, outcomes and communication activities of the projects and projected work for the year ahead, to an audience of fellow researchers/ investigators from other sub projects within the sub-program, plus a small number of interested producers and two external reviewers.

These annual workshops provide a valuable opportunity for researchers and sub program coordinators to review and revise both their individual projects and the sub program as a whole. They also provide an opportunity to further develop linkages between projects. This is a particularly valuable opportunity for the researchers, given that the sub-program is now supporting a significant suite of research projects which will make a major contribution to effective resource management in northern Australia.

The first Annual Project Review Meeting for projects in Sub program 2 (Improving Resource Management) was held at the Magnetic International Resort, Townsville in August 1997.

As background information for the workshop, **Part 1** of this report provides a description of the NAP Improving Resource Management sub program, as well as details of projects, publications and workshops conducted so far. **Part 2** provides details of the workshop and presents progress reports on on-going projects jointly funded by the Meat Research Corporation and Land and Water Resources Research and Development Corporation. **Part 3** contains an evaluation by participants of the workshop and reporting process, followed by comments from NAP Management.

Appendices I to IV provide details of past workshops, conferences, project final reports, and publications relating to NAP projects and activities. **Appendices V to VII** give details of the Peer Review meeting

The MRC's North Australia Program works in partnership with producers, state departments, CSIRO, universities, Cooperative Research Centres, agribusiness and other R&D corporations. NAP Management wishes to acknowledge their help and many contributions to the North Australia Program.

Barry Walker
NAP Program Coordinator

Part I. THE NORTH AUSTRALIA PROGRAM

1.1 Introduction

The MRC's coordinated investment in on-farm research, development and extension in northern Australia commenced in 1986 with the initiation of the first North Australia Program (NAP1). That five year program was followed by NAP2 (1991-1996).

The corporation's activities in this area have now evolved into its third phase, that is NAP3 (1996-2001). The focus of NAP3 is on the advancement and refinement of past achievements and their consolidation in an integrated management context. The program is also fully cognisant of the demands and direction that the expansion of the export of live feeder cattle to south east Asia is imposing on the northern beef industry.

NAP3 covers the beef producing areas of Queensland, the Northern Territory and the Kimberley and Pilbara regions of Western Australia, encompassing a broad diverse range of agro-ecological zones from the highly fertile fattening and grain producing brigalow country of Queensland to the arid desert regions of the Northern Territory and Western Australia.

Rainfall is also extremely variable but is predominantly summer, monsoon influenced with a pronounced, relatively short lived growing season and an extended dry season.

NAP3 is focused on the needs of beef producers in northern Australia. These 24,000 beef producers account for about half the Australian beef herd; 40% of national beef production and 60% of beef exports.

Of these northern producers, 15% of beef establishments carry about 70% of the cattle on about 85% of the beef lands. There is great variability across northern Australia in climate, infrastructure and markets. Although the largest 6% of beef properties demonstrate the most favourable profitability within the industry, there is a great variation in economic returns within the majority of holdings, irrespective of size.

The core issues which face the meat and livestock industry in northern Australia are continued deterioration in terms of trade, variable but generally low profitability, increased focus on the need for ecological sustainability and the capability and structures of the meat processing and marketing sectors.

The overall Goal of NAP3 is to enhance the productivity and sustainability, both ecological and economic, of the beef production sector in northern Australia and, by incorporating those enhancements in integrated property management, to improve its profitability and international competitiveness.

1.2 NAP3 objectives

Achievement of the overall program goal will be demonstrated by the following program objectives:

- a 1% per year increase in revenue and a 1% per year decrease in operational costs by June 2001, commencing no later than 1998/99, with changes in revenues and costs being on a per kilogram of beef produced basis, adjusted for global beef prices and domestic inflation respectively.
- at least a 50% increase in awareness by specialist beef producers of ecologically sustainable grazing principles, with at least half of such producers applying those principles by June 2001.

It is postulated that an increase in awareness of ecologically sustainable grazing principles will ensure that the pasture resource will be managed in an environmentally sustainable way and that market access for northern Australian beef products will not be denied on environmental grounds.

1.3 NAP3 Sub-programs

NAP3 is comprised of four interdependent sub-programs, each directed towards adding value to other sub-programs and all directed towards achieving the overall program goal of improving profitability, international competitiveness and ecological sustainability. The four sub-programs are -

<u>Sub-program 1</u>	Meeting market requirements
<u>Sub-program 2</u>	Improving resource management
<u>Sub Program 3</u>	Improving property management
<u>Sub program 4</u>	Improving program delivery

Details of all four sub programs are provided in the Meat Research Corporation's NAP3 Business Plan, published in October 1997. The following description applies only to the **Improving Resource Management** sub program.

1.4 Improving Resource Management (IRM)

1.4.1 Background

The objective of this sub-program is to improve the development and adoption of ecologically sustainable resource management systems and their profitable utilisation by the northern beef industry.

The strategies of this sub-program are underpinned by the need to make greater use of, and to further develop information and tools for resource management. The sub-program builds upon the work of NAP1 and NAP2 related to the development of sustainable pasture management practices, but also widens to include new work on catchment management, soil, water and nutrient issues, biodiversity, monitoring, whole property management and environmental assessment.

In NAP2 (1991-96) a production zone approach was used to categorise the R&D, whereas in NAP3 (1996-2001) a greater focus on ecological zones has been adopted. There are 24 pasture communities containing 151 pasture units across northern Australia. The condition of these pastures was assessed in 1991 and it was found that of the areas assessed 50% was well managed, 15% was degraded requiring major resources to reclaim them and 35% was in a deteriorated condition, which could be improved by low cost management techniques (Tothill and Gillies 1992). The R&D emphasis of NAP has been to work on these deteriorating pastures to develop management systems to maintain or improve them. It is clearly

impossible to work on all communities and pasture units. There was therefore a need to identify the most important communities and aggregate them into agro-ecological zones which have common soils, vegetation, climate and management systems. Eight major zones were identified viz - monsoon tallgrass, speargrass/ribbon grass, *Aristida/Bothriochloa* woodlands, brigalow/gidgee, bluegrass on clays, mitchell grass, spinifex and mulga pastures (Map 1). These zones cover 93% of the total area, 93% of the total domestic livestock, 96% of the area of sown pastures and 85% of the area under crops.

Because of the great heterogeneity across the area occupied by the northern beef industry, it is important that R&D focuses on specific regions or landscape components. Within these categories, research needs to address the impact of livestock production and of current practices on soils and nutrients, on water resources both above and below ground, and on flora and fauna. Research will be required to draw linkages between management requirements at the regional or catchment scale (for example, conservation of biodiversity), and the implementation of management at the property level. State and transitional models have been developed for these zones and all ecological projects have used these models as a basis for targeting research and delivering management guidelines to producers.

To provide coverage of these zones, ecological, grazing and woodland management studies have been located in an east/west transect (Kununurra WA, Victoria River District - NT and Charters Towers/Townsville/Mareeba - Old and north/south transect (north, central and southern Queensland). There are 15 major and over 50 minor research sites, with more planned (Map 2). NAP funding supports other projects in cattle management and nutrition, property management and efficiency, which provide strategies to reduce grazing pressure and resources to devote to resource management issues.

1.4.2 Reviews of NAP2 grazing management projects seeking progression to NAP3

A number of grazing management, woodland management and woody weed control and ecological projects were established early in NAP 2 (1991-96) to address some of the resource management issues. Most of them were planned to continue for up to 10 years. Two reviews of these projects were conducted in 1995 and 1996.

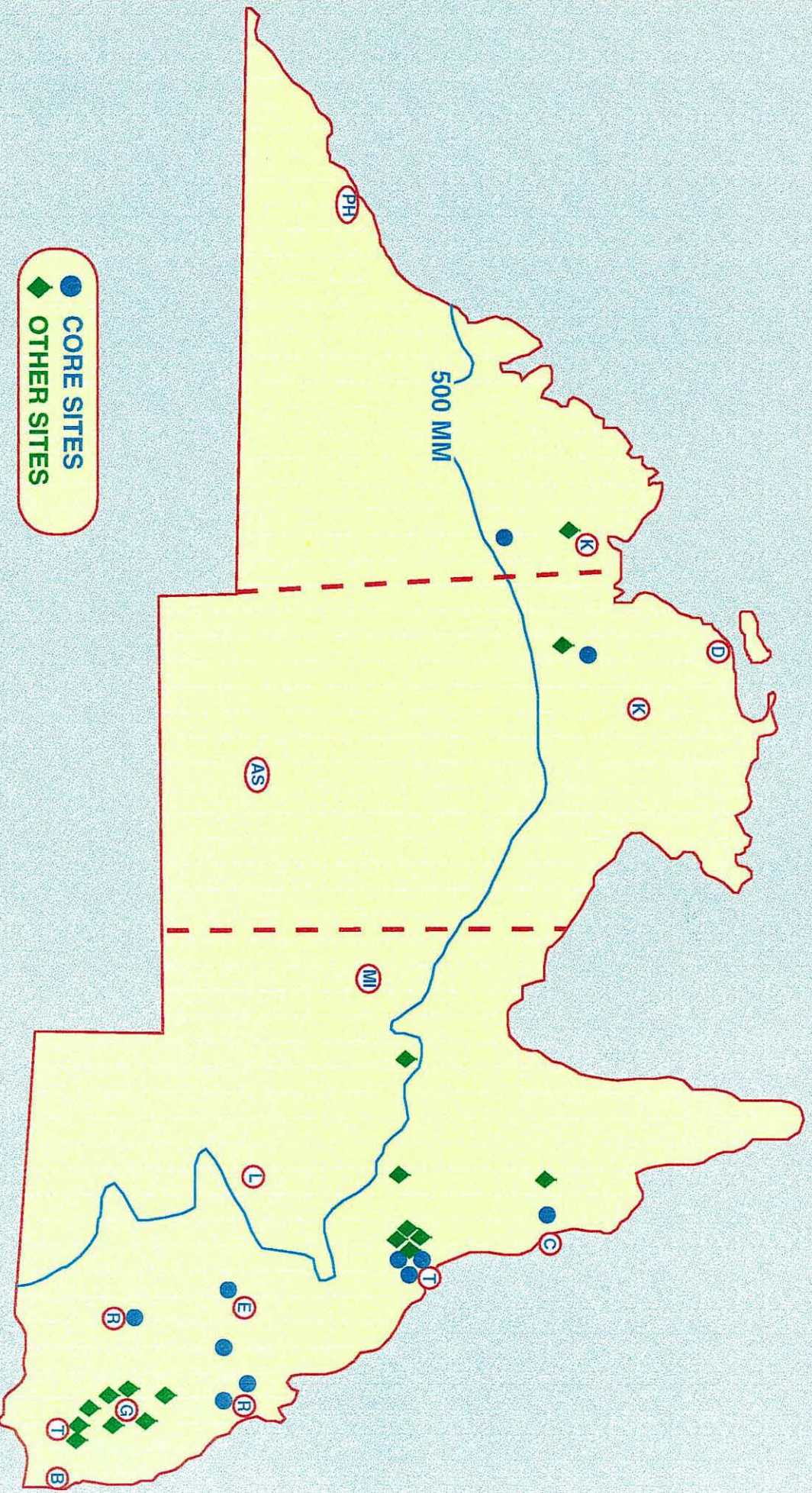
In late 1995 an external review of NAP2 projects for the MRC was carried out by a team of John Wrigley, Alec Holm and Bill Ryan. In May 1996, the NAP2 long term projects were further reviewed by a panel consisting of David Skerman (Program Manager, MRC), Dr Phil Price (Executive Director, LWRRDC), Dr Andrew McNee (ANCA), Dr Wal Whalley, University of New England, Armidale, Dr Allan Wilson, (Rangeland Research and Management Consultant), Tony Gleeson (Technical Coordinator, MRC) and Dr Barry Walker (Technical Coordinator, MRC).

The issues that these projects were set up to answer had initially been established in consultation with the beef industry and R&D organisations. The purpose of these reviews was to see what progress had been made and what changes were needed to make them more effective in delivering outputs and benefits for industry and the community at large. Continuation of 8 projects was supported in principle, providing the projects were revised to take on board the Review Panel's recommendations.

The review was comprehensive and thorough and proved to be very worthwhile. As a result, all projects were modified to accelerate the delivery of benefits to industry. Overall the scientific rigour and conduct of the research was very good. However, a number of important issues kept re-occurring in the discussions on individual projects. In looking forward to NAP3 some valuable lessons were learned. These have been summarised below.

1. Objectives were mostly couched in process/scientific terms and in some cases they were too optimistic. For NAP3, objectives will need to be rewritten to clearly focus on achieving industry outcomes and methodologies to do this will need to be outlined.
2. Adoption strategies were usually passive and directed towards achieving awareness, rather than being pro-active and trying to engender on-property outcomes.
3. Researchers did not have a whole property or systems concept or framework in which to "place" and integrate the technologies they are developing.
4. The need to scale up of results from small plot to paddock or property dimensions kept recurring. Yet those studies that were trying to do this came up for a lot of criticism, due to insufficient scientific rigour. The question of scaling up results will continue to be a key issue.
5. In the same vein, paddock and landscape variability/heterogeneity and the need for this to be taken into consideration was also considered to be important.
6. Site specificity; the need to be able to extrapolate results to wider areas; and variations in the major vegetation communities remain common problems. The GRASP model, when fully developed, and its use with the HerdEcon model could assist. Ways of handling the integration and use of data from NAP projects in a coordinated way will need to be developed more effectively in NAP3.
7. The lack of good economic analyses, particularly relating to trends and dynamic changes in vegetation, need to be addressed. The importance of the differences in time between economic and ecological thresholds is an important concept which needs to be understood and communicated more widely.
8. Good realistic economic information on whole property management and development is also needed, probably through the use of strategically located case studies.
9. Greater coordination and interaction between project teams is needed and in turn these teams need to develop closer linkages and become much more pro-active and interactive with producers.
10. The shortage of skilled rangeland scientists and managers, ecologists, biodiversity and hydrological scientists is a major constraint in the development of effective R&D on rangeland management and resource issues for northern Australia.

IMPROVING RESOURCE MANAGEMENT SITES



11. There was a general view that biodiversity issues should not be "forced" onto the present projects, just to give the projects wider dimensions. Rather, the main issues should be first identified and ways of tackling them resolved. This could then mean that some of the present projects could be expanded, but in most cases new studies would have to be initiated.

12. A number of potential ESD areas were identified that could be progressed as new work in NAP3. However, due to small plot sizes, most projects did not have the capacity to seriously address ESD issues. In some projects, where vegetation frequency and dynamics are presently being measured, the techniques being used are not appropriate for measuring biodiversity.

13. The importance of legume(stylo) dominance and native pasture instability was recognised repeatedly throughout this review.

1.4.3 NAP outputs

i. Workshops and conferences

The North Australian Program has facilitated and/or funded a number of workshops, conferences, coordination meetings, exchange visits, tours, etc and has generally assisted in creating a dynamic and rewarding relationship between producers, researchers and extension workers.

The NAP has supported the following workshops, which have covered a range of issues. Details of the proceedings from these workshops are given in Appendix I.

- Woody weed control (1988)
- Phosphorus and beef production in northern Australia (1988)
- Sown pastures for the seasonally dry tropics (1989)
- Sown pastures for the brigalow lands (1991)
- Tropical pasture establishment (1992)
- State and transition models for rangelands (1993)
- Parthenium weed workshop (1993)
- Beef production from ponded pastures (1993)
- Total Ranch Management (1994)
- Integrated management for sustainable forage-based livestock systems in the tropics (1995).
- Fire in the management of northern Australian pastoral lands. (1996).
- Measuring and monitoring vegetation on pasture lands in northern Australia for sustainable use (1996)
- Adoption of whole property sustainable grazing management systems (1996)
- Biodiversity workshops in northern Australia (1997)

The Meat Research Corporation has also provided funding support for the following national and international conferences.

- 17th International Grassland Congress Palmerston North, New Zealand and Rockhampton, Australia, February 1993.
- 5th Tropical Pasture Conference, Atherton, Queensland, June 1995.
- 8th Biennial Conference of the Australian Rangeland Society, Katherine, Northern Territory, July 1994.

- 9th Biennial Conference of the Australian Rangeland Society, Port Augusta, South Australia, September 1996.
- 10th Biennial Conference of the Australian Rangeland Society, Gatton College, Queensland, December 1997.

ii. Projects

Through its many projects and other activities a considerable amount of information has been collected, collated and synthesised into management packages by researchers, extension workers and producers, which have been adopted by some producers. Producers have also become increasingly involved in projects and have been responsible for contributing a lot of management information. Details of project reports and producer contributions are detailed in Appendices II and III.

iii. Publications

In the relatively short time that the IRM sub program has been under way (most projects commenced in 1991 or later) a great deal of information has been collated and published. These publications are listed in Appendices I to IV.

1.4.4 Future directions

Following program reviews and consultation with a wide range of stakeholders, the main resource management issues to be tackled in NAP3 are:

- continuation of some NAP2 projects on the long-term effects of different grazing pressures and management (eg. fire) on pasture composition and yield, tree/grass balance and weed management;
- nutrient movement and budgets, including the impact of introduced pasture legumes (stylos) on rates of soil acidification - this includes mapping vulnerable soil types and developing appropriate management responses;
- effects of grazing management on surface and sub-surface water movement, including changes in infiltration rate, cover and soil erosion, soil moisture levels and deep drainage;
- relationships between grazing, grazing management and maintaining key aspects of ecosystem function, including conservation of biodiversity;
- integration of sustainable management strategies into profitable whole property management systems;
- increasing involvement of producers in NAP's R&D activities.

Details of the ongoing projects which address these priorities are given in Part 2 of this report.

1.4.5 References

Meat Research Corporation (1997) North Australia Program 3 – Business Plan. October 1997. MRC, Sydney. 72 pages.

Tothill, J.C. and Gillies, C. (1992). The pasture lands of northern Australia – Their condition, productivity, and sustainability. Tropical Grasslands Society of Australia Occasional Publication No.5.

Part 2. 1997 PROJECT REVIEW WORKSHOP

2.1 Workshop details

2.1.1 Introduction

Within NAP3 the reporting and monitoring of projects has changed from each project having a number of detailed milestone reports, to an annual report and review process. The review process is by a presentation of the previous year's results and projected work for the year ahead to an audience of fellow researchers/ investigators from other projects within the sub-program, plus a small number of interested producers and two external reviewers, together with NAP3 management.

These annual workshops provide a valuable opportunity for researchers and sub program coordinators to review and revise both their individual projects and the sub program as a whole. They also provide an opportunity to further develop linkages between projects. This is a particularly valuable opportunity for the researchers, given that the sub-program is now supporting a significant suite of research projects, which will make a major contribution to effective resource management in northern Australia.

2.1.2 Meeting details

The first Annual Project Review Meeting for projects in Sub program 2 (Improving Resource Management) was held from 11th to 13th August 1997 on Magnetic Island, Townsville. In order to provide a forum for useful interaction and dialogue attendance was restricted to the following; project leaders and up to two other members of each project team, members of the NAP3 Management Committee (David Skerman, Phil Price, Annmarie Watt, Judy Lambert, Shane Blakeley and Barry Walker), two NAP Industry Committee members (Shane Walsh and Jocelyn Baker); and two external reviewers (Drs Sue McIntyre and Warren Mason). The names of participants and contact details are given in Appendix V.

2.1.3 Meeting format

Annual milestone progress reports were prepared according to a set of guidelines (Appendix VI) and distributed to participants by e-mail at least 2 weeks before the workshop. Project teams presented objectives, methods, outcomes and communication activities of their projects and projected work for the year ahead in 20 or 30 minutes, depending on the size of their projects. There was then a 10 or 15 minute period for questions and discussions. For this meeting, presentation was aimed at fellow researcher level. Project leaders arranged for a record of the main issues discussed following their presentation. The meeting program is outlined in Appendix V.

2.2 Annual progress milestone reports for on-going projects

These are presented in the following pages, together with summaries of the issues discussed. For the new areas of biodiversity, catchment management and whole property management, the reports have been updated to include new developments since the workshop. Details of reports on completed projects not reviewed at the workshop are given in Appendix II. Reports were presented for the following on-going projects, which have been listed below under the IRM strategies and activities outlined in the NAP3 Business Plan.

NAP3 Strategy 2.1 Developing sustainable grazing management systems

Activity 2.1.1 *Effects of grazing management and fire on sustainability and productivity of the pasture resource*

- i. Effects of stocking rate, legume augmentation, supplements and fire on animal production and stability of native pastures – W.H. Burrows
- ii. Restoring the condition of degraded black speargrass pastures in the southern speargrass zone – C. Paton
- iii. Enhancing pasture stability and profitability for producers in the *Aristida/Bothriochloa* woodlands – R.G. Silcock
- iv. Managing woodlands: Developing sustainable beef production systems for northern Australia – J. Brown and A. Ash
- v. Grazing systems and grazing management guides for Kimberley rangelands – P. Novelly

Activity 2.1.2 *Woodland management and woody weed control*

- vi. Woodland management and woody weed control for Queensland's beef pastures – W.H. Burrows
- vii. Managing tropical woodlands to control exotic woody weeds – J. Brown and A. Grice
- viii. Developing sustainable grazing management systems for the semi arid tropics of the Northern Territory – R. Dyer

Activity 2.1.3 *Management of biodiversity for sustainable feed production systems*

- ix. Biodiversity workshops in northern Australia – J. Lambert

Activity 2.1.4 *Stability and productivity of pastures oversown with tropical legumes*

- x. Soil acidification research in the semi arid tropics – A.D. Noble

Activity 2.1.5 *Development of whole property management systems*

- xi. Sustainable beef production on tropical tallgrass using the LBP approach – J. Kernot
- xii. BEEFPLAN – An 'holistic' approach to property management – S. Blakeley

NAP3 Strategy 2.2 Define and monitor soil, water and biological resources

Activity 2.2.1 *Monitoring resources*

- xiii. Determining the productive capability of your land to develop sustainable management practices – S. Walsh, R. Landsberg and C. Rodgers

Activity 2.2.2 *Catchment management, water quality and nutrient flows*

- xiv. Overview of catchment management, water quality and nutrient flows – R. Hook

Effects of stocking rate, legume augmentation, supplements and fire on animal production and stability of native pastures

MRC Project number: NAP3.207
Project duration: NAP1 & NAP2
NAP3 - 01/07/96 to 30/06/2001
Principal Investigator: Dr W.H. Burrows
QDPI, Tropical Beef Centre
PO Box 5545
Rockhampton Mail Centre, Q 4702
Ph: (07) 4923 8100 / Fax (07) 4923 8222
E-mail burrowb@prose.dpi.qld.gov.au
Co-Investigators: Dr D.M. Orr, R.E. Hendricksen, R.L. Clem,
K.A. Day and M.M. Sallaway

Objectives

- (i) Assess the productivity and stability of native pastures grazed at a range of stocking rates, with or without the addition of legumes and fire.
- (ii) Use the results recorded between 1988 and 1996 to demonstrate to producer groups that lenient grazing together with other pasture technologies can be both ecological and economically viable.
- (iii) Promote basic pasture science and monitoring techniques so that producers can better recognise ecological processes.
- (iv) Conduct comprehensive economic analyses of animal productivity from all pasture treatments including the application of the results to commercial case studies
- (v) Incorporate results from this study using GRASP to determine optimum stocking rate and economic performance for commercial beef enterprises in the black speargrass region.
- (vi) Promote the results from this study and encourage adoption of optimum stock management strategies as outlined in the draft communication strategy.

Summary

A core grazing study commenced in September 1988 at Galloway Plains, Calliope, to study the effects of management strategies on black speargrass pastures. The major thrust between 1996 and 2001 is to continue recording the effects of stocking rate, legume augmentation and pasture burning treatments on pasture and animal responses.

The lightest stocking rate treatment (0.125 beasts/ha) has been replaced with two new treatments: one treatment is stocked at 0.187 beasts/ha and burning imposed whenever conditions warrant and the second treatment is grazed at 0.5 beasts/ha without burning.

Design

Two replications of twelve treatments in a randomised block layout. Treatments are native pasture stocked at (1) 0.187, (2) 0.25, (3) 0.375 and (4) 0.5 beasts/ha with and without burning, native pasture oversown with legumes and grazed at 0.25, 0.375 and 0.5 beasts/ha and native pasture in good condition grazed at 0.5 b/ha.

Each treatment cell is grazed by five *B. indicus* cross steers which are replaced annually. Grazing pressure will be adjusted to accelerate stocking rate effects.

Methodology

- Pasture yield and botanical composition are measured every six months using the Botanal procedure (Tothill *et al.* 1992).
- The dynamics of *H. contortus* is monitored annually in permanent quadrats in native pasture, native pasture plus legume and native pasture plus supplements /burning treatments (Orr *et al.* 1997).
- The germinable soil seed bank of *H. contortus* is determined from soil cores collected annually in spring (Orr *et al.* 1996).
- Total pasture basal area is monitored every second year using a wheel point apparatus (Tidmarsh and Havenga 1955).
- "QGRAZE" pasture monitoring sites were established in all paddocks in 1992.
- Rainfall, runoff and soil loss are measured in plots established in the enclosure, 0.25 and 0.5 beasts/ha treatments.
- Rainfall, infiltration and runoff parameters are determined using a rotating disc rainfall simulator (Grierson and Dades 1977).
- Soil pore size distribution is measured using a disc permeameter (Perroux and White 1988).
- Animal production is measured as the growth of crossbred steers. Weight change is determined from unfasted weights recorded every six weeks.
- Estimates of the stocking rate effects within each forage source are made with steers fistulated at the oesophagus. Extrusa is described by a microscope point hit technique.
- Conduct economic analysis on the main treatment results.
- Conduct a series of regional workshops to update departmental officers and beef producers.
- Develop linkages with Property Management Planning personnel.
- Actively promote new findings through field days and Landcare groups etc.
- Publish papers describing plant and animal responses for the first eight years of the study.
- Test new technologies and processes in a whole property frame work using modelling techniques.

Results

This report summarises the results from the commencement of this study in 1988 until July 1997.

1. Design modification

- Changes to treatments proposed for July 1996 have been effected.

2. Animal production

- There is a significant effect of stocking rate on the performance of animals grazing native pasture (Mean 'a' values of 158 and 'b' values of - 99 for the eight drafts, where $y = a - bx$ and $y = \text{LWG kg/hd/yr}$, $x = \text{steers/ha}$).
- A large range in production per head has resulted from seasonal variation.
- Oversown legumes enhance livestock performance (Mean 'a' values of 215 and 'b' values of -161 for eight N.P. + legume drafts).
- There is a significant correlation between pasture legume content and the LWG advantage of animals grazing oversown native pasture .

- The major benefit of pasture legume to animal production occurs in the autumn - winter period.
- Burning native pastures (in Spring 1992) improved animal LWG in the first year following a fire by 35, 30 and 22 kg/hd at 4, 3 and 2 ha/hd but these differences were not statistically significant. In the second and subsequent years, there has been no significant differences in LWG due to burning.
- Diet selection studies highlighted the positive selection for legume in autumn - winter periods. At high stocking rates there was strong evidence of browsing on native woody species in dry spring seasons.
- The proportion of total legume and legume leaf content of diet extrusa declined markedly when stocking rates increased from 4 to 2 ha/hd.
- Diet extrusa obtained from the 2 ha/hd treatment contained 70% "decrease" species compared with 40% in the pasture.
- Systems studies (Figure 1) show it is feasible to produce reliable predictive models of animal LWG from native pastures but these models were unable to predict LWG from legume oversewn native pastures.

3. Pastures and soils

- Pasture yields have varied between years but show a consistent decline with increasing stocking rate. Yields of desirable species (*H. contortus* and *B. bladhii*) have decreased with increasing stocking rate.
- Considerable variation in pasture composition has occurred due to seasonal climatic variation, however permanent changes in pasture composition due to stocking rate have not been established. No significant differences in the frequency of *H. contortus* have occurred (Figure 2) but the frequency of *Chloris divaricata* shows a significant increase with increased stocking rates.
- Changes in density of *H. contortus* are more apparent in the permanent quadrats where plant density has increased at the light stocking rates compared with a decline at heavy stocking rates. Seedling recruitment shows strong 'pulsing' in response to summer rainfall. Seasonal rainfall also tends to mask stocking rate effects.
- Soil seed banks of *H. contortus* have been highest at the lighter stocking rates and lowest at the heavier stocking rates while that of *Chloris divaricata* and *Eragrostis sororia* have been highest at heavier stocking rates.
- Changes in the basal cover of *H. contortus* appear to reflect similar changes in species composition measured by Botanal.
- Changes in plant frequency data from QGRAZE monitoring sites appear to reflect similar changes in species composition measured by Botanal.
- Initial legume establishment was better on the duplex soils.
- Slow but inexorable increase in *Seca stylo* density across all oversown treatments. This increase is fastest at the lightest stocking rate.
- Patch grazing is rarely evident at the light stocking rate (5 ha/hd), seasonally well developed at moderate stocking rates (3~4 ha/hd) and disappears at heavy stocking rates (2 ha/hd). Patches are usually removed by fire.
- Total runoff, peak runoff and soil movement all increase with increasing stocking rate.

Objectives evaluation

Objective 1. Achievement criteria fully satisfied.

Objectives 2, 3 and 6. Dependent on the adoption of draft communication strategy outlined in NAP 3 project application. (Workshop to be held on 6 August 1997).

Objective 4. Appointment of designated economist is dependent on the outcome of Beef Industry Institute restructuring.

Objective 5. Achievement criteria satisfied. ("Simulation studies of Galloway Plains animal production - Stage 1" by W.B. Hall, G.M. McKeon and K.A. Day).

Communication activities

Subject to adoption of the communication strategy outlined in the NAP 3 project application. In the interim, project staff have continued their involvement with extension services, Property Management Planning staff, Landcare groups, Industry consultative groups and information service personnel in extending project results.

Plans for 1997-98

1. Continue to monitor and assess pasture stability and animal productivity.
2. Finalise communication plan.
3. Set up and measure approximately 500 ha commercial scale paddock on adjacent "Voewood" station to act as validation site for further simulation modelling activities.

Discussion/Comments

(Questions are shown in italics. Responses and comments are in normal print)

1. *Was not the response of *Heteropogon contortus* to heavier stocking rates predictable?* This was acknowledged, but the response of other decreaser and increaser species has been more buffered than anticipated.
2. Re: *Cassia rotundifolia* dominance - the comment was made that there are better legumes available.
3. *Is any place for fire in legume management?* Agreed that there was but the design of the Galloway Plains experiment did not include this treatment in the legume augmented paddocks.
4. *What is the message for the producers? Is any further research necessary?*
The overall message was that conservative stocking was desirable in terms of both animal production and pasture sustainability. The value of this research facility in documenting the effects of both a range of grazing pressures and legume oversowing on long term pasture sustainability cannot be overstated.
5. *Marion Becker indicated that her Seca pastures were good, but asked if she should get rid of it?* No because she was oversowing Seca with an introduced grass.
6. *Should Seca be sown into forest country?* We should appreciate that the advantage of Seca to beef producers outweighs potential problems provided

these pastures are managed to maintain a good grass balance (>50%) in the pasture.

7. Comment made that Seca dominance is "not on". Agreed, but this does not mean that you should be recommending no legume (see points 5 and 6).
8. *Were pastures in the trial being spelled and, if not, why not?* Bill Burrows replied that this trial was not designed for a "put and take" system, but the light stocking rate treatments will achieve spelling of individual plants.
9. *If legume dominance is leading to increased run-off then why do we recommend legumes?* We do recommend legumes and we need to manage the grass/legume balance. The need to research infiltration / run-off under Seca pasture is equally obvious. To date, the Galloway Plains hydrology research relates only to grass based pastures.
10. *Comments were made about the loss of desirable species in the Dalrymple shire and which have been replaced with Indian couch. Is this a disaster?* No clear answer was given - however, the desirable traits of Indian couch are a good pointer to what might be needed to maintain ground cover in pastures under stress.

Restoring the condition of degraded black speargrass pastures in the southern speargrass zone

MRC Project number: NAP3.209
Project duration: NAP2 and NAP3 - 01/07/96 to 30/06/2000
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Co-Investigators: Vicki-Lee Hansen, Russ Tyler, Benita Darrow,
Ian Crosthwaite, Bill Edwards, John Day and David Orr

Objectives

1. By the year 2000, develop cost efficient whole property management principles that will enable individual landholders to transform wiregrass infested pastures into productive speargrass pastures.
2. To demonstrate those management principles and encourage their adoption through a planned communication strategy
3. By the year 2000 have producers in the Burnett armed with the knowledge of these management principles and how to apply them as part of their whole property management.

Summary

This project is addressing the problem of wiregrass and other unpalatable pasture species dominating in commercial black speargrass pastures. Currently, three commercial sized demonstrations of pasture and cattle management principles for achieving speargrass dominance are using two annual burning and strategic stock management options to compare with unburnt and commercially managed paddocks.

The demonstration is showing that annual burning and reduced stocking pressure can improve pasture composition, individual cattle weight gains and profitability.

A feature of the project is the close producer involvement. After learning about suitable pasture and cattle management principles local producers are deciding on treatments for paddocks. Some producers have helped with pasture sampling. The demonstration has also afforded an opportunity for producer exposure to other property management aids. eg. Grass CHECK, Property Management Planning, etc.

The demonstration will continue seeking producer involvement and ownership, broader community involvement and demonstrating good management principles in a whole property context.

Report

Native pastures in Queensland's southern speargrass zone are less productive and prone to further degradation due to infestation by wiregrasses. Dominance by wiregrass is due to a number of factors, some of which include extended droughts, economic pressures causing overstocking and a resultant lack of seasonal burning of pastures. Known locally as SWAMP (Speargrass, Wiregrass, Animal Management Project), this project began in late 1993 and is using fire and strategic stock management, on a commercial scale, to restore speargrass and improve pasture condition.

Methodology

Four sites have been established on commercial properties: "Glencoe" in the Rawbelle district south-west of Monto; "Derarby" south of Mundubbera; "Corrunovan" in the Boondooma district west of Proston; and "Stanley House" near Somerset. At each site, six to twelve local producers formed a group to determine management and regularly monitor progress.

Each site has 3 large paddocks (ranging in size from 30 to 300 ha) with one of the following treatments being allocated to each paddock:

- (i) normal property stocking rate and no burning (Control paddock)
- (ii) half the normal property stocking rate and burnt in spring each year (half stocking rate paddock), and
- (iii) burnt each year in spring (tactical paddock) and either of the following treatments (which were determined by local producers at each site):
 - a. destocked between Christmas and May (Corrunovan); or
 - b. destocked for 2 months after burning or until the speargrass is 10 cm tall (Derarby);
or
 - c. destocked for 3 months after burning or until the speargrass is 15 cm tall (Glencoe);
or
 - d. reduce stocking rate to half between Christmas and May (Stanley House).

The Stanley House site has since been sold and is no longer part of the project. The remainder of the report gives results concentrating on the 1996/97 period but includes some other results to give some perspective.

Producer Involvement

Producer groups representing 6 to 12 properties were formed at each site at the start of the project. The groups were made up of producers invited by the co-operator and some who were invited by DPI staff. The first involvement of the groups at each site was to decide on the management of the third demonstration paddocks.

Group members are involved with all activities relating to the demonstration sites. One group member at one site is now regularly assisting with the pasture sampling. Others have been involved in the past. Group meetings at each site involve discussion not only on the progress and management of the site but on a wide range of activities in the beef industry such as Grass CHECK, Supplementary feeding, Wormcheck and general cattle and pasture management. Group members also assist with the burning and weighing.

There have been major field days at each site involving 20 to 50 producers. Topics at the field days were the results of the demonstration as well as other topics of interest at the time eg. Timber Management, Financial management, Wormcheck and tick management.

Management Changes

At the completion of the third draft of cattle in spring 1996, the producer groups met to discuss progress and future management. This led to some management alterations at two sites but not at Glencoe.

Derarby

The producer group at this site felt that the pasture was being under utilised in the half stocked paddock and that, even though the economics looked better in the half stocked paddock in 2 years out of the 3, a stocking rate somewhere in between full and half might be more economical while allowing for good pasture composition. We agreed that the pasture composition was reasonable already (see later in results section) and that there appeared to be little shift recently according to our measurements despite the pastures appearing to "look better" in paddocks stocked more leniently.

The outcome of discussions was that stocking rates in the half stocked paddock should go to three-quarters the normal rate but the amount of rainfall received after burning in spring would also effect the decision. If rainfall between burning and mid-December was decile 2 or less the stocking rate would be returned to half the normal property rate. The situation is then to be reconsidered about mid-March. If rainfall over the period of December to March is above average then the stocking rates can be returned to three-quarters the property rate. These stocking rates were not adhered to in the 1996/97 season due to other circumstances but the principles will apply for the remainder of the demonstration.

Corrunovan

It was agreed that pasture composition had reached its peak in the burnt paddocks (see results later in this section) and that the half stocked paddock should return to full stocking rate to determine the impact of better pasture composition and burning on cattle production and economics. This decision needs to be considered in the light of the already lenient stocking rates employed commercially on Corrunovan (1AE to 5 ha). The Tactical and Control treatments are being retained. These decisions will be reviewed annually.

Pastures and rainfall

Derarby

Rain for the 1995/96 season was the best on record totalling 961 mm from July 95 to June 96.

Table 1: Total Pasture yields (kg/ha) and Frequency of occurrence (%) of black speargrass (Spear), forest bluegrass (Forest), wiregrass (Wire) and slender chloris (Chloris) at Derarby.

Date	Paddock	Total Yield (kg/ha)	Frequency of occurrence (%)			
			Spear	Forest	Wire	Chloris
Oct 93	Control	1385	71	45	19	na
	Half SR	1450	49	44	29	na
	Tactical	1285	63	65	13	na
May 96	Control	2695	58	54	22	9
	Half SR	3645	43	40	25	7
	Tactical	3375	55	65	28	9
June 97	Control	1240	57	52	28	33
	Half SR	900	52	35	44	35
	Tactical	740	66	54	25	51

Good pasture growth resulted and yield and composition were exceptional in May 96. Pastures yielded 2695 kg/ha, 3645 kg/ha and 3375 kg/ha for the control, half stocking rate and tactically stocked paddocks respectively. (Table 1)

In contrast, rainfall for the 1996/97 season amounted to 470 mm, equal to a severe drought (5th percentile) when compared with the nearby Mundubbera post office historical records.

Accordingly, pasture growth has been poor and yields were 1240 kg/ha, 900 kg/ha and 740 kg/ha in the control, half stocked and tactically stocked paddocks respectively. (Table 1)

Frequency of occurrence of the better pasture species at this site (black speargrass (*Heterpogon contortus*) and forest bluegrass (*Bothriochloa bladhillii*) were acceptable (40% or greater) in all paddocks in both May 96 and June 97 (Table 1). However, a dramatic increase in the frequency of occurrence of slender chloris (*Chloris divaricata*) reflected the severity of the drought.

Table 2: Total pasture yields (kg/ha) and yields of black speargrass (Spear), pitted bluegrass (Pitted), wiregrass (Wire) and canegrass (Cane) at Corrunovan.

Date	Paddock	Yield (kg/ha) of pasture species				
		Total	Spear	Pitted	Wire	Cane
Nov 93	Control	1950	430	115	430	490
	Half SR	2235	870	180	225	490
	Tactical	2300	370	255	370	780
May 96	Control	2565	1090	404	95	670
	Half SR	2295	1430	126	65	355
	Tactical	1935	910	214	45	485
June 97	Control	3245	1255	280	140	1305
	Half SR	2045	1443	110	50	230
	Tactical	2145	1550	160	25	190

Corrunovan

Rain for the 1995/96 season was again exceptional totalling 882 mm at Corrunovan between July 95 and June 96. Pastures responded well and total yields were 2565 kg/ha, 2295 kg/ha and 1935 kg/ha in the control, half stocked and tactically stocked paddocks respectively. (Table 2) Rainfall for the same period in 1996/97 was 666 mm and pasture yields in June were again high being 3245 kg/ha, 2045 kg/ha and 2145 kg/ha for the control, half stocked and tactically stocked paddocks

respectively.

Yields of speargrass were similar for all paddocks in both May 96 and June 97 (Table 2). However, yields of the poorer and less palatable pasture species pitted bluegrass (*Bothriochloa decipiens*), wiregrass (*Aristida* spp.) and canegrass (*Arundinella nepalensis*) were much higher in the unburnt and more heavily stocked control paddock in both years. Yields of unpalatable species totalled 1725 kg/ha, 390 kg/ha and 375 kg/ha for the control, half stocked and tactically stocked paddocks respectively in June 97.

The frequency of occurrence of speargrass was 91%, 91% and 85% in the control, half stocked and tactical paddocks respectively in May 96.

Table 3: Total pasture yields, proportions of yields and frequency of occurrence of black speargrass (Spear) and wiregrass (Wire) at Glencoe.

Date	Paddock	Total Yield (kg/ha)	Proportion of yield (%)		Frequency of occurrence (%)	
			Spear	Wire	Spear	Wire
Nov 93	Control	2640	1	75	8	85
	Half SR	2510	3	67	14	75
	Tactical	2245	2	63	10	81
May 96	Control	1410	12	50	17	71
	Half SR	2630	3	58	7	80
	Tactical	1705	9	47	13	72
June 97	Control	1105	4	58	18	76
	Half SR	1625	4	48	20	87
	Tactical	1205	3	56	9	82

Glencoe

Rain at Glencoe totalled 585 mm for July 95 to June 96, still below the district average of 694 mm. Pastures yielded 1410 kg/ha, 2630 kg/ha and 1705 kg/ha for the control, half stocked and tactically stocked paddocks respectively (Table 3). Roughly half the pasture yields were comprised of wiregrass, with speargrass comprising 12% or less.

Rainfall for July 96 to June 97 was 517 mm and pastures yielded 1105 kg/ha, 1625 kg/ha and 1205 kg/ha for the control, half

stocked and tactically stocked paddocks respectively in June 97. Again, yields of speargrass were low in all paddocks but the frequency of occurrence of speargrass has more than doubled in the half stocked paddocks going from 7% in May 96 to 20% in June 97 (Table 3).

Cattle and Economics

Cattle weight gains are given in kg/hd and kg/hectare in Table 4 with some gross margin calculations for the two sites with growing cattle. Weaner weights and numbers for Glencoe are given in Table 5 but no gross margins were calculated. Weight gains for Derarby are from Sep 96 to May 97. Those for Corrunovan are from August 96 to April 97.

Stocking rates at Corrunovan are traditionally light, so reducing stocking rates to half the normal property rates would not be expected to boost individual cattle weight gains to the same extent as occurred at Derarby where stocking pressure is heavy. Consequently it has often been more economical to stock at the heavier rate at Corrunovan. eg. 1993/94 and 1994/95.

Derarby

In the first two years of the demonstration, stocking at the lighter rate (half normal rate) was more economical. With higher rainfall in 1995/96 the economics were similar for all 3 treatments.

Despite a dry year, the good pasture condition of the paddocks supported reasonable cattle weight gains for all paddocks in 1996/97. (Table 4) Cattle in the half stocked paddock (actually stocked at $\frac{3}{4}$ the usual rate) gained the most weight (156 kg/head). However, all cattle were in good condition and cattle from any one paddock could not be awarded a premium over others. Thus the premiums for better finish are shown for all cattle. Overall, gross margins per hectare were similar for all treatments in 1996/97.

Table 4: Gross margins for three systems of cattle on production on Corrunovan and Derarby.

Site	Year	Paddock	SR (ha/hd)	Av. weight gain		Gross margins (\$/ha)		
				kg/head	kg/ha	No premium - bought & sold at same price		10c premium
						0.90c/kg	\$1.00/kg	
Corrunovan	96/97	Control	2.6	95	37	10.55	12.69	19.03
		Half SR	2.8	114	41	14.46	16.97	23.64
		Tactical	2.9	99	34	10.08	12.06	18.03
Derarby	96/97	Control	1.6	139	87	37.95	43.74	56.50
		Half SR	2.2	156	71	34.21	39.16	48.85
		Tactical	1.6	128	80	32.89	38.12	50.21

Corrunovan

Cattle gained more weight in the half stocked paddock (stocked at a similar rate to the control), possibly due to pastures being in better condition with less of the poorer grasses. A small advantage in gross margins accrued to this paddock, particularly at the lower sale prices of 90 c/kg and \$1/kg liveweight.

Table 5: Average weights (kg/head) of calves in June each year and the number of cows and calves weaned from each paddock at Glencoe.

Paddock	Control	Half Stocking Rate	Tactical
Stocking Rate (ha/breeder)	5.3	10.3	5.4
1996/97			
No. of Cows	55	37	24
No. of Calves	40	25	22
Av. Calf weight	266	276	257

Glencoe

It is difficult to extrapolate from breeder data and assign effects to treatments due to the complex interactions in breeder herds. In the course of the demonstration there has been little or no benefit to reduced stocking and this trend has continued for 1996/97 (Table 5) except for an increase to 92% branding rates in the Tactical paddocks. As this treatment is to spell pastures after burning in spring, the cows were also mated when they were in another paddock not associated with the demonstration.

Plans for 1997/98

Pastures

Measurements will be taken in spring/summer after the break of the season when seedlings can be identified and in autumn. Pastures will be burnt where possible following sufficient rain. It is unlikely that pastures will be burnt at Derarby.

Cattle

Weighing will continue periodically, 3 or 4 times during the year.

Economics

The economic analysis will be developed to encompass the effects of the various management strategies on whole property economics.

Survey

A survey will be conducted to more accurately gauge the extent of the wiregrass problem, current commercial practices and the levels of awareness in the community of how to combat the problem. This survey will be complemented by a similar survey in the year 2 000 to gauge changes in both the extent of the problem and attitudes to it.

Communication Strategy

Farm walks and field days - communication with the local producer groups associated with each site will continue at informal gatherings for weighing cattle and deciding on paddock management. They will also continue to get SWAMP Updates (newsletters). Larger field days will be held at appropriate times to attract a wider audience. At these farm walks and field days various indicator pasture species will be pointed out and the respective management responses outlined.

Examples of how to employ management principles for reducing wiregrass and encouraging speargrass will be outlined in a whole property management fashion. Property management planning (now Future Profit) modules such as Assessing Your Livestock Management Options, decision aids such as RAINMAN, GRASSMAN and BREEDCOW/DYNAMA, property management planning economics packages and Grass CHECK can all be used to help plan strategies to combat the wiregrass problem and demonstrate the strategy's worth.

Producers from the producer groups at each site will be encouraged to implement strategies, record changes and report their findings back to the group.

Media articles for local and statewide press, a segment in the program Landline and radio talks associated with field days are also planned.

Discussion/Comments

1. *"What wiregrass species are sampled?"* All tall and coarse *Aristida* spp were included.
2. *"Is an aim of the demonstration to "restore" or "get rid of wiregrass" in the pasture?"* The aim is to restore the condition of pasture so that speargrass (*Heteropogon contortus*) again becomes the major species, with wiregrass a minor component.
3. *"What other poor pasture species are present at the sites other than wiregrass?"*
At the Corrunovan site Canegrass (*Arundinella nepalensis*) is quite prominent, while Pitted bluegrass (*Bothriochloa decipiens*) is present at both the Glencoe and Corrunovan sites.
4. *"Were the live weight gains significantly different from normal gains?"* The project is a demonstration, not an experiment and there is no replication which means we can't analyse the data and test for significance. So the data needs to be considered in this light.
5. *"How often each site had been burnt?"* The Glencoe paddocks were only burnt effectively in one year, spring 1996. The lighter stocking rates have allowed burning each year at Corrunovan while the paddocks could only be burnt effectively in two years out of four at Derarby.
6. There was a lot of interest in the economics coming from the demonstration. *"How do you reconcile your economics compared to work being conducted by Bill Burrows and Andrew Ash?"* The stocking rates are such that major differences in liveweight gains will occur in some years at one site (Derarby). The outcome is that liveweight gains/ha are similar but costs are much reduced in the more lightly stocked paddocks. So it is necessary to assess each situation according to its particular circumstances.
7. *"How much burning and stocking rate effects are in the gross margin?"* We can't separate the combined effects of stocking rate, burning and pasture composition on weight gains. Small changes in any of the previously mentioned factors can have large effects on the gross margins. One of our main aims is to continue the economic assessment to the property level. The gross margins we have presented are for individual paddocks only. We want to consider the economic impact of treatments on the whole property.

Enhancing pasture stability and profitability for producers in the *Aristida / Bothriochloa* woodlands

MRC Project number : NAP3.208
Project duration : NAP2 and NAP3 - 01/07/96 to 30/06/2001
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Objectives

1. Understand how pasture composition changes with different climatic conditions and management such as clearing, burning and grazing pressure
2. Determine management practices that either maintain or improve pasture composition, or result in undesirable pasture composition
3. Develop practical, sustainable management systems for maintaining or improving native pasture condition
4. Communicate native pasture management knowledge to producers, resource managers and the general community

Summary

The project centres on two grazing trials which began in late 1994. Trials are in silver-leaved ironbark country at Rubyvale and poplar box land at Injune. Main treatments are three levels of grazing pressure, killing or retention of trees and use of spring burning. Moderate grazing pressure has produced as much beef as heavy grazing but the value of that beef is much greater per kilo. Neither tree killing, burning nor grazing pressure has yet produced a major shift in pasture composition in the first 3 years. Timber treatment and grazing pressure is shifting the quantity of pasture on offer but seasonal rainfall often has a greater impact on pasture yield and quality. At Injune, tree killing doubles the pasture yield but the effect at Rubyvale is smaller and less consistent between years. Soil movement is much greater at Rubyvale but the amount of fine sediment lost in runoff is similar despite the more sodic soils at Injune. Regular field days, addresses to producer organisations and show displays are held in both districts.

Report

Main Activities

- Refine current knowledge of the pastures' dynamics
 - detail the composition for good, moderate and poor states
 - identify the factors that change the pasture from one state to another
- Determine critical life cycle details for key native pasture species
 - how long do they usually live
 - what most threatens or enhances persistence
 - what impact does stocking pressure, fire or timber clearing have on key species
 - how can desirable species best be favoured and undesirable species discouraged
- Measure cattle growth rates from two pasture types, silver-leaved ironbark and poplar box

- Determine the amount of runoff and soil loss from these pastures under different management
- Hold field walks and workshops to help graziers and other land managers to recognise key pasture species and to manage them better
- Develop practical paddock management options for maintaining or improving pasture composition and adequate landscape biodiversity

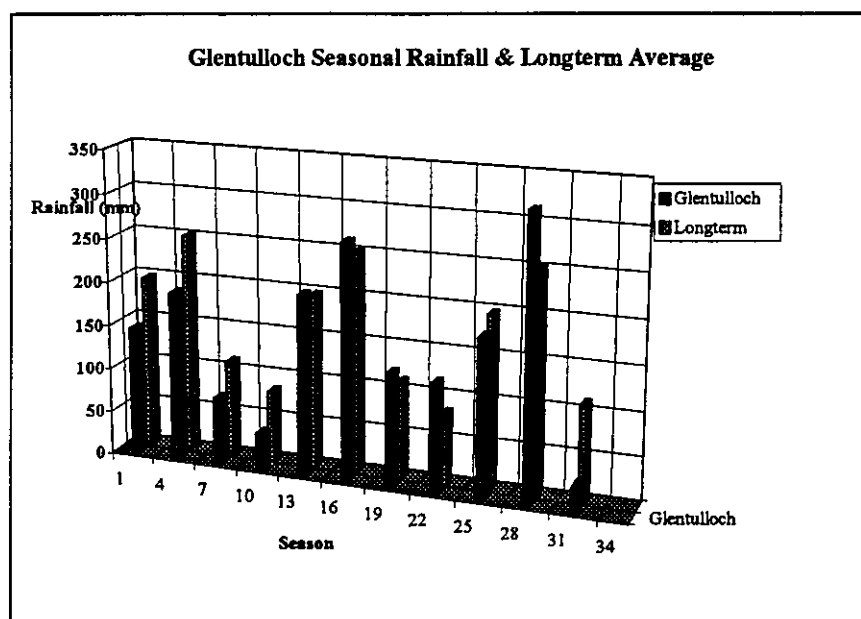
Trial design :

Utilisation level	Paddock Sizes (ha)			
	Glentulloch		Keilambete	
	TREED	CLEARED	TREED	CLEARED
HIGH	6	4	7	3.5
MEDIUM	9	6	11	5.5
LOW	18	12	21.5	11

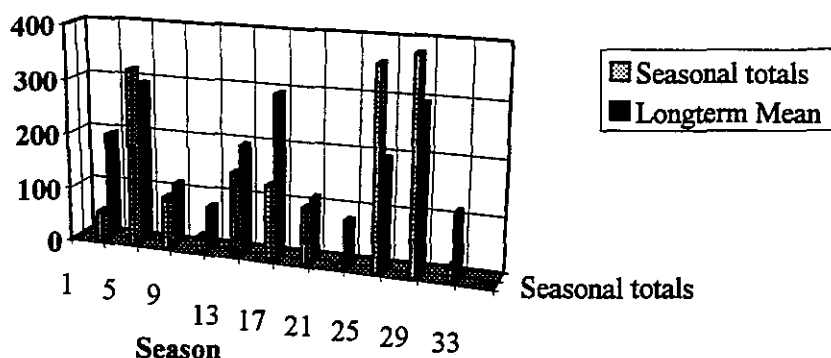
Results to Date :

We now have 3 consecutive years of data and can begin to separate out treatment effects from seasonal fluctuations in rainfall.

Seasonal rainfall



Keilambete Seasonal Rain vs Longterm Average



Both sites had 2 fairly dry growing season initially but the 1996-97 summer at Keilambete (KB) has been very wet and pasture yields reflect it. At Glentulloch (GT), last summer had periods of good and dry weather. Seasonal rainfall at both sites, compared to long term means is shown above. Rainfall for the 12 months to June 1997 was rated as decile 8 at GT (649mm) and decile 9 at KB (774mm) ie. higher than 80 and 90% of previous years respectively.

Pasture composition and yields

Pasture composition at both sites has not changed markedly yet due to treatments imposed. However some of the minor species in pastures have changed noticeably over the last 3 years, probably in response to seasonal conditions rather than treatments. The main perennial grasses remain dominant and at a similar proportion. The dominant species at Glentulloch are very different to those at Keilambete.

Keilambete Autumn pasture yield (kg/ha) for the first 3 yrs

	April '95	April '96	April '97
	DMY	DMY	DMY
TREED	1307	1127	3081
CLEARED	1242	783	3257
HIGH	900	203	2071
MEDIUM	1335	908	3186
LOW	1588	1755	4218
Percentage of pasture yield			
Forest mitchell	31.1	55.9	34.3
Blackspear	28.4	20	25.7
Goldenbeard	10.3	5.5	6.7
Kangaroo grass	5	1.3	4.6
Whitespear	2	2.7	1.27

Soil seed loads

Seed loads in the soil are sampled each spring. The key perennial grasses have neither large nor persistent seed banks. Herbs and small-seeded grasses such as lovegrasses and *Sporobolus* spp. have the largest and most persistent soil seed banks.

Total number of germinating seeds from 0.14 m² at Glentulloch

Plant Category	Sample date				
	Oct 1994		Oct 1995		Sept 1996
	Dec '94	Apr '95	Nov '95	Mar '96	Nov '96
TOTAL	1603	884	739	2453	874
Grass + sedge	1157	363	476	412	630
Herbs	446	521	263	2041	244
Pitted bluegrass	107	4	16	7	20
Qld bluegrass	12	2	7	1	7
Twirly windmill	187	3	70	15	37
Wiregrass	40	0	12	0	0
Goldenbeard grass	0	0	0	0	0
Legumes	3	0	5	3	11
Trees & shrubs	0	0	3	3	2

Effect of spring burns

Spring burns have been achieved twice at GT and once at KB, restricted mainly by cool weather. Burns have not produced any changes in pasture composition yet nor on total forage biomass at GT in most years.

Pasture Yields (kg/ha) and Ground Cover (%) at Glentulloch Burn Site

	Sample Date					
	July '95		May '96		April '97	
	DMY	Cover	DMY	Cover	DMY	Cover
BURNT	1200	25	2475	50	3250	43
UNBURNT	1215	32	2820	54	5000	39
TREES	850	26	1645	43	2135	31
NO TREES	1565	31	3650	61	6120	52

NOTE Plots burnt 3 Nov 1994, Sep 1996

Plant lifespans and recruitment in the paddock

Hundreds of plants have their size and position charted annually in fixed quadrats in every paddock. This data supplements our understanding of the pasture dynamics recorded by other techniques. Blackspear at KB and Qld bluegrass at GT have been the main perennial grasses to recruit seedlings to date.

Cattle growth

TREATMENT	LIVEWEIGHT GAIN (kg/hd) & MEAN RATE (kg/head/day)						TOTAL LWT GAIN (kg/ha) Nov '94 to May '97
	Nov '94 – Aug '95		Oct '95 – Oct '96		Nov '96 – May '97		
	Gain	Rate	Gain	Rate	Gain	Rate	
TREES	120	0.45	119	0.32	99	0.60	92
CLEARED	151	0.55	160	0.44	100	0.60	168
HIGH	98	0.26	100	0.27	74	0.45	163
MEDIUM	138	0.51	153	0.42	110	0.66	160
LOW	173	0.65	182	0.50	121	0.73	95
COMMERCIAL	129	0.49	139	0.38	106	0.64	
Best rate of		1.30		0.95		0.85	

Cattle growth has been better than expected, often reaching 1kg/hd/day during summer. The high (75%) utilisation treatments are only growing as much beef/hectare as the medium utilisation treatments while stressing the pasture and the animals much more. The low (25%) utilisation treatments are producing much less beef per hectare than moderate rates and not apparently benefiting the pasture or soil much more.

Tree effects

Clearing has had only a minor effect on pasture biomass at KB so far but a major effect at GT. The minimal impact at KB needs further study to confirm it as a real treatment effect.

Runoff and soil movement

There were 2 rainfall events of note in 1996/97 (Table 1). Runoff for the KB event, despite its intensity, did not make a major contribution to total runoff for the season.

Table 1: Peak rainfall intensity (mm/hr) for 6 and 30 minute periods. Return periods in brackets.

	Glentulloch	Keilambete
Rain Period	19/10/96	06/12/96
6 Min	132 (10 yrs)	276 (100yrs)
30 Min	84 (30 yrs)	154 (100yrs)

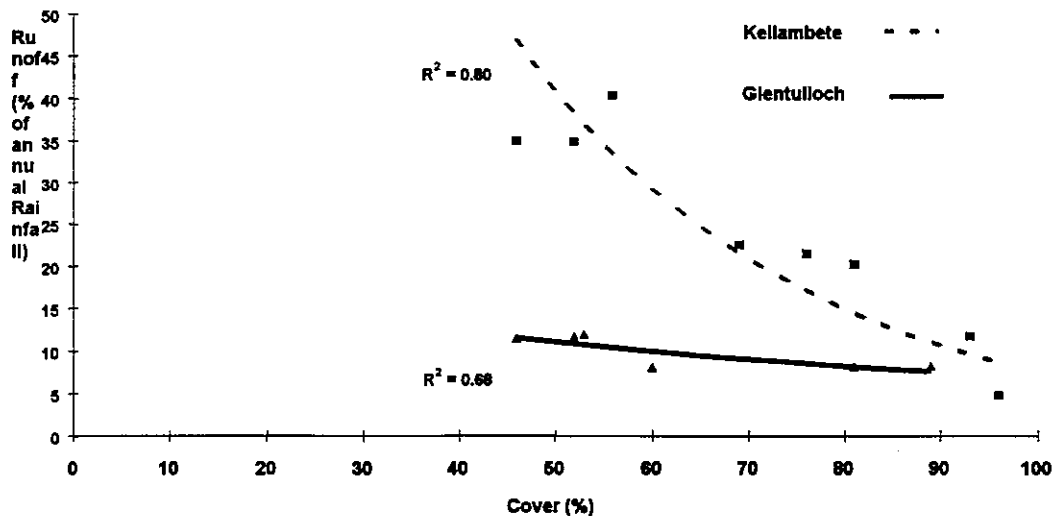


Figure 1: Effect of cover on Runoff (% of annual rainfall) at Glentulloch and Keilambete - 1996/97.

Large differences in runoff occurred between sites even though annual rainfall totals were similar (Figure 1). For GT, 30 runoff events occurred with 10 of these having in excess of 20 mm runoff. The high intensity rainfall event of the 19/10/96 produced about 50% of the runoff for the summer. There was not a major difference in runoff due to grazing pressure at GT. The average runoff ranged from 12% of annual rainfall for the high grazing pressure at 50% cover to 8% for the exclosure at 80% cover.

There were 28 runoff-producing rainfall events at KB with runoff events evenly distributed over the season. Ground cover had a marked effect on runoff for KB, ranging from 45% of annual rainfall at 45% cover to a minimum of 5% for 95% cover. So far, there appears to be no significant difference in runoff response due to trees at the Keilambete site.

Reduced grazing pressure or increased cover markedly reduced soil movement but rates differed between GT and KB for the season. A reduction in ground cover from 80% to 50% produced an increase in soil movement from 800 to 1,800 kg/ha at GT compared with an increase from 1,000 to 14,000 kg/ha at KB (Figure 2). Suspended sediments contributed approximately 50% of total annual soil movement at the high and medium grazing pressures and 25% of the total for the exclosed plots at both GT and KB.

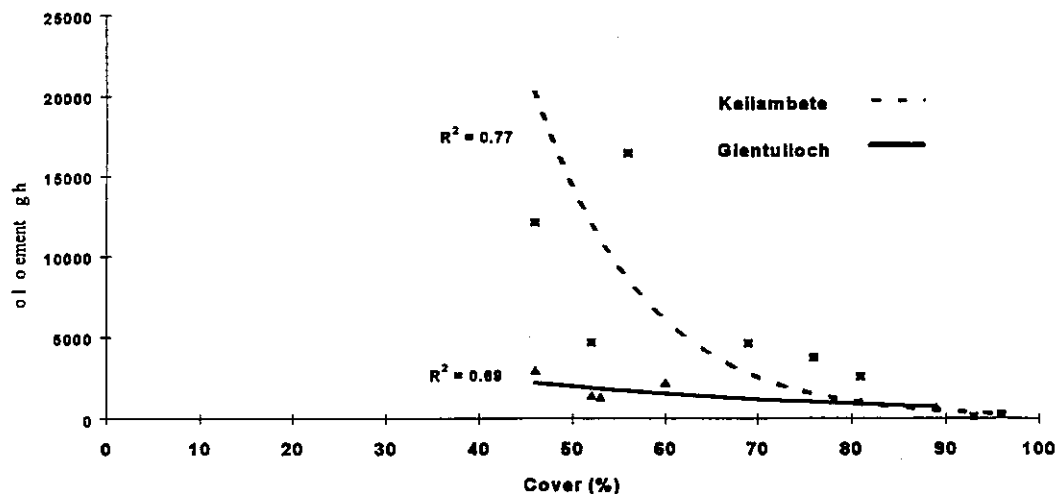


Figure 2: Effect of cover on Annual Soil Movement (kg/ha) at GT and KB - 1996/97.

Producer consultations

The consultative groups associated with each trial site have been kept informed of progress. Plans to exchange visits to the reciprocal sites were cancelled when project staff changes and funding restrictions made implementation difficult. Some of the GT producers participated in the MRC Biodiversity workshop held in Roma in May 1997.

Communication activities

Emerald staff have been very active at local and regional shows and meetings in discussing the project's progress and instructing about key pasture species and their grazing management. Shows included Alpha, Clermont, Emerald and Springsure, Ag-Grow '97 in Emerald and a CU meeting at Alpha. ABC Radio interviews about the project and shrub control have also been done this year. The most popular field excursion of the State Landcare Conference in Roma in late June 1997 visited the Glentulloch trial for 4 hours. A full rundown on all aspects of the trial was presented to the audience of about 50 people. They were most complementary about what we were doing and hopeful such work could be done for much longer, especially if nutrient cycling studies could be included.

We plan numerous communication activities, as shown in our project rollover submission, but are awaiting the outcome of the MRC Communications workshop in Rockhampton on 6th August before settling on future strategies, in consultation with MRC.

Achievement of milestones

Proposed milestones for 1996/97 were -

1. Agree on milestones - not yet finalised
2. Field days at focal sites - achieved for Glentulloch.

Plans for 1997-98 year

- a. Progress report on runoff and soil movement (Oct '97)
- b. Tree regeneration progress report (Nov '97)
- c. Field days at focal sites (June '98)
- d. Booklet on managing *Aristida* / *Bothriochloa* pastures, with Mr Ian Partridge (Jun '98)

Discussion/Comments

1. *Isn't the high grazing pressure ridiculously high?* Grazing pressure needed to be high for the trial and it is not high compared to some neighbouring commercial properties and several grazing trials in Qld. [On the Field trip to Cardigan on 14/08/97 we found similar utilisation levels being used in CSIRO trials to induce change rapidly]
2. The pasture composition is not changing rapidly here or in many other reported trials. Is this because the site may have been flogged in the past and responsive plants have gone already? This is probably correct; kangaroo grass is coming back in lightly used paddocks.
3. The communication strategy has been about collection and presentation rather than real communication. How do we get producers more involved so that it results in change eg. Follow-up and evaluation? Producer consultative groups have been working well at both sites and workshops on management and constraints have been held. This does not get adoption but helps. The owner of Keilambete is very involved
4. Concerns expressed by producers on the ecological effects resulting from stylo dominance on pasture stability and soil acidity at the recent stylo workshop. Thus, despite the superficial love by producers for stylo, some are listening to other opinions and recognising that there are sometimes down sides to apparent success stories. A lot of messages are getting through successfully, if slowly, eg. conservative stocking and overclearing
5. *Does the project team have the skills to get their info out to industry?* A good extension officer is involved with the project and producers are looking very closely at our work. The owner of Glentulloch was originally dubious about the value of the trial, but is now becoming quite involved to see what he can get out of it and is active in the broader industry issues confronting his operation
6. *What is the rating out of 10 for the importance of extension in this project?* Need confidence in data before doing extension. Extension staff always involved and we are trying to get an economist in the team to focus the relevance of messages
7. *When you have info what sort of communication plan would be appropriate?* The communication plan is developing, in conjunction with Judy Lambert. This is primarily a research project; I am primarily a researcher
8. *Is this detrimental?* No, industry can help and if they believe there is a good message they traditionally allocate extra resources to allow the project to deliver messages appropriately. Good messages will get across
9. Concern about the concept that a single trial will change industry. The NAP group of projects needs a communication strategy.
10. We do not have material to build a big picture without messages from individual projects.
11. Almost all the principles for grazing and resource management are already in textbooks All science does not have to be understood. Industry is looking for best bet ideas and not fine details.

Managing Woodlands: Developing sustainable beef production systems for northern Australia

MRC Project number: NAP3.205
Project duration: NAP2 and NAP3 - 01/07/96 to 30/06/2001
Principal Investigators: Dr Joel Brown & Dr Andrew Ash
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Co-Investigators Don Cowan and Dr Mick Quirk

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. Link management recommendations from Objectives 1 and 2 into a range of extension activities, including property management planning modules, small group activities, landcare groups, and training workshops.
4. Assess the economic benefits and costs of various grazing management strategies.

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, this recovery has been achieved through regeneration of existing plants with little recruitment of new plants.

Tree-grass interaction work has shown that trees in these woodlands exert their competitive effect uniformly across the landscape and modelling of forage production does not need a spatial component i.e. the GRASP model is adequate but needs better partitioning of water use between trees and grasses.

A more comprehensive communication approach is being developed and economic analyses of moving from one vegetation condition to another have commenced.

Report

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 CS.197 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 CS.197 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 - euschrozem; Cardigan - neutral red duplex; Allan Hills/Lakeview - yellow earth.

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.

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.

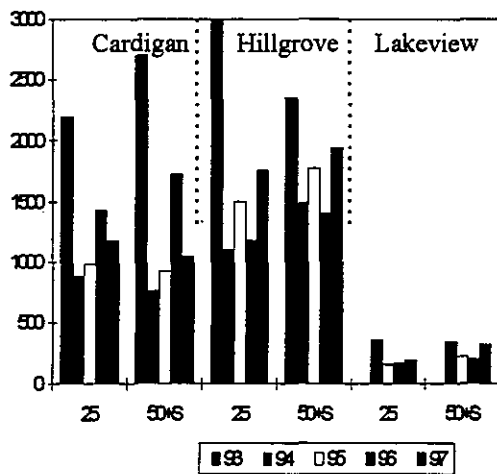


Figure 1. Yield of desirable perennial grasses in State I pastures with either light grazing (25% utilisation) or moderate grazing (50% utilisation) with spelling.

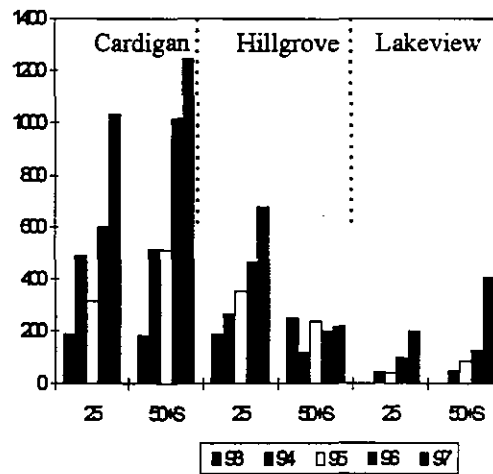


Figure 2. Recovery of desirable perennial grasses in State II pastures with either light grazing (25% utilisation) or moderate grazing (50% utilisation) with spelling.

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).

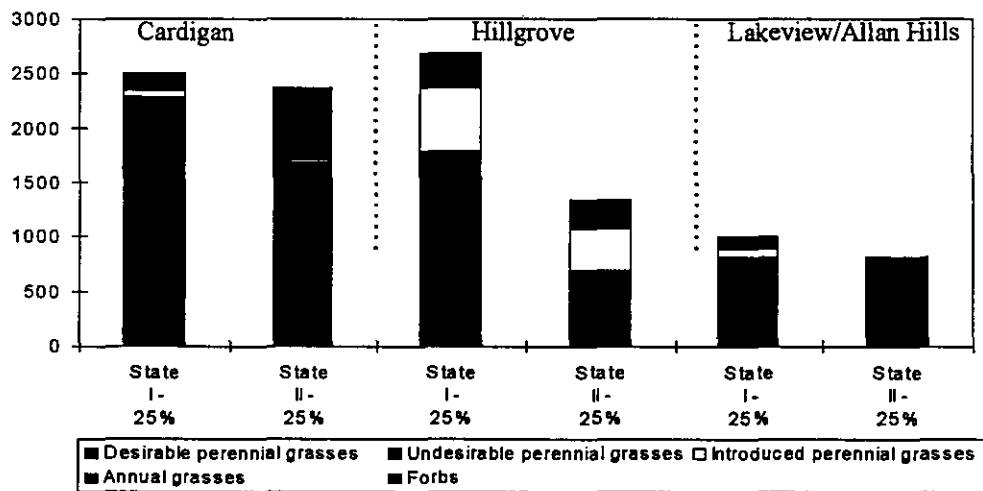


Figure 3. Comparison of yield and composition of State I and II pastures after 5 years of grazing at 25% utilisation.

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 suggest 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. This hypothesis is supported by frequency data of individual perennial grass species which shows that while yields may

have recovered, 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.

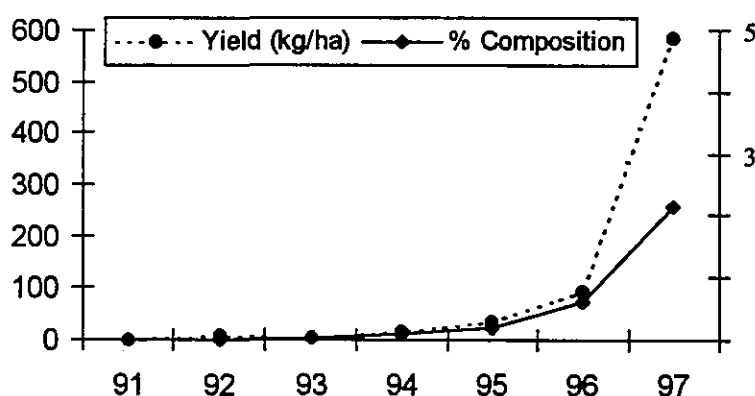


Figure 4. Spread of buffel grass into lightly grazed pasture (25% utilisation) at Hillgrove (State I).

Modelling studies

Results from the grazing studies have been used to develop relationships between utilisation and perennial grass composition which have been incorporated into the forage production model GRASP. Modifications to GRASP also now allow us to run forage-animal production simulations in different vegetation states. Through the linked GRASP-HERDECON model we have commenced analyses of the economic implications of moving from one vegetation state to another. These initial analyses have highlighted the need to better incorporate the effects of supplementation.

Tree-grass interactions

Next to precipitation, the factor that most directly influences forage availability in tropical tallgrass woodlands is the interaction of the tree layer with grasses. While there has been a substantial amount of research work describing the outcome of tree manipulation treatments on forage productivity, the mechanisms are poorly defined and difficult to predict under different soil and climate regimes. The objective of this study is to determine how manipulations of the tree layer affects soil moisture availability with a sufficient level of rigour to supply reliable data for modelling that can be applied across a range of conditions.

We have found that distance from individual adult trees has little effect on soil moisture within the grass rooting zone (0-15 cm and 0-30 cm). Soil moisture (mm water/mm soil) was similar across the distance gradient up to 10m from the adult tree. This is not unexpected because tree root distribution in the upper soil layers often goes well beyond the canopy and into the intercanopy area. Thus, it is unlikely that there is an individual tree effect when distance between adult trees is less than 20 m. We also found that individual tussock grass plants had significantly more negative Xylem Water Potential (XWP) outside the tree canopy than under the tree canopy during the wet. XWP is an accurate measure of soil moisture availability in grasses because of their intensive distribution of fine roots in the A horizon and inherent lack of stomatal control.

As in the measure of soil moisture, there is little evidence in this experiment for the need for a mesoscale (<ha) spatial component when modelling grass:tree interactions to predict forage production. The current point-based approach to modelling forage production in woodland environments with GRASP is therefore appropriate. The remaining time in this activity will be devoted to improving the partitioning of water use by trees and grasses in GRASP, particularly in deep layers of soil, using the soil water data collected during 1995, 1996 and 1997.

Communication

In the first phase of CS.197 extension activities focussed on promoting awareness of concepts, particularly the use of state-and-transition models as a framework for describing vegetation change, rather than relying on "management prescriptions" to effect desirable change. In many producer groups there is now a reasonable understanding of the consequences of inappropriate stocking strategies for the resource base. This educational and awareness approach is being continued throughout the current project but there is now increasing emphasis being placed on the adoption of management principles to bring about desirable changes in pasture condition and productivity. A Communication Plan was submitted to the MRC in December 1996 describing in detail the planned approach to achieve the adoption of management principles. The three main objectives of this plan were to: (a) initially create a dialogue (target - 30-50% of properties in the Bowen, Dalrymple and Etheridge Shires reached over the first three years); (b) awareness raising - despite a great deal of emphasis on sustainable management there is still a lot of confusion on what it really means and how to implement it within the management framework (target - 20-30% of properties in the Bowen, Dalrymple and Etheridge Shires have raised

awareness over the first three years); (c) information transfer - people actually use the principles and recommendations developed from this project (target - 10-15% of properties in the Bowen, Dalrymple and Etheridge Shires applying some of the principles in their management by 2001)

The property management planning process in QDPI/QDNR was identified as the best method for achieving adoption. This approach was viewed as the most appropriate, particularly given the large effort planned by QDPI/QDNR to reach a large number of producers in the Bowen, Dalrymple and Etheridge Shires with their 'Future in Beef' workshops.

We have recently received feedback on this communication plan and there were a number of criticisms, most notably concerning a lack of "management recipes" and the use of the property management planning process as the sole vehicle for adoption. We would like to discuss some of these communication and adoption issues at the August workshop as they are fundamental to the success of sustainability work in NAP3 and affect all projects, not just the Managing Woodlands project.

How do we broaden our approach to communication and adoption? Our current strategy is based on the belief that acquisition of better information and provision of it to the industry from the bottom-up should lead to gradual resolution of the grazing management problem and a consequent reduction in degradation. Hence, a change in the decision-making environment of pastoralists will allow for the solution of degradation problems, either by active extension or by gradual emulation of successful neighbouring enterprises. However, a fundamental problem with this belief is that it assumes that a pastoralist will manage sustainably for the long term. There is an alternative which rarely seems to be considered - that an economically rational pastoralist will discount the future and will, with the best intentions in the world, degrade the long-term productivity of the land in favour of economic survival. Despite its unpalatability, this possibility may well account for the difficulties we are facing in getting sustainable grazing management practices adopted. Even partial acceptance of this notion will require a major rethink in our approach to communication and adoption of sustainable grazing management and require a more top-down approach working with peak industry bodies.

The communication plan for this project will be amended following discussion and recommendations at the August workshop.

Discussion/Comments

1. Grazing pressure/utilisation levels

1.1 Are light utilisation levels in drought years impractical? More so on small properties, but more flexibility on larger properties should still allow low utilisation rates. A low utilisation rate is still perceived to be uneconomic. It depends on management systems. Also depends on initial conditions of pasture i.e. pastures in good condition going into a drought could sustain a couple of years of high utilisation without any loss of perennial grass species.

1.2 Isn't stocking at low rates just good business? Medium to long term, yes; in the short term maybe not. 25% utilitisional levels are not economic: soil fertility is generally not good enough to allow 25% every year, but 25% of 'average' year.

1.3 Resilience is built into grazing systems, can't we just make use of good seasons to get vegetation change in right direction? Need management not just climate to correct deteriorated pasture.

2. Property size

(Small) property size is a problem for resource management; there is not enough flexibility. Property-build up schemes in southwest Queensland are not working. Important to look at sub-division issues and drought policy. There is a lack of leadership for industry. Can't rely on top down approach, need to work with people at coal-face.

3. *Does GRASP use /account for climate variation?* Yes, in most simulation runs we use historical sequences of actual rainfall to provide a realistic simulation of rainfall variability

4. *The pasture yields at the Lakeview site are low. Why?* Due to low soil fertility.

5. *Is Indian Couch a desirable?* It depends on context - in terms of animal production it makes no difference. However there are producers who would prefer a mix of tussock perennials rather than pure Indian couch.

6. *How long for the reduction in termite species to occur under heavy grazing?*
3-4 years.

7. There was a general discussion on approaches to getting the research messages adopted and whether a top-down regulatory approach or a bottom-up community-based approach or a combination of both these approaches. Additional comments were –

- that there has not yet been sufficient time to properly evaluate the bottom-up approach.
- research has got this far - is it now up to producers to get information out there?
- need to expand information beyond Dalrymple into other grazing lands of North Australia.

Grazing systems and management guides for Kimberley rangelands

MRC Project number: NAP3.212
Project duration: NAP2 and NAP3 - 01/07/96 to 31/10/97
Principal Investigator: Dr P.E. Novelly
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Objectives

The primary objective of this project is to improve the understanding by land managers in the Northern Australian pastoral industry of the relationships between management options and the natural environment, and provide the tools to ensure that their management decisions are sufficiently proactive to be ecologically sustainable by maintaining rangelands in good condition.

Based on the findings to 1996, the specific objectives of Phase II (Phase 1 was conducted under NAP2) of this project (1996/97 to 1998/99) are:

- To define why cattle selectively graze one pasture community rather than another;
- To continue assessment of the possibilities of modifying this selectivity;
- To determine if such "modifiers" are logistically and financially applicable to extensive grazing properties and if they have an impact on range condition;
- To develop extension aids to permit proactive grazing management decision-making by managers.

Project summary

This project aims to modify cattle distribution (to the extent possible) by low cost means (salt placement, fire, modification of waterpoint distribution) while concurrently, using identified soil and vegetation indicators, monitoring the impact of intermittent heavy grazing on more preferred pasture types. By identifying triggers to substantial changes in range condition, and by low cost methods of making pasture community use more uniform, managers could better estimate paddock carrying capacities, better match management and grazing pressure to feed on offer and modify cattle numbers before degradation occurs.

Initial trial results indicated that within the watered zone cattle express an hierarchy of preference among pasture/soil type combinations. At the trial site, red soil areas (and associated grass species) were least preferred, black soil areas and frontage areas most sought after. There was limited change in preference over the year. Current range condition of these areas reflects this differential preference. Trial results, if confirmed and extended, would permit characterisation of the most and least preferred soil/plant combinations and so enhance the ability to manage extensive pastoral leases sustainably by better matching management to paddock characteristics. However, results on the degree to which modifying utilisation patterns has affected range condition and trend (a major focus of the research) are still preliminary and require longer-term validation.

Initial results defining range condition trend indicators are promising with significant species composition/species frequency changes occurring. These change are evident across a suite of species and species groups. However, as above, data are still preliminary.

Project Report:

Trial location

Trial is located at Springvale Station, via Halls Creek, East Kimberley WA (summer monsoonal rainfall zone) in two commercial paddocks of approximately 14 500 hectares *in toto*. Area is either hilly with lowland/riparian areas, black/brown cracking clays or arid short grass undulating plains. Predominant grasses include *Astrebla spp*, *Chrysopogon fallax*, *Sehima nervosum*, *Enneapogon spp.*, *Brachiachyne convergens* and *Plectrachne spp*, plus annual grass and forb species.

Achievement of milestones

A full report on the findings of the project to mid 1996 was prepared for the MRC in late 1996, and a communications plan for NAP3 activities prepared and forwarded to MRC for endorsement. The trial was proposed to enter Phase 2 (NAP3) as of 1 July 1996, with activities requiring considerable capital investment on two further leases. However, transfer from NAP2 to NAP3 delayed project activities during dry season 1996. But, at the base trial site, seasonal changes in utilisation were monitored as programmed in both late dry season (October, 1996) and early dry season 1997 (April) (see below).

One of the objectives of the NAP3 phase was to determine, if possible, the causes of the uneven grazing as well as means of reducing its impact. Data collection for this activity began in late dry season 1996 and continued through the following wet season and beyond (see below).

As of 1 July 1996, Mr Simon Osborne of Agriculture Western Australia, Kununurra assumed responsibility for the day-to-day project management of this trial within AgWA's Meat Program.

Seasonal conditions

Annual rainfall during the duration of the trial was at or above average (*Figure 1*). Periods of effective soil moisture (*Table 1*) influenced both the total forage produced and the duration of the green period.

Table 1. Growing season duration, Springvale Station, 1996/97, and mean values.

YEAR	DURATION OF GROWING PERIOD (DAYS)	DATES OF EFFECTIVE SOIL MOISTURE
1996/97	125	7/12 to 22/12; 27/12 to 15/4
MEAN	105	Average on-set date is 27-31/12 (1973 to 1997)

Utilisation

Forage utilisation continued highest on black soil (*Figure 2*). As the season advanced, differences between red soil and black soil forage utilisation decreased, although there was further forage utilisation on the black soils. Intermediate and mixed soil types were variable. Generally, utilisation of red soil species increased at a faster rate than that on other pasture communities during the late dry season.

Higher utilisation on black soil types also occurred with 'mid-level' woody species. This was particularly noticeable on the common browse plants (particularly *Acacia farnesiana*) on the black cracking clays. Whether this increased utilisation was a reflection of an attraction to the soil type *per se* or a function of the soil type possessing a specific mid-story flora is

debateable. However, the presence of palatable mid-height species on the 'black' soil areas was associated with a generally consistently higher forage utilisation rate overall (see below).

Apart from the overall utilisation levels being higher on the black and associated soil types, these soils also exhibited a far more uniform utilisation across all plants, not merely higher utilisation on those plants that were grazed. In contrast, red soils had a far higher proportion of non-grazed plants.

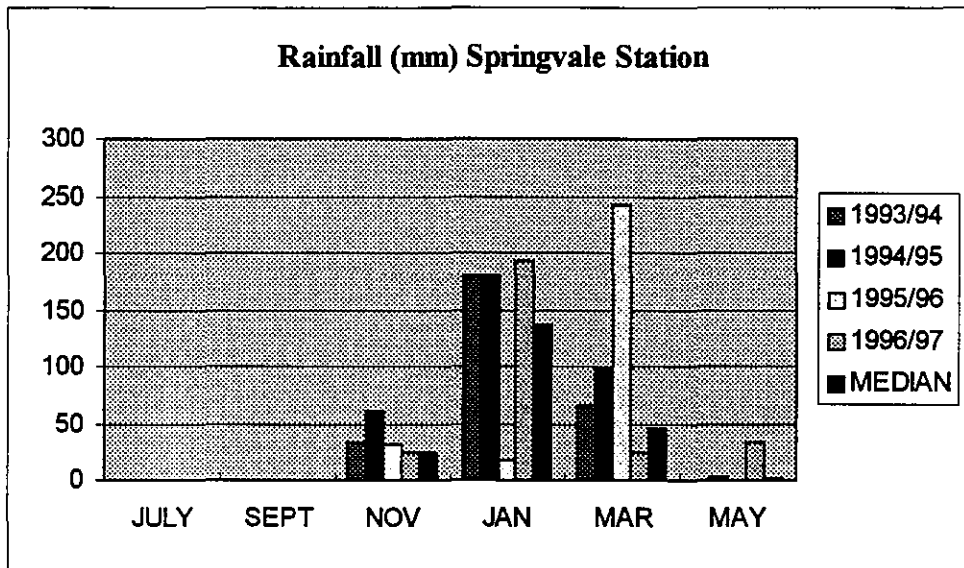


Figure 1. Monthly rainfall totals (mm) on a 'climate year' basis, Springvale Station homestead, and median rainfall (mm) Halls Creek, WA.

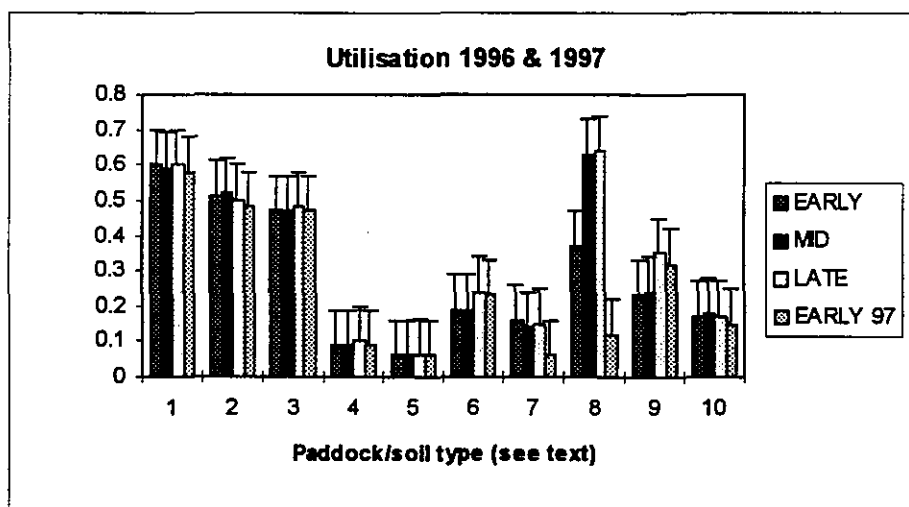


Figure 2. Assessed forage utilisation on a range of soil types, Springvale trial site, 1994 (Soil codes as listed below).

- | | |
|------------------------|----------------------------|
| Wilagee paddock: | Whitewater paddock: |
| 1 Black soil | 6 Grey soil |
| 2 Black/brown soil | 7 Red soil |
| 3 Frontage soil | 8 Black/brown soil |
| 4 Red soil | 10 Whitewater paddock mean |
| 5 Red/brown soil | |
| 9 Wilagee paddock mean | |

Utilisation at monitoring sites near the new bore (installed late 1994) continued to increase on the red/brown soil types, with a lesser utilisation increase on the red soils during 1996 and 1997 (Figure 3).

The effect of supplement location on utilisation appeared restricted to sites close to the supplement location. However, in those locations there was a sharp increase in the number of perennial plants grazed compared to the previous year (Table 2).

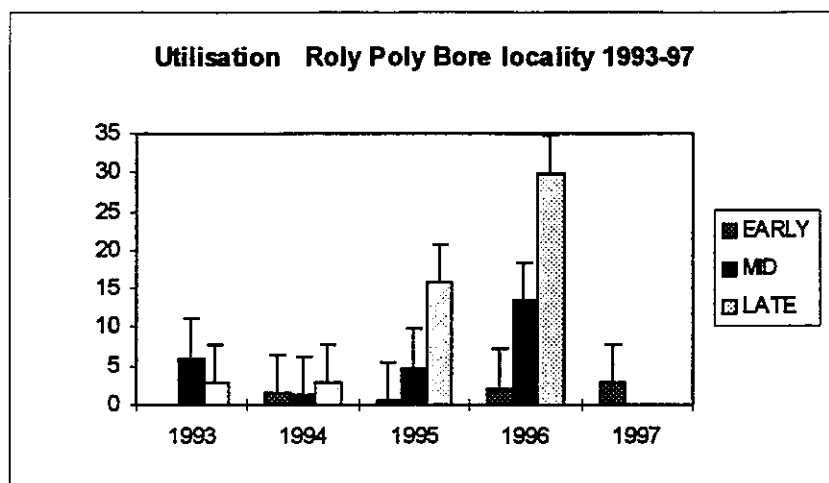


Figure 3. Assessed forage utilisation over time, Roly Poly Bore, Springvale

Table 2. Utilisation levels (% grazed plants) prior to and following distribution of supplements, 1996/97.

Sampling date	Location 1	Location 2
April 1996 (prior distribution)	15.3	4.1
April 1997 (post distribution)	18.1	27.2

Definition of range trend indicators

Substantial botanical composition changes were recorded in response to various management regimes imposed (exclosure, heavy/light grazing pressure). These changes were mainly associated with changes in frequency of annual and perennial grasses. There was little change recorded in soil surface condition. This provides a promising direction to the identification of indicator species that could signal both positive and negative changes in rangeland trend, with sufficient time then being available to managers to proactively respond in their management. However, the trial timeframe has not permitted identification of indicators at a sufficiently practical and robust scale, nor has there been a substantial shift in the 'state' of the pasture communities studied. This restricts definition of those indicators that signal a substantial shift in the range potential and overall condition. Moreover, results do not yet permit identification of 'triggers' that indicate substantial transitions from one state to another.

Cattle production

Cattle data were recorded at the August 1996 muster (Table 3). Cows from Whitewater Paddock were generally in poorer condition than Willagee cows. This is because of inter-paddock differences, calving pattern in the previous wet season and timing of weaning. Willagee is considered a "better" paddock than Whitewater and this is strongly supported by the recorded data of forage type and availability and the distribution of water and hence grazing radius and ability to select.

Causes of uneven grazing

Sample collection began in late dry season 1996 and continued through the wet season in an attempt to determine if some factor or factors could be identified that contributed to the uneven grazing distribution. Prior soil analysis had not indicated any consistent factor associated with cattle preference, apart from higher calcium levels on black soil. Further soil analyses in early 1997 suggested a trend for a higher levels of Ca, Mg, Cu and Zn in the black soils sampled.

Table 3 Willagee and Whitewater Paddocks cattle production summary, August 1996.

Measurement	Willagee Paddock		Whitewater Paddock	
	Number	Percentage of total/s.e.	Number	Percentage of total/s.e
Breeders mustered	484		522	
Breeders returned to paddock	436		388	
Calves returned	50		98	
Mean liveweight of breeders (kg)	355	2.7	339	9.8
Mean condition score of breeders	2.5		1.83	
Number of dry cows	211	48.4%	101	23.5%
Number of wet cows	225	51.6%	297	76.5%
Mean condition score of dry cows	2.8		2.4	
Mean condition scores of wet cows	2.2		1.66	
Number of empty and dry cows	21	2.6%	10	2.6%
Number of empty and wet cows	131	54.8%	213	54.8%
Number of pregnant and dry cows	186	23.5%	91	23.5%
Number of pregnant and wet cows	85	20.6%	80	20.6%
Mean condition score of wet empty cows	2.0		1.6	
Mean condition score wet pregnant cows	2.4		1.9	

Analysis of pasture samples collected in February for dry matter digestibility (DMD), (equating to energy content) and crude protein (CP) indicated a predominance of high nutritive value forbs and annual grass species on black soil. However, dry matter availability was low. Of this, a substantial proportion was *Rhynchosia spp*, with a DMD of 64% and a CP content of 21%. In February, little grazing was apparent on the black soil areas, however, much had been grazed by April. The species of grasses that have been consistently recorded as being grazed on both red and black soil sites include *Chrysopogon fallax* (Ribbon grass) and *Dicanthium fecundum*. In both the DMD and CP of the green leaf collected from black soil sites was numerically higher than that collected from red soil sites. (This is yet to be shown as statistically significant).

Communication

A communication plan was developed for the duration of NAP3. This was assessed by the MRC.

A field meeting was held on Springvale Station as part of the Halls Creek-East Kimberley Land Conservation District meeting. The concepts of the trial were discussed as well as the current results. Outcomes of the trial and the importance of considering the composition of within-paddock pasture communities are being incorporated into other Agriculture Western Australia projects.

Plans for 1997/98 and beyond

At a meeting of the Kimberley Beef Industry Development Team in May 1997, a decision was taken to terminate this trial. The decision was based on funding restrictions to the Agriculture

Western Australia Meat program, the program that funds the Agriculture Western Australia input into this project. This decision has been communicated by the manager of the Agriculture Western Australia Meat Program to the MRC. Discussions have begun with the cooperators and the MRC regarding the dismantling of the trial infrastructure. Final data collection at the trial site was conducted in late April 1997. However, in discussions with the cooperators, it has been decided to retain some exclosures etc. at the trial site to allow longer term monitoring of some of the impacts of the trial. Analysis of those data collected from the first stage of the trial (NAP2) will continue.

Discussion/Comment

1. *Were there any significant differences between soil types in chemical analysis and in analysis of forage?* The major differences are as outlined in the report. Calcium levels were certainly higher on the black soil, a characteristic of other sites preferred by cattle in different situations apparently. Some micro-elements also varied across soil types. Further analysis is really needed to tease out any significant differences.
2. *There is a clear preference for black soils. Shouldn't management strategy be based on the assumption that cattle only graze the black soils and set stocking levels accordingly?* This certainly appears a biologically correct option, and is mentioned in the introduction of the NAP2 report. However, the manager is then faced with losing the opportunity cost of the ungrazed areas (often being in excess of 80% of the paddock area). Obviously, this was virtually impossible to "sell" as a management guide.
3. *There would be more and less heavily grazed patches within the black soil?* Yes and no. For the most part, the individual pasture types varied in the degree to which 'patches' formed within them. Black soil was fairly uniformly grazed (heavily) and there was no real patch development at the trial site. The reverse was true on the red soil, the spatially dominant soil type, where typical patches formed. However, on other leases where black soil is more spatially dominant (including one of the leases on which research was to be established in Phase 2 of the trial) there was some patch development within areas of black soil.
4. *Reverse of preference for black soil is seen in cattle on Kidman Springs. How is preference influenced by the condition of the pastures. Preference may be for state rather than vegetation type per se?* Comments are true and match our experiences elsewhere. We also have recorded instances where black soil is avoided and red soil appears to be more preferred. In this case, the preference for black soil appeared more an aversion to the boggy nature of the black soil during the wet season, rather than an affinity for red soil. Certainly, the range of pasture types on offer and their topographical position is important. However, the aim of the trial was to identify the ability to 'deal' with the unevenness of grazing caused by different attractions of different pasture types, the Springvale site being one of a range of examples of this. However, in order to test how robust our outcomes were, the aim under Phase 2 of the trial was to establish trial sites on a further two leases with different combinations of pasture types (but where the problems of uneven grazing were apparent) and assess the effectiveness of the techniques identified on the original trial site at Springvale Station. As regards range condition (state?) and its effects on preferences, observations and experience suggest that cattle prefer areas dominated by annual and biennial species rather than perennials. This has shown true for both heavy clay black soils and red soils.
5. *Can fire greatly influence cattle distribution?* Definitely, and fire always was planned as a major tool for assessment in this regard within the trial. However, this trial has highlighted

the difficulties associated with research of this nature being conducted within the context of a larger commercial operation. Control of the trial remained with the station management. Without the agreement of the manager, burning was impossible.

6. Mick Quirk: How do "grazing for profit" (cell grazing) people adapt their technique for extensive areas? RESPONSE: I don't really know. Obviously, the 'cell' size would be a function of the carrying capacity of the pasture type. On much of the relatively low carrying capacity country under extensive conditions, cell size would need to be reasonably large to accommodate mobs of several hundred cattle unless there was a move among cells on a fairly frequent basis. Beyond that I cannot really comment further, since there has been little development of cell grazing in the north-west. Certainly, the long dry season in the Kimberley region would reduce any regrowth of grass following very heavy grazing during the dry season.

7. *Can more information be provided on the alkane technique?* The use of the alkane technique in this trial was twofold. Firstly, there was an interest in assessing its utility within extensively grazed situations, and the extent to which the alkane signatures of one species may vary over significant environmental (especially rainfall) gradients. Secondly, if successful, it offered a straightforward technique to establish the actual grazing distribution of the cattle by defining unique 'indicator' species of the various soil/pasture type combinations. As a means of determining cattle preference and the basis for uneven pasture type utilisation of available forage, plant samples were collected along a north/south environmental gradient of approximately 250 kilometres, and covering a rainfall gradient of approximately 300 mm annual average rainfall. Samples of ten genera comprising nine grasses and one shrub (*Heteropogon*, *Astrelba*, *Sehima*, *Acacia*, *Cenchrus*, *Chrysopogon*, *Dichanthium*, *Iseilema*, *Ophiuros*, *Panicum* and *Enneapogon* spp.) were collected and analysed for their n-alkane content (Dove and Mayes, 1991). Following determination that it was possible to discriminate among tropical grass genera using this technique, the cattle diet in the trial was assessed from dung samples collected in mid-1996. This additional information, in association with the data from the forage utilisation studies will provide a far more detailed picture of the cattle diet, and the relationship of the actual preference to the availability of forage in the field. Analytical results from the faecal analysis are not yet available.

8. Additional comment was provided that the alkane technique has difficulty distinguishing between species where there are more than 5 species. Histological faecal analysis is as reliable. Response from PN was that certainly the histological analysis technique is reliable. However, our experience suggested that the alkane technique could be far more straightforward and efficient. Since our aim was to identify indicator species rather than all species, the problem of differentiating among a large number of species was not an issue.

Woodland management and woody weed control for Queensland's beef pastures

MRC Project number: NAP3.210
Project duration: NAP1 & NAP2; NAP3 - 01/07/96 to 30/6/99
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Objectives

1. To refine and modify integrated whole property management systems for the sustainable and economically viable use of the grazed eucalypt woodlands. This to be achieved by:-
 - Increasing our understanding of the dynamics and ecology of eucalypt woodlands by monitoring change in both undeveloped and developed situations.
 - Developing control techniques for specific emerging native woody weeds.
 - Further development of the decision support packages *Woody Weed Adviser* and 'GRASSMAN' and testing the former's use and acceptance by survey.
 - Finalising the 'TRAPS' (Transect Recording And Processing System) manual and supporting software and to promote its use as a long term woodland monitoring tool for R&D specialists in northern Australia.
2. To implement an effective communication strategy to achieve the industry goal.

Summary

About 60 M ha of Queensland's 76 M ha of forest woodland communities are grazing land which remain amenable to various degrees of responsible development. This could conceivably increase beef cattle carrying capacity by 1-2 M head and reduce turn-off times. Development principles evolved should also be relevant to the Northern Territory's top half.

This Project is providing a comprehensive set of quantitative data, as well as testing the methodology necessary, for a soundly based woodland management policy for these woodlands through:-

- detailed descriptive studies of woodland structures
- by evaluating traditional and innovative development strategies
- by cataloguing available control measures for native and exotic woody weeds
- by testing new products, by establishing field trials and by using contemporary technology for data collection and processing, information exchange and decision support.

The expertise generated has enabled research staff to take leading and authoritative stands on the management of grazed woodlands when such management is being subjected to intense public scrutiny. It has enabled a defining position to be taken on Australia's

Greenhouse Gas Inventory. These stands at State and Federal level have been and continue to be of considerable benefit to the grazing industry and help shield it from unwarranted and unsubstantiated criticism.

Report

1. Whole Property Management Systems

a. *Dynamics and Ecological Studies of Eucalypt Woodlands*

The core woodland development site at "Wandobah" near Dingo in Central Queensland continues to provide data on regrowth rates following the initial clearing treatments in 1987. All the permanent transects were re-recorded in 1996. Because of the detailed knowledge of this site it has been used recently to collect data on woody plant biomass, soil carbon store and tree-grass relationships as they are affected by the various treatments imposed.

The portfolio of permanent vegetation monitoring sites on Queensland's 60Mha of grazed woodlands has been expanded appreciably in the past 12 months, with support from the State government's Statewide Landuse and Tree Study. Currently the direct database maintained by NAP3.210 includes some 75 sites. Sequential recordings, coupled with the 'TRAPS' processing software developed by the project, provide a powerful teaching aid for extension staff and producers (by graphically demonstrating changed woodland structures resulting from differing management).

b. *Woody Weed Control Studies*

(i). Fire

The control of wattles (*Acacia leiocalyx*, *A. grandifolia*) with fire study at "Wigton" near Gayndah in the Burnett is progressing to schedule. The current drought has meant that fuel loads for the 1995 and 1996 burns were not high but successful burns were obtained. There is again adequate fuel for this year's burn which will be carried out in the September/November period. A fire intensity rating is carried out after each burn and full assessments made prior to the next burn. This gives the effect of previous burns and growth rates following burns. The difference in the response to fire between the two species is very marked. After one fire the *A. grandifolia* density was greatly reduced whereas *A. leiocalyx* root suckered and the population exploded.

The control of currant bush (*Carissa ovata*) with fire study at "Pasha" in the Mt. Coolon area has been severely curtailed due to the ongoing drought in that area. However, the first burn was carried out in February 1996 and there is now enough fuel for the second burn in September-November this year. As with the *Acacia* trial a fire intensity rating is carried out after each burn and full assessments made prior to the next burn to document the effect of previous fires and growth rates following burns. The first fire resulted in a greatly reduced canopy cover of currant bush, but had little effect on plant numbers.

(ii). Herbicide Screening

A herbicide screening trial on bitter bark (*Alstonia constricta*) in the Theodore area is complete with the results from this to form the basis of further herbicide studies in the Central Highlands later this year. One significant result of the Theodore trial was the good kill achieved with foliar application of Glyphosate. This is a very useful finding because this plant is a major weed in cultivation on the Central Highlands and this precludes the use of residual herbicides.

A small screening trial to test the effectiveness of various herbicides applied as a cut stump treatment, basal bark treatment and overall spray for controlling swamp mahogany (*Lophostemon suaveolens*) was carried out in the Cawarral area east of Rockhampton. A number of treatments gave very good results for this hard to control plant (foliar application of metsulfuron methyl, metsulfuron methyl plus glyphosate and fluroxypyr all gave good results).

A trial to test the effectiveness of a the "SUCKERBUSTER", a machine developed by Grant Armour at Emerald for controlling mixed woody regrowth, was established at "Codenwarra" near Emerald in March 1996. Two herbicides at three application rates were used. This machine knocks the plant over and applies the herbicide as a wipe to the stems and leaves.

Two herbicide screening trials for controlling sally or black wattle (*A. salicina*) have been established. One was carried out in conjunction with DowElanco in the Alton Downs area west of Rockhampton in May 1997 (stem injection with nine treatments) and the other in conjunction with DuPont in the Dysart area of the central highlands(stem injection (8 treatments) and cut stump treatment (6 treatments) in June 1997. This species is seen by both these companies (the major players in the woody weed herbicide market) as the most important native woody weed in the better class of grazing land in Queensland.

Another small screening trial to test the effectiveness of various herbicides applied as a cut stump treatment (brushcutter) for the control of corkwood wattle (*A. bidwillii*) was established in the Dysart area in June 1997.

More herbicide screening trials will be established on other problem species as time and the opportunity become available. Species to be targeted include *A. farnesiana*, *Atalaya hemiglauca* and *Capparis lasiantha*.

c. **Economics**

Discussions with DPI economist Trevor Wilson were carried out early in 1997 to actively explore mechanisms for the economic analysis of resource management issues on a case by case and whole farm basis. The use of a case study approach, as in the Drought Plan project, will be adopted to demonstrate the utility of woody weed control and woodland management options to producers.

d. **Woody Weed Adviser**

A survey was conducted in December 1996 and January 1997 of all registered **Woody Weed Adviser** users and 72% responded. These were located throughout the state from Mareeba in the north to Ipswich in the south and west to Charleville and Longreach. There are also users in the Northern Territory and at Kununurra in Western Australia. From the survey it appears that most use is made of the package in the Burnett and South East Queensland followed by the eastern Darling Downs and Central Queensland. The DPI Information Services in Brisbane, Toowoomba, Gayndah, Monto and Dalby all report heavy usage of the package.

Whilst **Woody Weed Adviser** information is available to most producers through departmental staff, Landcare and PMP groups, agricultural chemical resellers and consultants it is felt that more use of the package could be made by resellers (only 5 at present) and consultants (2) and that these people should be targeted more vigorously. Local council weeds officers will also be targeted as only one council (Mackay) has purchased the package to date. This will be done through the Queensland Local Government Association.

Ninety four percent of respondents said they would like a 'Windows' version of **Woody Weed Adviser**. A 'Windows' version is now being developed and will be distributed as the 1997 upgrade in November.

Many respondents made comments on the package. The most widely suggested improvement was the inclusion of colour photos of plants to aid identification, either as printed photos or as a CD ROM format. To this end a CD Writer has been purchased with funds generated by the project and a CD ROM with photos is in preparation. (The MRC provided funds for the initial

development of *Woody Weed Adviser* but the project is now self funding with enough income to produce the annual updates and further software development.) There were also requests for more information on herbaceous pasture weeds, mechanical control methods and the effects of fire. It is not intended to include herbaceous weeds at this stage but identification photos could be included in the CD ROM package.

e. 'TRAPS' Software Development and Manual

The 'TRAPS' (Transect Recording And Processing System) field manual and electronic field recording module is complete. This module has undergone intensive field testing both by this group and others and has proved reliable.

The data processing module is in the final stages of development and an evaluation copy has been distributed to a number of users for testing and comment. This is a 'Windows' program which allows the data to be edited, individual or groups of species selected, displays the data in graphic form, allows capture of the graphic data, analysis of data, data saved in either .DBF or .TRD (field logger) format and enables reports to be exported in either .DBF or text format.

The user manual for this program has been prepared.

2. Communication Strategy

A workshop to formalise the communications strategy for this and related projects is planned (to be facilitated by Judy Lambert, Community Solutions) for August 6th 1997. In the meantime the following point strategies have been implemented.

a. Beef 97

This was held in Rockhampton in April 1997 and woodland management and woody weed control was a major theme at the comprehensive DPI and TBC displays. Beef 97 is the premier beef industry exhibition in Australia and attracts many thousands of producers. This project highlighted woodland management for sustainability.

b. Publications/Media

A DPI NOTE on 'Control of currant bush in developed brigalow country' was prepared from the results of the "Tullach Ard" trial and was distributed through the DPI NOTE system.

A program segment on managing eucalypt woodlands was filmed at "Wandobah" in June for the "CROSS COUNTRY" national television program. Emphasis was placed on the part that this study has played in developing the State Tree Clearing Guidelines.

More DPI NOTES are to be produced as results from herbicide screening trials become available.

c. State Tree Clearing Guidelines /Greenhouse gas debate

Bill Burrows is Scientific Adviser to the Minister for Natural Resources on the State Trees Group which is overseeing the implementation of the tree clearing guidelines on Queensland's leasehold land. Information available from this project has been extremely important in securing a sensible outcome for both primary producers and conservation interests in this guideline process.

The database developed in this project has also contributed significantly to improving the Land use Change and Forestry sector calculations of Australia's Greenhouse Gas Inventory. For example, estimates of net CO₂ emissions from this sector have been reduced from 131Mt (Workbook 4.0) to 122Mt (Workbook 4.1) to the current estimate of 67Mt (Workbook 4.2). Additionally Workbook 4.2 for the first time acknowledges this project's evidence that woody plant thickening is a man induced process in the grazed woodlands of northern Australia. Data

supporting this contention should be included in the next revision of the Land use Change and Forestry sector. (As a consequence this sector will then be identified as a positive sink of c. 20Mt CO₂ equivalent).

Without the information available from this project there is little doubt that graziers ability to maintain carrying capacity in the grazed woodlands, and improve it responsibly where appropriate, would have been seriously curtailed because of 'data free' tree clearing and greenhouse arguments aimed at completely stopping woodland development in Queensland.

d. Industry Consultative Committee

The CQBRC has agreed to provide a Consultative Committee to discuss the direction and results of the research in order to keep abreast of industry concerns and to help evaluate adoption of new systems.

Discussion/Comments

1. *What was the burn rating used in the Pasha' currant bush burning trial?* 0 = no visible effect, 1 = all leaves brown, 2 = all leaves consumed and 3 = all the plant consumed.
2. There was general discussion of burning for native woody weed control. Prevention was better than cure and the move away from pasture burning in the north had contributed to the woody weed thickening problem. Tony Grice queried the frequency of burning and said his work suggested burning every 5 years was sufficient to control native woody plants.
3. Sue McIntyre was concerned that sandalwood and wattles would be over cleared because of our success! She also took exception to the idea of native woody plants being described as invasive.
4. *Did the 'State Tree Clearing Guidelines' embody our principles and follow our earlier recommendations?* Not only do they follow these principles but that the information available from the NAP2 project had been vital in getting acceptance of these guidelines across the various interested parties.
5. The widespread adoption of the 'TRAPS' monitoring package was advocated. It could be used by Universities and Agricultural Colleges as well as woodland researchers.
6. *Have these native woody plants have become weeds in response to management?* General discussion followed with the consensus being that historical, anecdotal, empirical and $\delta^{13}\text{C}$ evidence strongly endorsed this conclusion.

Managing tropical woodlands to control exotic woody weeds

MRC Project number: NAP3.206
Project duration: NAP2 and NAP3 - 01/07/96 to 30/06/99
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Objectives:

1. Quantify, for land management purposes (i.e. seasons, plant size), the amount of time that elapses between germination of a woody weed cohort and seed production by that cohort
2. Determine biologically and economically efficient burning frequencies from the relationship between individual woody weed plant size and density and forage production
3. Develop management practices (fuel loads, environmental conditions, season etc) for the frequency and intensity of burning to control a suite of exotic woody weeds by limiting seed production and direct mortality of juvenile and adult plants
4. Develop a computer based decision support package for use by research and extension officers to assist property managers to evaluate ecological and economic priorities for prickly acacia control at the paddock scale
5. Integrate ecological data (seed production, seedling establishment, growth rates, time to flowering, burning mortality etc) into economic analysis for decision support of rubbervine management at the paddock scale

Summary:

The initial phase of this project (NAP2 CS.219) was oriented toward developing management principles for maintaining landscapes in a weed free condition when exotic weeds were present in low populations. The results from that work have shown that weed invasion may not be as constrained by competition from herbaceous vegetation to the extent that most land managers, advisers and researchers believe and that fire, if properly managed, can be an effective tool for both containing the spread of weeds. In extending this work into the next phase, we wish to more fully address the long-term nature of the problem of using low input techniques to manage weed problems and develop explicit management practices that producers can confidently and reliably implement.

Report

Seedling recruitment and growth (Objective 1):

Acacia nilotica: With a return to precipitation patterns that are closer to long-term average in 96/97, we have been monitoring several populations of *Acacia nilotica* at sites ranging from western to coastal Queensland. There is wide variability between sites depending primarily on patterns and amount of localised rainfall, especially in the more arid Mitchell grass areas. However, we have observed seedling survival in excess of 60% on some sites and greater than 30% in most areas. Seedlings exposed to defoliation by sheep seem to have lower survival (10%) than seedlings exposed only to cattle grazing (>30%).

At coastal sites (Bowen and Giru), a good 96/97 wet season resulted in large numbers of seedlings emerging. A cohort of 1996 seedlings followed until July 1997 had only about 2%

survival to juvenile stage. Of seedlings that were recruited in 1997, over 30% were still viable in July 97. The 1996 cohort only maintained 20% survival over the same time period in 1996, so it is likely that the 1997 cohort will result in at least some new recruitment.

Populations of juvenile *Acacia nilotica* planted in 1991 continue to have very high levels of survival. Of seedlings that emerged and survived the 1991/92 wet season at Lansdown, more than 60% are still alive. About 5% of the juveniles have flowered and produced small seed pods at five years old.

Cryptostegia grandiflora: Rain during February 1997 resulted in the emergence of large numbers of rubbervine seedlings at the Lansdown site. Their survival is being monitored through the 1997 dry season. 35% of rubbervine seedlings survived until mid-July 1997. At that point, survivorship of rubbervine in 1997 was similar to that in previous years. In earlier years, post July survival has fallen dramatically, with few surviving seedlings. However, improved rainfall during the late summer and autumn this year may increase seedling survival.

Populations of juvenile *Cryptostegia* planted in 1991 continue to have high levels of survival. Of seedlings that emerged and survived the 1991/92 wet season at Lansdown, more than 40% are still alive. None of the 5 year old juveniles have yet flowered or produced seed pods. However, these are upland populations on relatively poor soils and rainfall has been less than half the long-term average for the past five years, so that should be considered minimum juvenile survival levels in undisturbed conditions.

Prosopis pallida: More than 7000 mesquite seedlings that emerged in a stand near Hughenden have been monitored over the past two seasons. To date, there have been six germination events (three each year) and survival across all germination events is approximately 10%.

Seedling emergence is positively correlated with adult trees greater than 2 m in height. Seedling survival was highest when seedlings germinated during periods of prolonged, consistent precipitation or when there was good follow up precipitation within one month. When these conditions are met, seedling survival after three months ranged from 22 to 36%. Without adequate follow up rainfall events, seedling survival is only around 4% after three months.

Ziziphus mauritiana: Rain during February 1997 resulted in the emergence of large numbers of chinee apple seedlings at the Lansdown site. Their survival is being monitored through the 1997 dry season. 89% of chinee apple seedlings survived until mid-July 1997. At that point in time, survivorship of chinee apple seedlings from the 1997 cohort was considerably greater than that of 1996 or 1995 cohorts.

Summary of the seedling recruitment, survival and growth experiments: Across all species survival experiments suggest that recruitment of new individuals into the population has two aspects. First, there is an ongoing recruitment of individuals at low levels sufficient to maintain the population at a stable level (to account for mortality of adults). There is also likely to be episodic recruitment during favourable periods (defined primarily by moisture availability over a two to three month period) in which germination, emergence and survival are very high and capable of greatly increasing the population.

These data from naturally occurring populations agrees very well with data from rainout shelter experiments conducted during NAP2. For all species, even during average rainfall years, there is often recruitment of a few individuals (5-20% of emerging seedlings).

Burning for shrub control in grazing operations (Objectives 2 and 3):

Cryptostegia grandiflora and *Ziziphus mauritiana*: Seven 1.2 ha plots at Lansdown were burnt in September 1996, continuing the fire treatments imposed at this site since 1994. Overall, fire had major impacts upon the growth and survival of rubbervine but little impact upon chinee apple.

Mortality of rubbervine due to fire was up to 95% for once burnt and twice burnt small plants and for twice burnt medium-sized plants; mortality of twice burnt large rubbervine was approximately 80%. Mortality was 7%, 0% and <4% for unburnt small, medium-sized and large plants respectively. All fires were conducted with a minimum of 2000kg/ha standing fine fuel, ambient temperatures in excess of 30° C, light winds, humidity less than 30% and fine fuel moisture content less than 25%.

Mortalities of small chinee apple were 5%, 16% and 22% for unburnt, once burnt and twice burnt plants respectively. Mortality rates of medium-sized and large chinee apple were <2% regardless of the burning regime. Reproductive outputs (fruits per plant) of rubbervine subject to various burning regimes were estimated in April 1997. No plants burnt in 1996 produced any fruit in April 1997. Plants in unburnt treatments produced only 1 ± 0.25 pods per plant (mean \pm s.e.).

Reproductive outputs (fruits per plant) of chinee apple subject to various burning regimes were estimated in July 1997. Mean fruit production per plant for the various plots ranged from 16 (for an annually burnt plot) to 385 (for an unburnt plot). There was high variation between plots in the mean number of fruits per plant. On average, unburnt plants produced more fruit than did those subject to any burning regime but these differences were not significant.

The Larkspur sites were not burnt in 1996 due to a lack of fuel. They will be burned in spring 1997.

- Five sites have been established in riparian environments in the Charters Towers areas. The rubbervine populations of up to 20 plots per site were described. One of these sites was burnt in December 1996. The effects of this fire are being monitored; mortality rates are typically around 50%. Other sites had not yet been burnt due to flooding and heavy rain.

Prosopis pallida: A fire experiment was commenced in November 1996 at the Hughenden site. It appears that fire can be very effective in managing this species. Six months after burning, only 7% of plants showed growth compared to over 90% in unburnt plots. Mortality was variable and related to fuel contiguity. If grass is sparse, it is difficult to get a fire to carry between trees, however, crown fires in dense stands proved very effective in killing adult trees. There also appears to have been a negative effect on seedbank survival after burning.

In all cases, environmental conditions associated with weed mortality have been collected for the development of management practices that describe 1) frequency of burning and 2) fire temperatures required for control. Fire temperatures required for control will be expressed in terms of amount of standing fine fuel and ambient environmental conditions (wind speed, temperature, humidity etc) for effective use.

Acacia nilotica: Small plot burning trials indicate that even at levels of moderate standing fine fuel (1200 kg/ha), fire has significant effect on mortality of both one-year old and two-year old seedlings. Fire generally kills all of the seedlings and juvenile plants less than two years old if fire temperatures are adequate.

Summary of burning for shrub management: Fire is an effective control technology for use in managing rubbervine, prickly acacia and mesquite populations. However, it is important that standing fine fuel levels exceed 1200kg/ha and that burning be done on relatively dry hot days. Burning rubbervine along riparian areas shows a great deal of promise and mortality rates are high.

Decision support for integrated strategic shrub management (Objectives 3 and 4):

As a result of a collaborative effort among QDNR, CSIRO, JCU and CRC for Tropical Savannas, a simple computer aided decision support package was developed to assist extension officers and groups of land managers to improve strategic management of prickly acacia at a paddock scale. The package allows the operator to set initial densities and then uses field observations to illustrate rates and patterns of *Acacia* increase at the paddock level. This allows land managers to compare the costs and benefits of different management strategies on their property. This software package is available for demonstration.

An economic analysis of burning for rubbervine that integrates the cost of spelling paddocks, fire planning and implementation, lost forage and reductions in forage production capacity with increased shrub density has been completed. The analysis shows that internal rates of return for burning upland populations of rubbervine at low to moderate densities are on the order of 5 to 6% in tropical tallgrass areas. This analysis only considered the value of forage and did not account for changes in ease of mustering, access to water or environmental damage.

Communication Activities:

1. Information derived from this project, and the preceding project went into developing the Strategic management plans for Rubbervine and Prickly Acacia for inclusion in the National Weed Strategy
2. Information from this study and the advice of investigators went into submissions of several National Heritage Trust proposals for weed control projects by landholder groups
3. Information and outputs from this project are the basis of work in the CRC Tropical Savannas, LWRRDC proposals and RIRDC proposals to develop weed management systems

A communication plan was submitted to MRC as requested. Communication objectives during the second phase of this project are to focus on getting research results integrated into property level weed management plans via the Property Management Planning process. Feedback on this approach was heavily criticised because it lacked simple messages and "recipes". We are most eager to discuss our approach in the context of other Projects and activities in the north.

Discussion/Comments:

1. *What is the philosophy ie native vs exotic woody weeds? Parts of northern Australia don't have problems. Should we concentrate on prevention or cure? Exotics should be contained; this doesn't apply to natives.*
2. *What is the rate of spread of rubbervine to the south? Is there a need for an awareness program? Rates of spread are unknown but probably varies greatly in time and space.*
3. *You have identified differences in spatial and temporal dispersal patterns but have you identified characteristics of "boom" years in time and space? This would be difficult, especially in space.*

4. *Should one target poor years?* Rubbervine has limited capabilities for dispersal (10's to 100's metres). Human activity may be an important mechanism.
5. *Fire has been suggested as a means of managing rubbervine. How acceptable is that technology to producers?* Survey of 30 producers all recognised the need to use fire, but couldn't use it today. Catchment groups are working towards management to allow fire (Roger Landsberg). Complaints regarding money for workshops - give us the chemicals. But producer will kill weeds forever. Therefore weed interaction approach - look at landscape.
6. I have advocated fire but other techniques are also useful (Tony Grice). Likewise, chemical/mechanical techniques alone won't work. Need better understanding of interactions.
7. There is a good argument for a fire regime as a regular management tool.
8. *Relationship between fire and grazing. How does one manage post-fire?* Need to have control. Logistically its hard, particularly in extensive areas. Post fire management relatively simple if have objectives and management.
9. Fire is a tool, but has negative consequences. Effects on soil/infiltration etc. There is a price associated with fire.
10. *Killing rubbervine immaterial. Another weed will take its place. How do you counter this?* There is a relatively small group of shrub weeds that pose the major threat. In many areas where rubbervine is a problem there are not immediate threats of other species become major problems.
11. Roger Landsberg disagreed regarding the mechanism of spread of chinee apple. Water is also important as suggested by the fact that it grows on high water marks. Response: It grows there because the habitat is suitable. Water may disperse some seed but it is not the primary means of dispersal. Cattle are most important.
12. Rust and other biological control agents. There is a need to consider how they interact with the "SWEEP" program. Use biological agents in thick areas. Push for outcomes/points of key intervention.
13. *Can general principles for woody weed control be used for the whole of north Australia?* We can for woody weed control. General principles are available with basic rules. Need education - but, there is more than one variable economics become involved, as does social factors - it's a dilemma. But we do know general principles.
14. Present management systems exist in particular regions for good reasons. It takes a considerable effort to change this. Agencies produce information that doesn't change attitudes. How can this be dealt with? How can we cause change?
15. One problem on information uptake is associated with "hierarchy of needs". Lots of people are dealing with basic survival and these people can't focus on better management at present.

Developing sustainable grazing management systems for the semi-arid tropics of the Northern Territory.

MRC Project number: NAP3.211
Project location: Katherine, VRD and Sturt Plateau regions, NT.
Project duration: 01/07/96 to 30/06/2001
Principal investigator: Rodd Dyer
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Co-Investigators: Michael Cobiac and Linda Cafe

Project Objectives

To ensure by 2001, throughout the VRD and Sturt Plateau regions -

1. The majority (>65%) of pastoral land managers have an increased understanding and knowledge of local pasture communities and basic grazing ecology and management.
2. That 50% of pastoral managers have investigated the economic viability of a range of sustainable grazing management options using a range of Decision Support Systems (DSS) in a whole-property framework.
3. 60% of pastoral properties have documented current paddock and property stocking rates and developed individual estimates of sustainable livestock carrying capacity.
4. 70% of producers are aware of the principles and best practice of controlled burning by providing a relevant and practical fire management manual and presenting information at on-property workshops, field days and shows.
5. that the majority (>80%) of land managers and administrators are aware of the increase, cause, impact and potential cost of unchecked woody plants.
6. that 50% of pastoral leases have developed or implemented strategic grazing management plans as a result of active participation in whole paddock demonstrations of sustainable grazing management options.

Summary

The emphasis of the NTA 022 project in NAP2 was the development of effective burning strategies, understanding the competitive relationships between trees, shrubs and pastures and the development of pasture growth models that can be used to investigate the stocking rates and carrying capacity. The first phase of the project involved extensive collection of data. Continuing work will focus on incorporating available data and information into simple management guidelines that fit into whole property management.

To ensure effective development and implementation of sustainable grazing management practices, several approaches will be taken in six new sub-projects. Together these projects will produce a range of products providing information to land managers in a simple and effective manner. Significant work will be undertaken on-property with individual managers in order to capture and record producer knowledge and experience, and provide a cooperative approach to investigating relevant economic and management scenarios at a realistic property level. The power of (GIS), land unit mapping, pasture growth models (GRASP), complete herd and enterprise models (RANGEPACK Herd Econ), and climate (RAINMAN) decision support systems will be utilised to enhance the analysis and presentation of information at a landscape scale and in a whole property context. Finally the establishment of demonstration paddocks on several commercial properties aims to promote the development sustainable grazing management plans by individual pastoralists through group learning.

The project will:

- Produce an information booklet on native pastures and their management.
- Provide economic assessment of grazing management options.
- Record current stocking rates and provide estimates of sustainable carrying capacities at a land type and paddock level.
- Produce an information booklet on practical fire management for pasture management and woody plant control.
- Investigate the impact of woody vegetation on carrying capacity.
- Use grazing demonstrations at the property level to encourage group learning and promote sustainable grazing practices.

Communication Activities

- A summary info-sheet outlining the project goals and activities is being developed for pastoralists and other interested people.
- A large display outlining the project goals and activities was presented at the Katherine Farm and Garden Day at which approx. 2000 rural and urban people attended.
- Plans for on-property economic case studies have been presented to the Sturt Plateau Local Best Practice Group.
- Five on-property case studies have been carried out in conjunction with Rosemary Buxton.
- Collaboration with researchers within the CRC SDOTS has widened the scope of investigations into changes in vegetation structure.
- A summary paper and poster of fire research was presented to the Bushfires '97 Conference in Darwin in July 1997.
- A field day has been organised at the Mount Sanford Stocking Rate Demonstration site where project goals and progress will be presented.
- Government and pastoralist inquiries into sustainable stocking levels throughout the Sturt Plateau have identified an urgent need for objective assessment of stocking rates in this area and better planning processes.
- Plans to finalise on-property demonstrations have been delayed due to reporting commitments, however several potential sites have been identified.

Report

A description and information booklet for better land management of native pasture communities in the VRD (Objective 1)

A total of twenty three SWIFTSYND sites were established in NAP2 to calibrate and validate GRASP pasture growth models for a range of pasture types and land conditions throughout the VRD. Completed models will enable the description of seasonal variability effects on pasture production. From these sites a detailed data set of pasture, soil and climate relationships exists. Fire management research at Kidman Springs and the Mount Sanford stocking rate demonstration has also yielded valuable pasture and animal production data.

The aim of this sub-project is to utilise research information gained throughout the first phase of NTA 022 to produce a booklet directed at graziers throughout the VRD, Katherine and Sturt Plateau areas. This booklet will provide description of the basic characteristics of the major pasture communities and outline the likely impact of land management practices in a state and transition model framework. Collaboration with the Resource Capability Assessment section within the NT Dept. of Lands, planning and Environment will be sought.

Possible headings within the booklet are summarised below:

- Influence of climate and seasonal variability on pasture production.
- Description and characteristics of major pasture communities
- Description of state and transition models (STM's)
- Assessment of land condition
- Management strategies for avoiding land degradation
- Safe levels of utilisation, stocking rates and carrying capacity
- Examples of sustainable grazing management strategies from producers

Detailed analysis of pasture, soil and climate data is underway. Input from pastoralists, other government agencies and other researchers will be sought. The format and content of the booklet will be determined by December 1997. A draft outline is expected by June 1998.

Economic assessment of grazing management options (Objective 2)

The economic analysis of development, management and marketing options is essential to assess the potential financial risk and impact of management decisions. It is also necessary to promote the increased adoption of sustainable grazing management options.

In cooperation with individual pastoralists, the economic impact of various climatic and management scenarios is being investigated throughout the Sturt Plateau and VRD. On-property case studies will utilise Herd Econ, GRASP, Breedcow Dynama and RAINMAN decision support systems. Input data for each enterprise will be provided from producer records and knowledge, and available production and economic data..

During June and July 1997, Rosemary Buxton, from CSIRO Wildlife and Ecology in Alice Springs demonstrated the use of the Herd Econ and undertook, in conjunction with DPIF, case studies on five individual properties in the Sturt Plateau and VRD. This has provided an excellent start to this sub-project, and will be continued for other properties throughout the project. Individual property reports are provided to each pastoralist. Major regional issues will be summarised in regional reports.

Four of the five properties were located on the Sturt Plateau. This is a unique biogeographic region characterised by the ongoing subdivision of large extensive leases (2000km²) to smaller privately owned and managed properties (600km²). Grazing management issues in this region are unique. Properties are in the early stages of development. Current herd sizes are generally small but increasing. Grazing is totally reliant on native pastures however there is potential for improved pastures and opportunity cropping enterprises.

Herd size is currently restricted by limited fenced country, the availability of capital to purchase livestock, fencing and water infrastructure, the natural rate of herd increase and the supply and cost of labour. Trading in cattle, providing land for agistment and short term "depoting" of cattle on route to the live export markets in Asia provides important additional income and cash flow for enterprises in this region. Regional and property stocking rates are generally very low, however there is potential for localised overgrazing with the confinement of cattle to available fenced paddocks during herd development. There are currently no objective assessments of carrying capacity for different pasture communities within the region.

Property case studies investigate herd and property development options that maximise cash flow while maintaining stocking rates at sustainable levels. Case studies will include stocking strategies (conservative, flexible) the influence of seasonal variation, herd management options, purchasing and marketing options, sensitivity analysis of reproduction and market performance, burning management and the possible future impact of increasing woody plants.

Assessment of stocking rates and carrying capacity for pastoral properties (Objective 3)

Livestock stocking rates determine the profitability of pastoral enterprises as well as influencing the risk of degradation to grazing lands. Long-term carrying capacity is determined by average seasonal conditions and the, proportion, and condition of various pasture communities represented in each area. There are few objective estimates of safe stocking rates for pasture communities throughout the VRD and Sturt Plateau. Current recommendations are based on subjective estimates over the years. Disagreement regarding "safe" stocking rates exist between different government agencies and pastoralists.

This project will gather current stocking rate information and utilise grazing research results, pasture growth models, producer knowledge and GIS to estimate safe levels of stocking on a pasture community (land unit), paddock and property basis. The methodologies outlined by Scanlan *et al* 1994 and Johnston *et al* 1996 will be utilised.

During the project:

1. Current recommended stocking rates will be collated and summarised from available sources.
2. Stocking rates on a property basis will be recorded at the paddock level in conjunction with the land manager.
3. Estimates of safe stock carrying capacity at a paddock level will be presented on a property map using GIS. These estimation will account for pasture type, condition and seasonal variation using "safe: levels of utilisation (from producers and research results) and predictions of pasture growth from historical climate data. Current stocking rates and estimated safe carrying capacities will be compared and large discrepancies investigated.
4. The relationship between stocking rates and land condition will be made from objective observations from selected paddocks where current stocking rates exceed estimated safe levels of stocking.
5. Maps showing current and "safe" stocking rates and levels of utilisation on a paddock basis will be provided to station managers
6. A regional summary of property stocking rates, carrying capacity and levels of utilisation will be undertaken.

The GRASP pasture growth model will be used to described the effect of seasonal variation on pasture production for a range of pasture communities. Final validation of GRASP pasture growth models is ongoing in coordination with Ken Day. Model validation will be complete by December 1997. Current recommended stocking rates on a land system basis are being assembled.

Safe levels of utilisation for Mitchell grass pastures

Preliminary estimates of safe levels of utilisation and stocking have been made for Mitchell grass from data collected at the Mount Sanford Stocking Rate demonstration. In the Mount Sanford trial area, most of the stocking rate treatment paddocks would be considered to be in "good" condition. The pastures are characterised by a dominance of perennial tussock grasses, mainly Mitchell grass species, complimented with a range of annual grasses and forbs in inter-tussock spaces. Since 1994 the proportion of perennial grass across the sites has increased, while annual grasses have generally decreased. The proportion of legumes and forbs has remained steady. This is a result of an exceptional run of above average seasons.

Safe levels of utilisation of Mitchell grass pastures in good condition appear to be between 20% - 25%. Utilisation rates around 22% were calculated for the highest stocking rate paddock (Budgie paddock; 15 breeders/ sq km). Between 1993 and 1997 the proportion of palatable perennial grasses (particularly Mitchell grass) increased under this level of utilisation, while annual grasses and forbs decreased. This rate of utilisation would then be considered both productive and sustainable. These values agree closely with "safe" utilisation values summarised from grazing trials by Johnston *et al* (1996).

Determining a safe stocking rate

Although a stocking rate of 15 head/km² would be appropriate for recent seasons, long term stocking at this level would result in an average utilisation rates of greater than 40%. At these levels reduced animal production and pasture degradation would be likely. Stocking rates between 7.5-10 head/km² provide average utilisation rates between 21.4% - 28.5% respectively. Likewise average stocking rates can be calculated for a desired level of utilisation. A stocking rate of 9.4 head/km² will utilise on average 22% of annual pasture production.

Developing practical burning guidelines to manage pasture communities and woody plant populations (Objective 4)

Fire management is of particular importance for the sustainable use of pastoral lands in northern Australia. There is considerable uncertainty and difference of opinion regarding the potential benefits and cost associated with the prescribed use of fire.

The effects of fire on pasture condition and woody plant structure have been examined on black and red soil pasture communities in the VRD. Results are summarised in the MRC final report for NTA 022. The longer-term influences of fire season (early dry and late dry season) and frequency (0,2,4,6 years) are being investigated in continuing research. Successful late and early dry season were carried out in October 1996 and June 1997 respectively. Early results indicate that regular fire is essential to manage native woody tree and shrub structure. Plant mortality following fires over a range of fire frequencies, intensities and seasons is very low. Woody plants are well adapted to regular fire. There is little impact of fire on the yield, cover and species composition of perennial grass pastures in "good" condition. Preliminary recommendations have been made regarding fire frequency, season, intensity and fuel load required for effective management. Relationships have been identified that allow the prediction of fire impact on woody vegetation from fuel (yield and cover) and average woody plant height inputs. Investigations have identified that fire should not be used as part of land management on pastures in poor condition. Where annual forbs and grasses are recolonising heavily utilised areas, fire can cause significant reductions in yield and cover.

The aim of this sub-project is to further develop burning guidelines and provide land managers with a booklet that details the expected benefits and impacts of using fire. The booklet will be directed at land managers and provide answers to frequently asked questions such the reasons for burning, when, where, how often, what types of country and how much to burn for a range of climatic zones and pasture communities. It will also serve to outline practical operational procedures involved in sustainable use of fire. Information will be collated from available fire ecology research undertaken in the VRD and across northern Australia and involve input from experienced pastoralists, other researchers and other agencies such as the NT Bushfire Council and Bureau of Meteorology.

Possible chapter headings for fire management booklet

- Management uses for prescribed fire
- Fire weather
- Fire effects
- Fire behaviour
- Fuel characteristics and management
- Case study (producer) examples
- Operational procedures
- Fire management planning and calendar
- Use of remote sensing and fire history maps
- Fire information and technology

Within the next six months the booklet format and content will be determined in collaboration with the NT Bushfire Council and with ongoing consultation and input from pastoralists and other

researchers. It is hopeful that the editing skills of Ian Partridge will be utilised in the production of the booklet.

The impact of woody vegetation throughout the semi-arid tropics of the Northern Territory (Objective 5)

Anecdotal and scientific evidence suggests that the size and density of native and shrub species are increasing throughout the VRD. The influence of the tree and shrub layer on pastures in northern Australia is poorly understood.

Four experimental sites have been established in the Victoria River and Katherine districts to determine overstorey and understorey relationships in densely treed and cleared areas. The aim of this trial is to: 1. Quantify the effects of tree density on soil moisture and pasture production at two locations with distinctly different rainfall; 2. Provide sufficient data to calibrate and validate tree effects within the GRASP pasture growth model for the communities sampled and; 3. Utilise GRASP to extrapolate tree effects across a range of climate, soil and vegetation systems.

Pasture production for treed (Eucalypt woodland) and cleared plots and the daily rainfall for the 1995/96 and 1996/97 seasons are shown for one Katherine site (Figures 1.) . Pasture production was significantly greater in cleared plots during both years. Rainfall during 1995/96 (790mm) was poorly distributed and below average (960mm). During 1996/97 rainfall (1520 mm) was amongst the highest recorded and was constant during the wet season. Soil moisture between cleared and treed plots was significantly different during 1995/96 but not so during 1996/97 (data not shown). Final plant nitrogen yield was significantly greater in cleared plots.

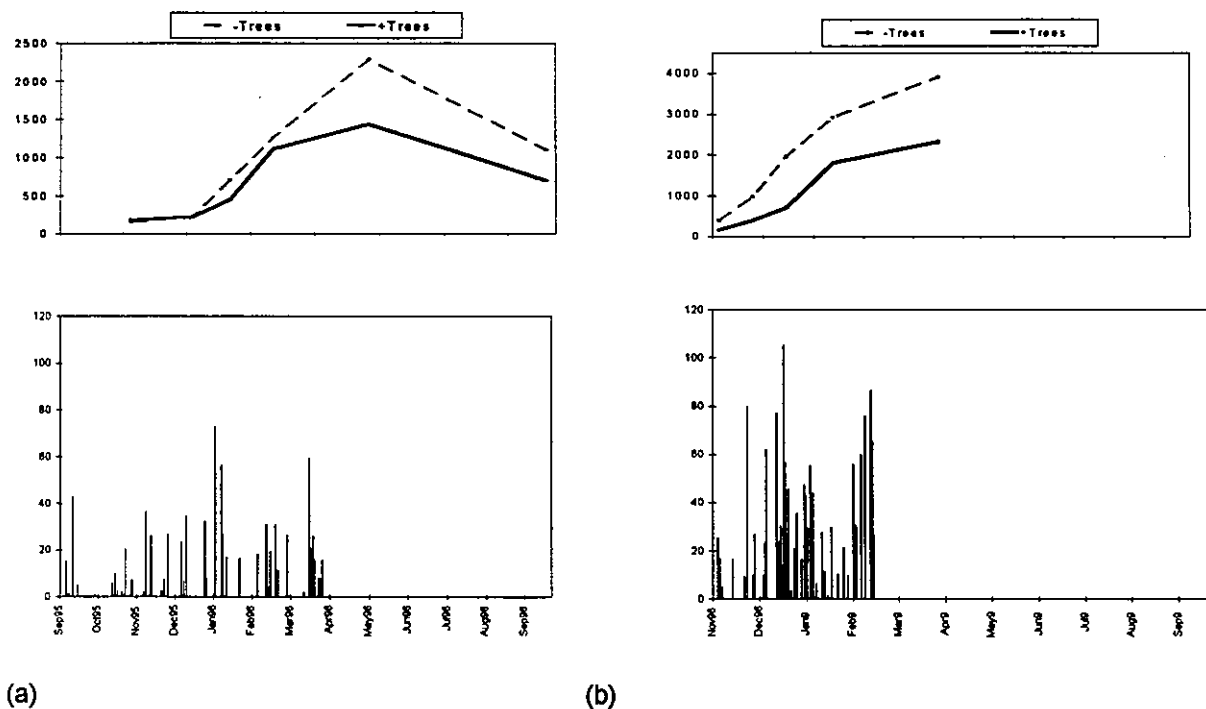


Figure 1. Daily Rainfall and Total Pasture Yield for the (a) 1995/96 and (b) 1996/97 wet season at the Paige site, Katherine Research Station.

Early results indicate that tree effects may be suppressing pasture growth however this response may well be a result of competition for nutrients, particularly nitrogen, rather than for soil moisture

alone. Nitrogen, which is tied up in the woody overstorey root system is released from roots upon clearing, enabling enhanced pasture growth. Continued measurements over time will investigate the trend in plant yield and nutrient content.

Initial calibration of tree effects in GRASP has been undertaken by Jillian Heywood, (University of Queensland student), in cooperation with Greg McKeon. These early results also indicate the role of nitrogen. A complete data set over a two-year period will be utilised for more complete calibration and validation by December 1997.

During 1997 collaborative work in a CRC DOTS case study project will investigate historical changes in canopy cover throughout the VRD from temporal series of aerial photos. This work will also involve assisting Daryl Lewis (historian and anthropologist) relocate and photograph historical photographs from the 1880's showing dramatic vegetation changes throughout the district.

Implementing and monitoring sustainable grazing practices as part of whole paddock management (Objective 6)

Pastoralists are faced with a range of grazing management options, which affect both animal productivity and land condition. These will include decisions regarding stocking and spelling strategies, fire management as well as native and exotic weed management. Before adoptions of "sustainable" grazing practices can be expected it is necessary to implement and monitor proposed strategies under conditions that are relevant to the scale and complexity of extensive and spatially diverse grazing lands.

In cooperation with pastoralists, sustainable grazing management demonstration paddocks will be established on several properties throughout the region. A process of local producer group input and consensus will identify a range of management objectives and options, which will be implemented over a period of four years. Ongoing feedback and input will be sought from producers. In regions where fire management is a critical issue a coordinated effort will be undertaken with the NT Bushfires Council.

The impact of implemented grazing and land management practices across the paddock will be monitored twice yearly throughout the project. Of particular interest is the interaction between the imposed grazing management practices (eg stocking rates, burning and spelling) and influences such as seasonal variation, pasture community, pasture condition, distance to water, previous grazing history have on land condition and grazing pressure in a spatial context. A measure of animal performance (eg. weaning rates, growth rates etc) will be undertaken where able.

The impact of rotational burning and flexible stocking on pasture condition and animal performance is underway in a small paddock (approx 500 ha) within the Mount Sanford stocking rate demonstration trial area. Annual stocking rates are determined using desired levels of utilisation for separate pasture types and available standing pasture in April. The paddock is currently stocked with 120 large weaners (approx. 230kg). An area of 45 ha will be burnt in August to provide nutritious green leaf during the following wet season and to manipulate grazing pressure around the paddock. Paddock pasture types and topography are described using available land unit maps and ground-truthed with GPS. Grazing impacts, grazing pressure and pasture condition will be sampled on a stratified basis throughout the paddock and geo-referenced with GPS. Spatial analysis of grazing impacts will be undertaken using GIS, while statistical differences of grazing pressure and land condition between soil/pasture type, distance from water, grazing history, land condition and burning will be undertaken. This paddock will act as a pilot study for larger study sites. The location and initial measurements of other demonstration properties and paddocks will be finalised and carried out before 1998.

The primary outcome of these demonstrations is to establish the practicality and impact of a range of sustainable grazing management practices at an extensive paddock scale. It will establish and demonstrate a methodology for developing grazing management plans. It will also involve

producers throughout the trial, to record and monitor their inputs and perceptions in regard to grazing management.

Discussion/Comments

1. *Producers on the Sturt Plateau are breaking their properties into blocks which may be too small to be sustainable. Why?* There is considerable difference of opinion as to whether they are 'sustainable'. They may be too small for native pasture enterprises alone, but suitable for mixed enterprises with improved pastures or crops. The area is just being developed, and producers need the money that selling off blocks provides to carry out essential property improvements such as fencing.
2. *Will VRD data help the Sturt Plateau when the areas are quite different?* The general pasture characteristics and relationships are usually applicable and will be used (e.g. suitable % pasture utilisation levels, etc.)
3. *Sturt Plateau intensification problems. Can the information you have collected help to influence them in their setup?* We don't have definite answers to their problems now, but can give guidelines. The Pastoral Lands Board are not willing to make a commitment regarding stocking levels and development plans with the information currently available. Planned stocking rate work will definitely provide more objective information..
4. *Individual case studies give you a lot of information on one place, and on one person's management options. How do (Herd Econ) case studies fit in with LBP?* By studying a number of properties in a region you get a good idea of most of the options.
5. *Are producers involved in their Herd Econ reports?* All information comes from the producers. We then write the report and send it to them for comment to complete the report.
6. *Are you modelling the soils and hydrology of your experiment sites?* There is definitely potential for obtaining more information where soils are concerned. The GRASP (SWIFTSYND) sites could be used, but we don't have enough time or expertise to tackle it.
7. *What did you do with tree canopies when plots were cleared for the Tree/Grass experiment?* Canopies were removed from the plots and burnt. Extra N available to the plants in the cleared plots will be due to the breakdown of dead tree roots.
8. *In your example of burning a pasture in poor condition, was seed of any good species present at the time of burning?* We did not look at seed banks. Ground is hard and seeds just sit on top, so exposed seed is 'burnt'.
9. *What do you do to fix bare areas?* Reduce stocking rate (refer to work by Barney Foran and Gary Bastin).
10. *With GRASP etc, where you are parameterising land types, condition, tree cover, etc, it seems necessary to do this on each property. Can this be done?* Have to do it more generally than per property. Can intensively map demonstration paddocks. Land utilisation rates are the main outcome.
11. *Where areas have soil types with different carrying capacities, why not fence along the land type and stock accordingly?* Not practical at the scales involved. Cattle do better when they can select across different pasture/soil types e.g. red And black soil areas.
12. *Is the whole paddock stocking rate a dream? Aren't you just looking at the dominant communities when setting it and sacrificing more selected areas?* The first objective of management should be to ensure the paddock stocking rate is suitable. If you can run

acceptable levels of stock, no area should be sacrificed. The use of additional management techniques, such as patch burning, can be utilised to reduce the chance of pockets being degraded by shifting the grazing pressure.

13. *Grasslands are in transition. May need to let them degrade a bit before implementing management strategies to fix them?* All states would exist in any paddock. ('States' to be discussed during presentation of project NAP3.205).
14. *Do producers on the Sturt Plateau realise that by stopping fire they will get an increase in tree density?* Their fire control is aimed at preventing wildfires, not excluding fires altogether. By burning areas within paddocks, they will benefit by reducing wildfires and gaining useful effects of burning on tree and plant communities.
15. *How do branding rates, stocking rates, etc of Sturt Plateau group properties compare to those of large company owned properties?* Company properties are definitely ahead. They have high levels of technology, and DPI and University people are involved. They are generally well established, have available capital, and the room to move animals around.
16. *May be better off getting company owned properties to work with other properties owned by the same company, rather than with their neighbours.* They already do. Business plans and aims are company driven. This is probably why LBP groups in the VRD (mostly company owned stations) do not function very well.
16. *Does the active Landcare group in the VRD interact with the Sturt group?* The areas have different needs and aims. The Sturt group is in a development phase and is attempting to do things such as get an access road to the area, while the VRDCA see themselves as protecting against the 'greenies'.

Biodiversity workshops in northern Australia

MRC Project number: NAP3.215
Project duration: 01/04/97 to 30/06/97
Principal Investigator: Dr Judy Lambert
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Objectives

To determine producer and research perspectives on priority issues and mechanisms for integrating biodiversity conservation issues into sustainable resource management for beef production across northern Australia.

Summary

Small groups of interested producers, research scientists and extension staff were invited to participate in workshops to discuss key biodiversity issues for the northern beef industry, mechanisms for integrating biodiversity conservation into sustainable production and the most effective ways for bringing together scientific research and producer perspectives.

The workshop series has identified a range of key issues, all of which are part of developing a more integrated approach to whole property and landscape R&D for sustainable production. A possible mechanism for recruiting integrated projects has been identified. Participants in the workshops also identified as a priority, the need for R&D which will identify barriers to and mechanisms for greater adoption of existing knowledge on issues contributing to sustainable production.

biodiversity - the variety of all life forms (plants, animals and micro-organisms), the genes they contain and the systems of which they are part
ecosystem - the dynamic collection of plants, animals and micro-organisms and their associated non-living environment which interact as an ecological unit
sustainability - using resources so that ecological processes, on which life depends, are maintained and the total quality of life can be increased both now and in the future. Sustainability depends on ecological sustainability, economic viability and social feasibility
ecological sustainability - maintaining ecosystems and ecological processes, both now and into the future. This requires the use of species and ecosystems within the capacity of those species and ecosystems to renew or regenerate
best practice - a method of management in which all available information, insights and resources are used to identify, record and recommend the best way of doing something.

Report

Background and methodology

The goal of phase 3 of the Meat Research Corporation's North Australia Program is

To improve the profitability, international competitiveness and ecological sustainability of the beef production sector in northern Australia.

Protecting biodiversity underpins work towards achieving ecological sustainability - which in turn leads to overall sustainability for the industry.

However, for many northern Australian beef producers the term "biodiversity" is not much more than a strange jargon word used by scientists or government bureaucrats. Some may even be concerned that it means yet another layer of control will be imposed on already hard-pressed producers. Almost certainly, in these tough economic times, when commodity prices are low and the climate is extremely harsh, there are few northern Australian producers who see a need to think too hard about biodiversity.

However, Australia's biodiversity is an important part of all the rural industries, including the beef industry. On any rangelands property, maintaining production, pest control and genetic diversity will all be affected by the condition of the biodiversity on that property. Conserving biodiversity will ensure that beef producers can defend a commitment to ecological sustainability and at the same time can take fuller advantage of 'clean and green' market opportunities. It will also ensure that Australian industry does not run the risk of encountering consumer boycotts based on environmental concerns.

The Australian beef industry can demonstrate its commitment to greater protection of biodiversity through

- including protection of biodiversity in the development of 'best practice' for the industry, and in environmental monitoring
- initiating and supporting R&D projects which link biodiversity protection and ecological sustainability to production

To assist in achieving these objectives, the Meat Research conducted a series of workshops which brought together interested producers, research scientists, government extension staff and others with an interest in biodiversity, to plan how best to develop integrated research which the North Australia Program might fund as part of its research support for improving resource and whole property management.

Results

Participation in the 5 workshops was as follows:

Location	Participant numbers (Numbers contacted)*					Totals
	Producers	Extension staff**		Research scientists**	Other interested groups/individuals	
Charters Towers	7 (19)	-	(9)	8	- (4)	15
Katherine	3***(8)	4	(11)	8	3 (8)	18
Kununurra	5 (11)	3	(8)	4	1 (4)	13
Longreach	2 (18)	2	(11)	1	2 (3)	7
Roma	6 (14)	2	(5)	8	3 (11)	19

* Numbers in brackets are those contacted ie. those to whom phone calls were made, invitations and background materials provided. Some research personnel, corporate property managers and head offices of relevant agri-political bodies were advised of the full series of workshops. These are not included in this table.

** In some instances staff were responsible for both research and extension, with emphasis changing over time. Their primary responsibility is as self-defined, with invitation numbers being combined for R, D & E

*** Only one participant was a full-time producer, with two others being producers while having other primary responsibilities

Despite extensive telephone networking within the various communities, information distribution and follow-up calls, participation by producers was limited, especially in Katherine and Longreach. This appears to be a result of a compounding of several factors

- extensive demands on producers to participate in a variety of local workshops in recent times
- some resistance resulting from the atmosphere surrounding the current debate about land tenure and title
- a lack of perceived importance of biodiversity issues to cattle production.

All participants endorsed the importance of biodiversity as an issue to be addressed within NAP, although some pointed out that the term 'biodiversity' is not helpful in conveying the issues to those involved. Despite these limitations, the workshops have provided some very useful feedback on the biodiversity issues of greatest relevance to the northern beef industry, the ways in which they might be integrated into R&D and the role which MRC's North Australia Program might play.

Not surprisingly, the issues identified are not uniquely biodiversity-related, but rather reflect the fact that conservation of biodiversity underpins any shift to sustainable production. Specific 'biodiversity' issues raised in the workshops included

- grazing management, stocking rates, total grazing pressure and impacts on biodiversity
- understanding landscape systems, their flora and fauna
- vegetation management - native pastures and tree clearing
- the role of water and soils in maintaining healthy environments
- riparian corridors
- introduced species - pastures, weeds, feral animals

- fire management and biodiversity
- identifying and using indicators for biodiversity
- ecological restoration in pastoral landscape
- cultural aspects of land management & biodiversity conservation - indigenous & European

Three recurring themes can clearly be identified across all of the workshops:

- 1) the need for R&D which integrates biodiversity issues into sustainable landscape and property management, together with cattle production and 'bottom-line' economics**
- 2) the need for R&D to become more producer-driven and property-relevant**
- 3) the need for 'social research' which identifies ways of increasing uptake of existing knowledge on sustainable production.**

Processes for addressing key issues

a) Integrating biodiversity issues into sustainable landscape and property management, together with cattle production and 'bottom line' economics

Several of the workshops provided quite similar processes by which themes 1 and 2 might be addressed. These can be summarised as follows:

Step 1

MRC/NAP identify key issues arising from the biodiversity workshops, develop Terms of Reference which clearly define priorities and give preference to producer-initiated projects to be conducted by composite teams involving relevant technical/research expertise.
MRC/NAP call for short (2-4 page) Expressions of Interest from relevant teams. Allow sufficient time (6-8 weeks minimum) for teams to form & to develop initial project proposal.

Step 2

MRC consider project proposals and select teams to develop more comprehensive submissions. In considering project proposals for funding account should be taken of

- producer initiative, expertise within the team and evidence of strong collaboration
- regional distribution
- quality of the work proposed
- inclusion of a broader biodiversity perspective, together with on-farm pasture and herd management.

Step 3

MRC provide seed-funding and facilitation to enable coordinating group for each short-listed project to develop detailed project proposal.

Step 4

Full submissions assessed on the basis of

- integrated approach, involving economic, social and environmental aspects of property management
- sound scientific approaches to research and development
- regional distribution
- collaborative effort involved
- producer group ability to lead/manage the project or to delegate aspects to other key partners
- opportunities for 'multiplier' effort resulting from the project
- inclusion of a concise but well-developed communications plan as a component of the proposal.

Step 5

MRC to ensure that projects include a process for ongoing review and development

Participants in various workshops expressed a preference that NAP3 seek to build on work by existing groups, rather than developing new groups in which social networks and trust have not been established. In this context it is worth noting that there are several regions across northern Australia, in which the basis for such work with established groups already exists through past and/or present activities in

- northern Queensland (Charters Towers and Mareeba areas)
- central Queensland (Rockhampton area)
- Roma area
- Victoria River District
- Kimberley (especially east Kimberley)

There are also potential complementary groups based around Queensland's South-west strategy, the Queensland Desert Uplands, the Southern Highlands LWRRDC/CSIRO regional study and the CSIRO/LWRRDC case study work in south-east Queensland.

Other MRC-funded activities could readily be linked to whole property R&D in these regions.

While the integration of biodiversity issues into whole property and landscape approaches to R&D form an important emphasis for future NAP3 work, lack of adequate knowledge of the links between grazing management and the maintenance of biodiversity indicate that there may also be a need for some more specific projects which place emphasis on better defining these relationships. It may be that this is an area in which conservation agencies such as Environment Australia's Biodiversity Group can provide significant financial and technical assistance.

b) Research into mechanisms for increasing uptake of information

Aside from the need for integrated research, which brings together economic, pasture and landscape management and beef production, workshop participants generally identified as the other priority need, research to identify more effective mechanisms for developing and communicating research outcomes, to ensure greater adoption among producers. A small number of participants indicated that the information is available and that rather than research, all that is needed is a greater 'extension' effort to get it into the producer community. However, this was not the prevailing view.

Work to increase uptake by producers was generally seen as requiring social research expertise not generally associated with MRC/NAP work. Outside expertise should be sought to work with producers and extension staff to identify the existing barriers to uptake, and to establish innovative approaches which might be cost-effective and at the same time enhance uptake of information leading to greater emphasis of sustainability as a focus of management.

While preferring that research proposals be sought from individuals or teams having expertise in relevant social sciences, there was also a strong emphasis on the need to ensure empathy with and an understanding of the northern beef industry.

Various workshop groups proposed mechanisms by which these issues might be addressed. However, NAP3 management will conduct a review of existing research in this area before proceeding in this area.

Recommendations

1. That MRC/NAP3 adopt as priority issues for new work

- 1) the need for R&D which integrates biodiversity issues into sustainable landscape and property management, together with cattle production and 'bottom-line' economics**
- 2) the need for R&D to become more producer-driven and property-relevant**
- 3) the need for 'social research' which identifies ways of increasing uptake of existing knowledge on sustainable production.**

2. That while some specific work to better define the links between grazing management and maintenance of biodiversity may be necessary, biodiversity generally not be dealt with as a distinct separate issue within NAP3. Rather it need to be incorporated into whole property management initiatives.

Note: It is important that biodiversity be clearly identified as an issue of relevance within NAP3 and that it not be submerged under other issues.

3. That funding and technical assistance be sought from Environment Australia's Biodiversity Group to enable significant support for those aspects of R&D which place strong emphasis on better defining relationships between grazing management and the conservation of biodiversity.

4. That MRC/NAP3 initiate a process (similar to that described in a) above) to recruit projects encompassing whole property management and biodiversity aspects of sub-program 2 within NAP3. The issues arising from this workshop series provide a basis for preparation of an Issues Paper to begin the process.

5. That budgets allocated to Whole Property and biodiversity research within NAP3 be amalgamated, with biodiversity issues to form an explicit but integral part of new projects.

6. That MRC/NAP3

- i) explore the extent of social/communications research available from sources such as other R&D Corporations
- ii) identify suitable consultants/research teams to undertake "social" research encompassing the issues addressed in section b) above.

7. That both the NAP3 management team and NAPIC consider these options at their earliest opportunities.

8. That a plain English Executive Summary of the more detailed report to be provided on this biodiversity workshop series be circulated to all those who participated in the workshops and to those unable to attend, but expressing an ongoing interest in the process.

9. That media reports on the series of biodiversity workshops and their outcomes be provided through rural outlets such as the ABC 'Country Hour' and 'Country Life' to inform both those who participated and others not involved in the process of its progress.

10. That an article about the workshop series be included in the next issue of NAP News.

11. That the names and contact details for those participants in this workshop series who do not currently receive NAP News be incorporated into the mailing list for future receipt of NAP News.

Further actions

Following the completion of the workshops, expressions of interest were invited from four groups to address the issue of incorporating practical measures to assist conservation of biodiversity within sustainable beef production. The following project was then contracted with a team lead by Dr Sue McIntyre.

Incorporation of practical measures to assist conservation of biodiversity within sustainable beef production

MRC Project Number:	NAP3.222
Project Duration:	01/10/97 to 30/06/2001
Principal Investigator:	Dr Sue McIntyre CSIRO Tropical Agriculture 306 Carmody Road St Lucia Qld 4067 Ph: (07) 3214 2391/Fax (07) 33214 2288 E-mail sue.mcintyre@tag.csiro.au
Co-Investigators:	Dr John McIvor and Dr Neil MacLeod

Description

This research project will be conducted in a whole property context so as to enable producers and other stakeholders to consider the trade-offs between production and conservation of biodiversity. The project will concentrate on increasing the underpinning knowledge of biodiversity as it relates to sustainable beef production and as a consequence, bring about change in management at the property level.

This project was conceived and designed alongside the socio-economic project 'Applying management principles on variegated landscapes: identifying production/ conservation trade-offs' (LWRRDC/EA Project CTC9). An additional project, 'Responses of Vegetation to Land Use and Disturbance' in the Global Change and Terrestrial Ecosystems program (GCTE Task 2.2.1) will provide a strong intellectual framework in which to analyse and interpret data from the experimental work, and to seek out relevant findings from related systems in other countries.

Goals

The broad scientific and communication goals are, by June 2001, to:

1. Significantly advance conceptual understanding of the relationships between the grazing of cattle and grazing management, and the conservation of regional biodiversity within the variegated landscapes of the north.
2. Quantify these relationships for at least one ecosystem that is economically important to the northern beef industry.
3. Link these quantified relationships to measures of productivity, and thence to economic indicators of enterprise returns, and assess alternative management strategies for both economic and biodiversity costs and benefits.
4. Identify practical measures to conserve biodiversity that producers can incorporate within their sustainable management practices, together with simple indicators they can use to assess results and continue to adapt and improve management.
5. Assess whether the results of this project can be used to assist management for conservation of biodiversity in other ecosystems within northern Australia.
6. Pro-actively publicise and disseminate project results to the industry and others concerned with natural resource management in northern Australia, including providing assistance to producer-led management within NAP3.

Project Objectives

By June 2001,

1. Develop a learning module for producers introducing concepts of ecological sustainability and biodiversity conservation in a whole property context.
2. Develop a manual providing appropriate technical information for producers and other resource managers wishing to implement sustainable management.
3. One hundred beef producers in northern Australia implementing management strategies on their properties to maintain biodiversity and sustainability.
4. At least 500 beef producers demonstrating awareness of the role of biodiversity on their properties.
5. Communication activities aimed at building the capacity of extension personnel to promote practices to maintain biodiversity and sustainability.

Soil acidification research in the semi-arid tropics

MRC Project number: NAP3.216
Project duration: 01/05/96 to 30/06/96
Principal Investigator: Dr Andrew Noble
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Project Objectives:

- (i) Further identify the impact of pasture legumes, *Stylosanthes* and *Leucaena*, on the rate of soil acidification for the major soil types used in beef-production of northern Australia.
- (ii) Identify future research and development activities in regard to soil acidification in northern Australia.

With respect to (i), this was achieved by sampling long-term grazing trials at Wrotham Park and Kangaroo Hills, northern Queensland, Manbulloo and Katherine, Northern Territory and Samford, southern Queensland.

Summary

Land degradation issues are assuming increasing importance in northern Australia beef cattle grazing systems and are challenging the concepts of sustainability of current land management systems. In this study the impact of long-term (11 - 33 year) grazing trials with *Leucaena leucocephala* or *Stylosanthes* on soil acidification were compared to original soil chemical data or improved grass pasture production systems. Significant ($p < 0.05$) acidification was observed to at least 30 cm on 6 of the 8 sites sampled. The net acid addition rate for the sites sampled ranged from 0.31 to 1.37 kmol $H^+ \cdot ha^{-1} \cdot yr^{-1}$, with approximately 14 % of this acidity having originated from animal product removal. The results of this survey confirm previous findings and bring into question the long-term sustainability of these legume based production systems in northern Australia. Future research and development activities with respect to soil acidification are suggested.

Report

Land degradation issues are assuming increasing importance in northern Australia beef cattle grazing systems and are challenging the concepts of sustainability of current land management systems. One of these issues that could potentially have a negative impact on current legume based pasture systems in northern Australia is accelerated acidification. To date soil acidification research has largely focused on temperate based farming production systems where the decline in pH has been estimated to be of the order of one unit over 50 years of pasture. However, soil degradation through increased rates of acid input may not be confined to temperate pasture systems of southern Australia. The wet-dry tropical climate of northern Queensland is generally conducive to leaching of nutrients at certain times of the year and therefore soil acidification due to the introduction of a pasture legumes is a distinct possibility.

The impact of long-term (11 - 33 year) grazing trials with *Leucaena leucocephala* or *Stylosanthes* on soil acidification were compared to original soil chemical data or improved grass pasture production systems. Statistically significant ($p < 0.05$) acidification to depth in profiles due to the introduction of a legume component into a pasture production system was observed in six of the eight sites sampled. The net acid addition rate ranged from 0.31 to 1.37 kmol H⁺.ha⁻¹.yr⁻¹. These values are in the same range of selected sites previously sampled, thereby confining initial observations. At two of the sites sampled in the current survey, soil samples collected at the initiation of these trials were available to compare the extent of acidification. The decline in soil pH values for Wrotham Park (*Stylosanthes* pasture) was in the order of 1.78 units over a 25 year period. In the case of a *Leucaena* based production system at Samford (Site 2) soil pH declined by 0.38 pH units and an adjacent improved grass pasture ley system by approximately 1.01 units over a 36 year period. An estimate of acidification due to product removal was undertaken on two of the sites (Kangaroo Hills and Wrotham Park). In both these cases the acid addition due to product removal was estimated to contribute 14 % of the net acid addition rate. This would represent a relatively small component of the total annual proton accumulation. It is postulated that the major component contributing to accelerated acidification in these wet-dry tropics is increased nitrogen mineralisation and subsequent nitrate leaching.

It is suggested that future research into soil acidification in northern Australia should focus on understanding the mechanisms of acidification, being able to predict the risk of acidification and the development of production systems that reduce or reverse the risk of acidification.

1. *Understanding the mechanisms of acidification under legume based pasture systems.*

Accelerated acidification under legume based pasture production systems are assumed to be the result of increased product removal, nitrate leaching and organic matter accumulation. In the first instance, an estimate of net proton accumulation due to the export of cattle can be made using a series of regression equations and the determination of the ash alkalinity of material exported from site. Quantification of the contribution to the total proton pool by nitrate leaching and organic matter accumulation needs to be assessed.

2. *Predicting the risk of acidification.*

The data collected to date represent a relatively comprehensive biophysical data set that could be used to model the risk of acidification under certain climatic conditions and soil types. This would be of importance in designating potential sites/regions where the introduction of legumes would have their least impact on the soil resource base. It is suggested that the rate at which a soil acidifies is a function of the inherent soil chemical properties, climate and the productivity of the pasture. Using these parameters it is thought that a relatively robust model could be developed to predict risk of acidification and be a key component in predicting the financial implications of accelerated acidification from a resource economist's perspective.

3. *Development of sustainable legume based production systems.*

Conventional methods of remediation (lime applications) of soils affected by accelerated acidification due to the introduction of legume based pasture systems in southern Australia are proving to be uneconomic under present commodity price structures. The same would apply to beef production systems in northern Australia. Alternative methods of ameliorating acid soil infertility are currently being

investigated by CSIRO. Preliminary research with a small range of tree species has shown wide differences in the ash alkalinity's, and basic cation contents of leaf litter. In addition, it has been shown that the leaf litter of the tree species *Melia azedarach* (common name: white cedar), which has a high ash alkalinity, is able to neutralise substantial acidity when mixed with an acid soil. Current research being undertaken is centred around evaluating the efficacy of trees and shrubs as biological nutrient "pumps" in reducing and ameliorating soil acidification, this being based on their ability to redistribute nutrients from depth to the soil surface through litterfall and the production of organic anions. To date this research has focused on initial characterisation of species with respect to their chemical composition. Since several trials have been established (Hillgrove, Cardigan and Manbulloo) with a tree component intentionally retained in an improved pasture system, these trials may provide a unique opportunity in assessing the ability of trees to act as biological nutrient pumps.

All milestones were met in this short term study and a full project proposal based on research issues associated with soil acidification in *Stylosanthes* based pasture systems submitted to the MRC in January 1997. Results of this study were reproduced in an MRC commissioned review entitled 'Stability and Productivity of Native Pastures Oversown with Tropical Legumes' by J. G. McIvor, A. D. Noble and D. M. Orr. In addition, the results of this and a previous study were presented at an MRC sponsored producer consultation meeting on the 7 November 1996 and a presentation entitled 'Managing soil acidity associated with *Stylosanthes* based pasture systems in northern Australia' was made to producers and extension staff of DPI at Rockhampton in June 1997.

Discussion/Comments

1. *What was the significance of measuring soil particle size?*

Particle size analysis, along with soil organic carbon content, were determined in order to establish a relationship between these parameters and pH buffer capacity. Pedotransfer functions incorporating clay, silt and organic carbon content were established for surface (0-20 cm), subsurface (20-70 cm) and for the entire profile. These relationships will assist in the prediction of pH buffering capacity and in the development of risk maps. Work has been initiated in producing a soil acidity risk map for the Dalrymple Shire using data collected from the land resource survey undertaken by QDPI and CSIRO Land and Water.

2. *Since soil acidification is a natural process, why is it that not all of the soils on the continent of Australia are acid?*

In natural ecosystems soil acidification does occur but at a significantly slower rate. This is largely due to the fact that the systems are generally in a degree of equilibrium in that any acid input is to a large degree counteracted by natural processes of pedogenesis. That is, the weathering of soil parent material releases bases and exchangeable basic cations and with processes such as biological pumping these are redistributed onto the soil surface through litter fall.

3. *Why are the pH values so low in the graphs show in the presentation?*

The soils on which *Stylosanthes* tends to become dominant are in general of a light texture and are inherently acid. Consequently, one is starting off with an acid soil. In addition, the pH values presented were all measured in a matrix of 0.01M CaCl₂ which would result in pH values of approximately 0.8 to 1.0 unit

lower than in water. This was undertaken in order to reduce any confounding effects of dissolved salts.

4. *It is suggested that soil samplings of Leucaena stands be undertaken in highland area of central Queensland to ascertain whether there had been reduction in soil pH.*

It is speculated that the decline in soil pH in these systems due to the establishment of a legume based pasture system would be negligible since these soils are predominantly classified as vertosol which have an extremely high buffering capacity as well as having free CaCO₃ nodules in their matrix. In this respect the planting of aff. scabras, which are adapted to the cracking clays, would have very little impact on accelerated acidification and therefore should be encouraged.

5. *The growing of perennial grass species which are deep rooted may not always reduce nitrate leaching as has been observed in southern legume based pasture systems.*

It is assumed that reference was being made to the planting of the perennial *Phalaris aquatica* which has been recommended for planting in subterranean clover pasture systems. There is certainly evidence in the literature presented by Ridley et al. that the rates of acidification are lower under phalaris/sub clover pasture systems. However, it must be stressed that by evaluating soil acidification rates over the entire profile, one may not account for acid generation in surface layers and net alkalisation in subsurface layers. The term 'spatial disjunction' can be used to describe this process. In order to effect no net input of protons into the system through the nitrification process, the nitrate produced in the mineralisation of organic nitrogen must be taken up by the plant at the point of production. Consequently, there must be synchronisation between nitrate production and demand by the plant.

6. *Why would the removal of animals from the paddock result in accelerated soil acidification?*

The export of animal products from the paddock is effectively an export of cations and anions from the soil. This represents a net loss from the system. In the uptake of cations from the soil solution by plants, there is a net efflux of protons (H⁺) from the root into the soil solution. Consequently, the area around the root (rhizosphere) becomes acid due to greater amounts of cations being taken up by the plant than anions. This difference is even greater in legumes since they produce their own nitrogen.

Sustainable beef production on tropical tallgrass using the LBP approach

MRC Project number: NAP3.306
Project duration: NAP2 and NAP3 (01/07/96 to 31/12/97)
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Marnie McCullough

Objectives

By December 97 to –

1. Document best practice, whole farm management practices and strategies recommended by experienced producers for 24 groups in five North Queensland and to share this knowledge between producers.
2. Identify and publish management strategies that improve productivity and profitability and are environmentally sustainable
3. Identify and document knowledge deficiencies in sustainable production systems and identify high priority research and development needs.
4. Prepare and detail activities to promote changes in land management towards long term profitable and sustainable whole property management.

Summary

The Local Best Practice Project has provided a structured framework for graziers to share knowledge and experience, to self critique existing knowledge, to explore options for change and to develop confidence in new management ideas. Nineteen groups have completed the LBP process while a further 5 groups will be completed by December 97.

The LBP reports have documented current, whole farm management strategies recommended by experienced graziers for a range of land types in North Queensland. The reports have identified knowledge deficiencies and future research and development directions.

The ongoing success of group extension in the north is, however, dependent on dedicated group drivers.

Report

The Local Best Practice project is process driven and as such, methodology is the backbone of the project. I will therefore record in some detail the methodology we have used in the 4½ years since the project commenced.

Methodology

The first stage of the LBP process is the documentation of experienced grazier's recommendations for managing their country for optimal production with minimal degradation of natural resources.

Our first step was to break up the north region into broad land type areas. In some cases there were clearly defined land type groupings such as basalt, granite or desert country but

often groups encompassed a range of land types. This was unavoidable in some of the extensive areas such as Cape York. While it was preferable to keep the groups within a similar land type, those groups with multiple major land types were equally successful.

Where possible, groups revolved around properties with a common social focus. Most groups had from 10 to 20 properties within the group boundary and all properties were invited to the meetings. This meant that we were targeting all properties, as opposed to the central Queensland LBP model where it was often a sample of the better producers within an area. Typical group size was 6-12 properties. Husbands and wives were encouraged to attend but most meetings were dominated by the male half of the partnership. Unlike the CQ LBP project, there was no insistence on participating producers having 10 years experience. It was felt that this requirement would preclude some progressive land managers as well as younger graziers with the most to benefit from the process. New innovations in the north often result from newly arrived, experienced graziers from other regions who are prepared to try management options that differ from the established practice in the district.

A key producer was selected for each LBP group. This person was consulted on the appropriateness of the group boundary and changes were made if necessary. The process was clearly explained to the key contact who then helped organise the initial meeting and encouraged neighbours to attend. Some groups had natural leaders who organised the process from start to finish while other groups needed considerable inputs from DPI staff.

At the first meeting, graziers were asked to describe the land types within their area and then describe a sustainable management system for a typical property in the area. DPI input was strictly limited to facilitating the meeting and recording grazier comments. There was no technical input from DPI staff. Meetings would usually run for three hours. A report of the meeting was then drafted and sent to all members of the group. This covered the various land types including their vegetation and relative grazing value, an enterprise description, cattle management, grazing land management and concluded with typical property management data and a list of plant species in the area.

Consensus on the range of issues discussed was not always reached but when differences of opinion occurred the different views were recorded. A second meeting was held to review the report and make corrections and additions as necessary. In some cases a third meeting was required to fully satisfy all group members that the report was an accurate record of their views.

The reports address the first project objective, namely the documentation of best bet, whole property management practices and strategies recommended by experienced producers. While being beneficial to local graziers, the reports are also highly valuable to government agencies, both state and local, agribusiness and industry bodies. The main benefit of developing the best practice reports however is the exchange of local experience and technology by graziers within the group. This has led to greater awareness and uptake of technology than has occurred through conventional extension. The reports also act as a benchmark allowing the impact of future industry practices to be assessed.

Second Stage The original CQ LBP model then involves a workshop where "specialists" are challenged to improve the grazier recommended production systems. A subsequent meeting would then be held with graziers to discuss opportunities for improved management systems, to identify gaps in knowledge and constraints on production and to prioritise these for further research and extension.

This approach was tried with our first LBP group but our DPI project team felt that it was not the most appropriate way to proceed. The concept of a specialist workshop was seen as a problem. The LBP technique was being promoted as a producer driven process which acknowledged that a great deal of collective wisdom resided within the group. It was also an attempt to break from conventional technology transfer extension methods based on the "we know what's best for you, if you would only listen" approach. We considered the specialist workshop to be a return to conventional extension techniques and not appropriate for achieving the project outcomes.

During the initial LBP meetings it soon became apparent that within our groups there was a range of producers, from those operating under traditional management practices to innovative producers using the full spectrum of new technology. This broad range proved highly useful for comparative analysis and was critical to the success of the second stage of the LBP process.

The approach our project team developed was to hold a modelling workshop to determine the profitability of current management practices. The model was then used to look at a range of options for improving profitability and sustainability. The model used was the Breedcow herd budgeting model devised by Bill Holmes. Breedcow gives a gross margin for a stable herd on a fully stocked property. It can be used to compare gross margins for different management strategies while running the same number of adult equivalents.

The analysis was conducted using a computer projection panel that allowed the group to see all the computer operations on a large screen. A typical property running an agreed number of adult equivalents, using current management, was analysed. All figures for calving and death rates, sale prices, female and male herd structure, and variable costs were given by the group. In many cases these figures were the subject of spirited debate within the group. Once the final figures were entered, the task of verifying the model would begin. The breedcow model works by adjusting the number of weaner heifers that must be retained to maintain a stable herd. All surplus females are sold to keep the herd numbers stable. The group would be asked if the figure for female turn off was comparable to what they were selling. Invariably the figure would be too high, indicating that either death rates were higher than stated or calving rates lower. The process then began of matching the branding and death rates to the known figures for the number of breeders on the property and the number of males and females sold.

The typical outcome of this analysis was that death rates were usually greater and/or branding rates lower than what was thought. In some cases producers could see that significant herd build up was occurring and several acknowledged that overstocking was becoming a problem. The model enabled the group to see the importance of female turn off in profitability and the number of females that needed to be sold to maintain a stable herd.

The strength of the process was that every figure in the analysis came from a producer in the area. Every figure was debated until the group was satisfied that it was a true reflection of their area. The result was a gross margin that the producers had confidence in, and ownership of.

The next step was to ask the group what alternative management strategies they wanted to look at. Most groups initially examined the effect of age of turn off. The breedcow model can be used for break even analyses. This allowed groups to look at a range of "what if" scenario's, such as "what price is required for live trade steers to be as profitable as bullocks?" The economics of early weaning, phosphorus supplementation and production feeding were also commonly examined.

This procedure allowed the group to quantify the benefits of different management strategies in their area. The power of this part of the process was that a producer would be describing to his peers the benefits he was achieving from improved management, and the associated costs. The group could then see the resulting bottom line profitability and compare it to their own management.

The analysis was also used to look at the implications of stocking rate on land condition and profitability. The Georgetown granite group found that by using an improved management package they could reduce their number of breeders by half and still generate the same gross margin achieved using traditional management.

In summary, the LBP process has provided a structured framework for graziers to share knowledge and experience, to self critique existing knowledge, to explore options for change and to develop confidence in new management ideas.

Results and Achievements

The project has a target of completing 24 LBP groups by December 97. The current situation is that 16 groups have completed the 3 workshops and have final reports, a further 3 groups have completed the workshop series but final reports are still being written. 2 groups have completed second workshops, 2 groups have completed their first workshop and a final group is due to start in September. The project team is confident that the target of 24 groups will be reached by the December deadline. This will mean that the project has run for 5 years since its commencement in January 1993.

The original objective of documenting current, whole farm management strategies recommended by experienced producers and sharing this knowledge between producers has been achieved. While in most cases the producer reports document current practice rather than best practice, the third workshop addresses this issue by comparing and discussing the productivity and sustainability of the innovative producers in an area relative to the district average.

The group meetings have enabled a true picture of current industry practices and views to be documented. In many cases these practices and views have been significantly different to preconceived ideas and beliefs held by DPI. The reports indicate that the northern beef industry is operating well below its productive potential. In many cases the technology is known to the industry but adoption levels remain low. There is clearly scope for a major increase in the productivity and profitability of the industry and in the use of more sustainable management practices.

Some of the major issues and concerns highlighted by the groups have been

1. The increase in tree density associated with increased stocking rates, the lack of fires and below average rainfall.
2. An extremely poor knowledge of native pastures and the significance of annual versus perennial species.
3. The reluctance of most graziers to adjust stocking rates to seasonal factors or feed availability.
4. Awareness of the need for sustainable production systems and the threat of the green lobby.
5. The loss of species, erosion and degradation of better land types.

6. The significant gap between district average production and the production levels of innovators.
7. Increasing problems associated with the cost price squeeze.

The 24 reports when completed will enable us to satisfy project objectives 2 and 3 namely:

Objective 2. To identify and publish management strategies that improve productivity and profitability and are environmentally sustainable.

Objective 3. To identify and document knowledge deficiencies in sustainable production systems and identify high priority research and development needs.

The first 3 project objectives were relatively easy to achieve. The real challenge for the project team, and for the industry, is to achieve actual changes in land management toward long term profitable and sustainable whole property management. The fourth project objective is the preparation and detailing of activities to promote these changes.

DPI and funding bodies have determined that group extension is the way of the future. The LBP process is an ideal starting point for producer groups. The relationship between producers and government agencies changes fundamentally with LBP. The traditional extension role of being "all seeing and all knowing" is replaced by a partnership that values local knowledge and lays the foundation from which group members may self direct both learning and eventual change. The adult learning relationship is essential to the success of subsequent group activities.

Most of the LBP groups have undertaken ongoing group activities after the completion of the LBP process. Examples include

- The Coen and Weipa LBP groups which joined together to develop live cattle export from Weipa.
- The Chillagoe LBP who progressed through a group needs analysis to WIGS and have now successfully lobbied for rural power for their group. A Chillagoe landcare group is now forming.
- The Mingela LBP are also forming a landcare group.
- The Mt Garnet, Georgetown, Lower Cape and Belyando LBP's have either commenced or committed to the Planning a Future in Beef workshop series.

Other group activities undertaken include several producer demonstration sites (PDS), producer initiated research and development (PIRD), inviting experts to address local meetings as well as ongoing local group meetings.

Future Direction: The key factor present in groups that have continued developing to address their needs has been the presence of a driver. Without a driver, the momentum and group energy developed by LBP is lost. Clearly it is preferable that this driver be a producer, but our experience in North Queensland is that very few producers have the time, skill or inclination to take on this role. Whether it be a producer, consultant or DPI extension officer it is crucial that a driver be available to every group. The role of driver is purely to assist and facilitate the group. The group itself must determine the direction they wish to proceed in.

There are a number of excellent group processes/activities available for groups but without a driver the ultimate goal of achieving change in practice will remain elusive. Project staff were frustrated by their inability to remain actively involved with groups after the third workshop due to the need to meet milestone requirements with other groups. There was a continual underestimation of the time required to continue the role of group driver. These activities were

also in many cases not funded directly and relied on funds being redirected from other projects.

The success of groups in the future is dependent on a driver being available for groups to take advantage of the opportunities that exist and to realise their potential. I believe that an individual driver could manage 3 or 4 groups, or alternatively in the case of DPI extension staff, 2 officers could share 6-8 groups. Unless this role is formalised, funded and adequate time set aside for the role then group extension will not bring about the changes in practices that are needed for the future success of the beef industry.

Comments/Discussion

1. Profitability (\$) depends on perceived values
2. How long do some people expect their hands to be held?
3. Do producers realise the inconsistency between their concern of the green lobby threat and recognition of existing loss of better species, erosion and degradation of better land types.
4. Company managers have space and little pressure - have existing company programs so difficult to keep together in LBP sense compared to smaller family properties whose owners are often newer to area.
5. Rate of degradation is high and accelerating - LBP suggests that no real change is occurring.
6. We are responsible for sustaining all the land. Maybe we should more closely target where increased productivity occurs.
7. Can't separate profitability and sustainability.
8. Can see more people working in groups.
9. Would groups be willing to pay a facilitator to keep going?
10. Shane Walsh -Would like to think monitoring groups will be dynamic enough to move on to achieve other group goals.
11. There was general agreement on the need and importance of the group "driver". Roger Landsberg spoke of his experience as a group driver and reinforced both the importance and the heavy time demand of the role.

BEEFPLAN - An 'Holistic' approach to property management

MRC Project number: NAP3.
Project duration: 01/01/98 to 30/06/2001
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Project description

Introduction

The North Australia Program is a key program within the Meat Research Corporation (MRC), dealing with productivity and resource management in the northern beef industry. The BEEFPLAN project will fund 5 groups of producers and allied management and technical advisers across northern Australia to develop an integrated systems approach to whole property management.

This project recognises that beef producers are accomplished business people, using their knowledge and experience to manage their properties for profit. BEEFPLAN intends to build on that base by developing management systems that enable the appropriate application of a mix of new technologies and principles, information and opportunities to the business

In the long term, this approach offers the best chance of accommodating change and capturing the available benefits and opportunities available to the industry and to individual producers.

Background

NAP3 has nominated *"increasing the profitability, international competitiveness and ecological sustainability of the northern Australian beef industry by improving property management"* as one of its key objectives. Northern Australia in this context encompasses Queensland, the Northern Territory and the Kimberley and Pilbara regions of Western Australia.

Substantial technical research work has been done in areas of pasture management, nutrition, reproduction and genetics, growth, animal husbandry, and to a lesser extent, resource management. All of these have the potential to greatly improve the productivity of extensive beef operations. However, the adoption and application of such technology has been modest and, in many cases, the expected benefits have not yet been seen. The BEEFPLAN concept seeks to achieve the full benefit of research and development work by developing implementation strategies that bring together the research results in ways that will clearly enhance profitability and sustainability. The complexity of combining business approaches, technologies and management practices in a beef production enterprise can be, at times, overwhelming. This project will assist managers and proprietors in coming to terms with that complexity to better utilise the physical, financial and intellectual resources of the grazing business to generate income and capital growth, while maintaining or enhancing the vigour of their resources. BEEFPLAN will also develop processes to enhance resource management and to enable consideration of the health of the environment in the management process.

BEEFPLAN recognises that there is a lack of suitable information and skills to undertake this work in northern Australia and a large part of this project will focus on developing the new information flow, expertise and skills for producers, agency and agribusiness people.

Within this context, NAP3's BEEFPLAN project represents the beef industry's first attempt to bring together the broadest possible range of technically-based beef production and resource management R&D streams into an integrated management approach. It will introduce successful management philosophies now commonplace in manufacturing and other areas of general commerce to the grazing sector.

The Project

The BEEFPLAN project will improve long-term sustainability and prosperity of northern beef producers by:

- developing an understanding of, and strategies for, integrated beef property management across the various northern Australian beef production systems
- developing systems which can effectively integrate both production and resource management in an equitable way;
- improving the understanding of whole farm systems among producers, researchers, extension officers and agribusiness personnel to enhance their knowledge, management and decision-making skills
- establishing a whole-farm focus across the industry and within supporting agencies and business
- developing new opportunities for beef producers through better integration of components of whole-farm systems
- fostering a collaborative community/regional approach to developing integrated management systems.
- identifying the most successful strategies and approaches developed by the producer groups and extending these processes widely throughout the northern beef industry
- providing ownership to the northern producers of this whole property initiative

As the first stage towards achieving these goals, 5 core groups of producers from contrasting environments and production systems across Northern Australia will develop and apply BEEFPLAN principles to their properties, with the assistance and close involvement of technical and managerial specialists.

This will provide core information, principles and processes as a model for sustainable and profitable operation and growth in the beef industry. It will also develop a pool of skilled practitioners, both producers and advisers, within the industry to champion the integrated property management process and demonstrate the benefits of this approach.

From the outcome of the core group activity, the project's objective is to establish 150 producers with the appropriate skills by June 2001, and at least another 1,000 initiating BEEFPLAN activities. The BEEFPLAN project will aim to put business management processes in place, enabling participants to judge various marketing, cattle production, and resource management options and decide how they might be applied to their own operations.

Because of the strong producer management element in the project, it is envisaged that an important part of the project will be the identification and appraisal of the vast knowledge and experience that exists within the grazing sector.

BEEFPLAN will also help participants put new industry concepts like biodiversity and landscape ecology into the context of their own operations, and allow better informed value judgements about their application. It is expected that each group will link in closely and interact with a range

of technical projects in NAP sub-programs covering livestock production and resource management.

Once each group has its project in place, it is envisaged that group members will then develop communication and extension activities to raise awareness of the whole property management approach among their peers and to demonstrate that approach to others.

Project rationale and differentiation

But why the need to take a holistic approach, when producers can currently choose from a wide range of subject-specific R&D activity which they feel best applies to their own circumstances?

The answer lies in the fact that by adopting one specific piece of technology or strategy in isolation, it is not possible to thoroughly evaluate the impact of that activity on other components of property operation and performance. A simple example would be adopting dry season nitrogen supplementation which, by enabling higher female fertility and calving rates, could have impacts on many other issues such as stocking rate, pasture management, and marketing of cull females. Unless such inter-relationships and co-dependencies are recognised, it is impossible to measure the real economic or environmental impact of new technology.

Just as a new technology must be considered in terms of its impact and fit with all the components of the enterprise, so too are there a myriad of considerations in the process of adoption of that new technology by producers. Points such as the complexity and cost of implementation, compatibility with the owners' goals and ambitions and, particularly in the case of resource management, the need for a regional approach and the social and community support implications are issues that enter into this holistic management approach.

This project is also responding to the strong demand by producers to make the outcomes of their levy funded research relevant and applicable to their circumstances. This demand has been clearly expressed through the strategic plans developed by a number of Regional Beef Research Committees and through their umbrella body, the North Australia Beef Research Council. It has also been evident in producer workshops conducted by MRC and in the direction set for NAP3 by the NAP Industry Committee advisory board.

There has also been a strong desire by industry to participate in the management and direction of research development and extension. This project is consistent with that desire. Indeed, the extent and capability of the producer involvement in managing the project will be a major consideration in selecting the participating groups.

BEEFPLAN will augment the Property Management Planning (PMP or Future Profit) work underway in northern Australia. PMP facilitates the construction of a farm business plan. The BEEFPLAN project offers the opportunity to extend that process by overseeing the implementation and operation of that business plan, drawing on the relevant specialist competencies for assistance as required. Moreover, the continuing evaluation and finetuning of the developed management plan by the group and individual participants is a major additional aspect offered by the BEEFPLAN project. However, it is by no means mandatory that selected groups will have completed a property management planning workshop.

PMP is federally funded and is likely to have a limited operating life. Consequently, it is critical that the beef industry be equipped with the skills and expertise necessary to effectively manage the production base, independent of PMP. The BEEFPLAN project provides an opportunity for producers to develop those skills in collaboration with relevant technical specialists.

How will the project operate?

The project is designed to apply to beef producers of all sizes. Large, integrated cattle operations stand to benefit as much as their smaller contemporaries, through better integration of various production/environmental/marketing options.

Under Stage One of the BEEFPLAN project, an initial call will be made for producer groups across northern Australia to submit a short project proposal outlining how their group will manage a project in their area. From these applications, five groups will be selected, representing various geographic and production areas. The groups themselves could be drawn from a number of backgrounds such as established producer groups from within Landcare, marketing, Beef Improvement Association, Regional Beef Research Committee, Producer Demonstration Site, Best Practice, or from other special purpose groups formed specifically to take part in the program.

Each of the five selected groups may then utilise specialist consultants from a range of fields including business management (business systems and comparative analysis); and technical management (productivity, marketing, resource management, and other areas of R&D) to develop a full and detailed proposal. This process of project development could take some months and a degree of seed funding could be allocated to assist with this process. Substantial funding will be provided by NAP3 to fund a part-time group coordinator, consultant specialists, project operation and communication activities.

It is intended that the consultants contributing to the local projects will be drawn from a mix of private and agency backgrounds, strengthening the linkages and networks within that sector. It is anticipated that each group would involve 10-20 families or property managers, each of whom would involve their properties, and provide access to their records for the program.

While project activities and identification of priorities and their relative importance will vary from group to group, the following issues are considered integral to the project:

- Group strategy and direction
- Business management and planning systems including the identification and management of key profit drivers
- Resource management planning to maintain and enhance the health and biodiversity of the resource base.

Other issues, by no means an exhaustive list, which may be considered are:

- an inventory of current production/management systems, practices, skills, etc
- development of benchmarking and comparative analysis
- resource, production and economic monitoring of whole-farm systems
- business planning
- managing total grazing pressure
- family, community and social issues and impacts
- establishment and use of case studies
- assessment and use of decision support systems
- skills training and enhancement, action learning programs
- communication and extension
- risk assessment and management
- project evaluation and reporting

Close linkages will be developed between the five groups. Participants will be required to show commitment to the project's strategic direction, a willingness to adopt tactical and strategic changes in management and contribution to the extension of these principles to other producers outside the core project is essential.

Funding

On final selection of the five groups, the Meat Research Corporation will provide seed funding to each group to develop their project plan in detail, prior to final contract and implementation. MRC will then provide reasonable funds for each group, where necessary, to secure the services of

appropriate specialists and advisers to assist them in their activities. Where those advisers are from government agencies, the Corporation may support them with operational funds.

Where the group leader or champion intends to devote considerable time to the project, MRC may negotiate a remuneration contract with them. MRC is also prepared to consider costs and other disbursements associated with the groups' activities.

A contribution of \$1,000 per year from each participating business towards the cash cost of the project is expected.

What are the benefits of the project?

Benefits to group members will stem from::

- a planned approach to technology uptake, leading to improved productivity and enterprise performance
- a better understanding of the impact of potential management or husbandry changes on the environment, and accommodation of those considerations in decision-making
- coordinated management to deliver products that meet identified market needs
- improved access to technical information
- ownership of the project and processes arising from it
- risk management protocols leading to greater profit and less stress
- greater understanding within the finance industry of the complexities and interactions within the farm management process
- better resource management
- a possible increase in the number and quality of consultants available for specialist advice to the industry
- a more rewarding future

The broader beef industry will benefit from greater awareness of whole property management techniques and direct contact with people using them, and enhanced skills and a wider pool of specialist assistance available.

Agencies and agribusiness people will benefit by an increase in their skills, expertise and knowledge.

The project's systems approach to planning is intended to avoid any additional burden on departmental extension and advisory staff beyond their normal activities, and should complement extension activity with the broader grazing community.

Strategic R&D

Expressions of Interest will also be called for a consultant experienced in strategic R&D to monitor and analyse the various approaches, strategies and processes used by the different groups, determining which are successful and why. This work is separate to that involved in the project coordinator's role.

Through this comparison of the different groups' approaches and strategies developed, new knowledge will be generated on how the approach can be used or adopted by the industry at large.

How will the project unfold?

A part-time coordinator will be recruited by NAP3 to coordinate the project. She/he will be directly responsible to a management team consisting of NAP3 management, producers and technical people. The duties and responsibilities of the project coordinator have been outlined in a separate document.

Short submissions are being called for from producer groups interested in taking part in the project, briefly describing the composition and management of their group, issues and priorities to

be addressed and projected outcomes. A short list will be developed from those preliminary submissions. Selected producer groups will then be asked to make a presentation to a selection panel, leading to the final selection of the five groups.

On in-principle selection, the five producer groups will be assisted by the project coordinator in association with relevant specialists identified by the group to develop the full project detail. Some seed funding will be available at this stage.

From that point, it is anticipated that a group management team will be established to guide each project over its lifetime. It is likely that a group champion may emerge from that management team to drive the project forward, providing support and encouragement to group members. Ideally this champion will be a producer and producers will be expected to manage their individual projects.

Applications will close on February 16, 1998 and a project coordinator will be recruited at the same time. It is anticipated that at least two groups will be operational by May 1998

Selection of Groups

Beef producer groups from across northern Australia (ie Queensland, the Northern Territory and the Kimberley and Pilbara regions of Western Australia) are being called on to indicate their interest in participating in the BEEFPLAN project.

Producers will need to formally establish groups and select a group chairperson who will be responsible for organising the expression of interest submission. A group of about 20 is a useful number for this type of project, but this is not mandatory. The group would be able to co-opt other technical and agribusiness people into their group and seek their assistance in developing the submission.

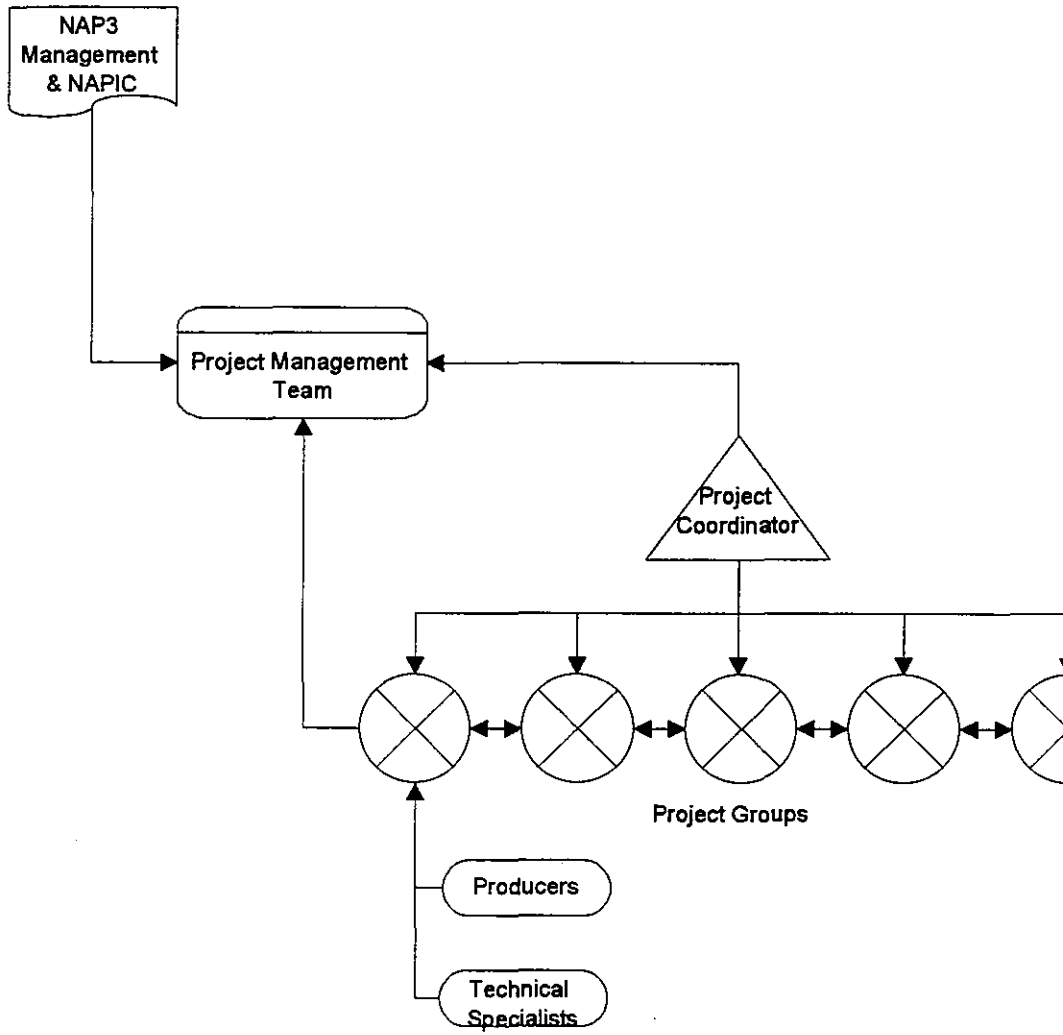
There is no formal application form. Instead the group is asked to address the following questions in a letter (approximately six pages) to MRC (see below). The group may also attach additional documentation as attachments to the letter of submission.

The submissions will be assessed by a panel of producers, technical experts and NAP Management personnel and groups will be informed of the outcome of their submission by the end of March, 1998.

Questions to consider

- What is the name of the group, location, contact details, etc?
- Who is involved and what are their responsibilities? How do you see the group functioning?
- Who and what will drive and motivate the group. What time commitment is required and is that realistic?
- Describe local issues, problems and opportunities. What are the main profit drivers on your properties? How will the project address and advance those issues?
- How does the group propose to integrate the issues of biodiversity or landscape ecology, productivity and business management? What are the priorities?
- What support is required and is it available? What are the linkages and association with managerial and technical specialists?
- What are some of the risks associated with the proposal and how might those risks be guarded against?
- What is the group's attitude to communicating its findings and changes to its colleagues?

Organisational Structure of BEEFPLAN



Determining the productive capability of your land to develop sustainable management practices

MRC Project number: NAP3.213
Project duration: 01/05/97 to 30/06/2001
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Objectives:

1. By 31 March 2000 to have 120 producers from 6 diverse areas of Northern Australia acquire monitoring skills and initiate a monitoring and adaptive management program on their properties as a result of these workshops.
2. By 31 March 2000 to have demonstrated to the north Australian beef industry the benefits of monitoring and pasture management and have implemented programs for 2000 additional producers to acquire monitoring skills to initiate a monitoring program for adaptive management by 30 June 2001.

Summary

The project will be managed by the above mentioned team of specialist beef producers operating under the name Vision Development. Dr Judy Lambert will oversee the project on behalf of the MRC.

Target areas will be decided after the selection of six regional co-ordinators from across northern Australia and a preparation workshop will then be held to:

- (a) increase the interpersonal skills of the management and the regional co-ordinators and create a team concept;
- (b) network and build rapport with resource extension people who are a vital component to the success of the project; and
- (c) consider the suitable monitoring methods for each of the chosen regions as well as the structure and composition of the regional workshops.

A two-day producer workshop will be held in each of the selected regions before the end of the 1998 "wet" season. Each workshop will introduce producers to a resource monitoring and adaptive management program for use on their properties. Information days on plant identification and interpretation of monitoring information will be encouraged. Local co-ordinators will conduct on-property visits to assist with site location and technical issues.

Following completion of the regional monitoring workshops, a planning process will begin to extend pasture monitoring beyond the targeted producers. This process will involve all project participants and other relevant groups.

Report

Objective 1

An extensive advertising campaign for the six local co-ordinators resulted in 50 position descriptions being requested and 21 high quality applications being received. The essential criteria for these positions was:

- Good interpersonal skills and a demonstrated ability to participate in information sharing to assist individuals, groups and communities to build up skills and knowledge with regard to resource monitoring for adaptive management.
- An understanding of rural communities and the issues of sustainability and viability as it relates to them.
- A rural background with demonstrated experience in on-property work.

The project management team met on 12 and 14 June to short-list the highest quality applicants for interviews which resulted in the employment of the following five regional co-ordinators. Appointment of a sixth regional co-ordinator is still being considered.

- Mr Kent Lithgow, "Koala", Chinchilla
- Mrs Jo Wearing, "North Dalziel", Taroom
- Mr Phillip McKeering, "Stirling", Barcaldine
- Mr Eugene Matthews, "Blue Range Station", Charters Towers
- Mr Bob Millington, Centralian Land Management Association, Alice Springs

Appointment of a sixth regional co-ordinator is still being considered.

Objective 2

Shane Walsh attended the inquiry into the Rural Adjustment Scheme led by Mr Sam Doumany. At the inquiry Shane submitted a paper outlining the advantages of using information gained from pasture and soil monitoring in Whole Property Management planning. The report was favourably received by the Messrs Sam Doumany, Ian McFarlane (QGGA) and Larry Acton (UGA) who are members of the inquiry team.

Shane Walsh attended a workshop convened by Ms Kelen Klieve (QDPI) to investigate the effectiveness and efficiency of the Drought Relief Assistance Scheme and the freight subsidies. At the workshop, Shane successfully raised the issue of pre-drought resource management and the importance of pasture and soil monitoring in determining drought conditions. The management team understands that following other workshops around the State, Ms Klieve will prepare a report with recommendations.

The management team has taken every opportunity to raise the subject of resource monitoring.

Communications

The management team strongly believe that the communication strategy which identifies client groups, communication goals, and constraints is imperative to the project's success.

The primary client group for this project will be those north Australian beef producers who might participate in the initial series of monitoring workshops. The management team conducted a comprehensive media campaign across north Australia aimed at:

- (a) informing the north Australian beef industry about the project; and
- (b) attracting interest in the regional co-ordinators' positions.

This was achieved by a series of radio interviews on the ABC rural programs across Queensland and the Northern Territory and newspaper articles in the Queensland Country Life, NAP news and The Cattleman.

Other producers who are not yet ready to participate, but who might be influenced by the outcomes of the pilot program will form an important second part of the primary audience, as it is upon those producers that the success of the multiplier aspects of the project will depend.

Whilst the project is directed primarily at producers, its success also depends in part on increased awareness and support by several other groups.

The management team recognise the importance of communicating and working with research and extension providers, government and bankers in the rural sector. Discussions regarding the project have been held with a number of key people in those areas including Dr Eric Anderson (QDPI), Mr Tom Stockwell (NT Department of Agriculture), Ms Renata Paliskis-Bessell (WA Agriculture) and Dr John McIvor (CSIRO).

In addition, the project team has informed producer organisations and the North Australia Beef Research Council and its regional beef research committees whose support will enhance the probability of producers becoming involved in the project.

Contact has been made with Mr John Stewart (NABRC), Mr Richard Golden (CUA) and Mr Gus McGowan (UGA) and others, all of whom have indicated their support for the project. As the project advances, communication links will be made with beef consumers and environmentalists who are seeking greater evidence of a shift to ecologically sustainable management within the industry.

Plans for 1997/98

The preparation workshop will be held in Townsville from 15-17 September. The management team and the regional co-ordinators will liaise with resource extension people in the targeted areas to seek assistance with the project, particularly the monitoring workshops.

Each regional co-ordinator will liaise with extension officers in their regions. Following this, they will conduct a monitoring workshop involving about 20 properties in their region before the end of the 1998 "wet" season. Regional co-ordinators will provide on-property assistance if required. Plans will be made to extend the use of resource monitoring beyond the workshop participants.

Discussion/Comments

1. *Which monitoring method will be used? Is the project taking into account existing methods? Project management needs to avoid confusion with producers. Grasscheck will be used as a start, but this is not finalised and the methodology may vary from region to region. The project management team does not intend to use anything but existing methods.*
2. *How will the data be used ie: just on property or will it be available to other sources? Project management are keen to see it used more widely.*
3. *How public is the data? The individual data is confidential and possessed by the property owners. The project management team would be keen to have the information collated to a broader scope, but emphasises the need for communication and negotiation with property owners.*
4. *What percentage of beef producers in Northern Australia does the project aim to cover? 8%*
5. *How do you know if the project is achieving success?*
 1. Seeing the data used in property management decisions.
 2. Producer feedback.
 3. Further adoption by other producers.
6. *The project is about getting information on to the property. The project needs a formal measure of impact now and at the end.*

Regional workshops will address this issue primarily from an educational viewpoint rather than a scientific one, taking into account adoption and annual monitoring on the property. In addition, this project was rigorously refereed prior to its acceptance by the MRC. The project's budget includes an amount for an independent assessment and evaluation of the project.
7. *Is the project about learning and understanding rather than application?*

The project will provide producers with a tool to help them better understand the resource and make more informed management decisions.

Overview of catchment management, water quality and nutrient flows

MRC Project Number: NAP3.214
Project duration: 15/04/97 – 22/08/97
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Objectives

To prepare an overview of catchment management, water quality and nutrient flows as they relate to management in the beef industry across northern Australia.

Background and methodology

This review is essentially concerned with the hydrological cycles and the closely associated nutrient cycles in northern Australia, how these have been modified through the introduction and management of extensive grazing systems, and the effects of these modifications on the land and water resources of the region. In particular, the project seeks to explore whether the modifications have resulted in changes in system properties and processes which are undesirable from the perspective of continued productivity of our natural resources.

The Terms of reference for the review were to -

1. Collate, review, critically evaluate and provide a concise report on the current state of information and knowledge on interactions between clearing, pasture improvement, grazing management, drought, vegetation cover, soil erosion and downstream effects on the hydrological cycle in northern Australia. The amount and quality of surface water, the capacity of groundwater and the ecological status of riverine systems are all important aspects of this work.
2. Identify the key players, whether individuals, groups or institutions, involved in R&D in these areas.
3. Identify major issues and problems in this area for both economic production and ecological sustainability within the beef industry and for downstream systems.
4. Identify those aspects of current knowledge which might immediately be translated into strategies which can be adopted by beef producers or others in the community who are seeking to improve profitability, international competitiveness and ecological sustainability.
5. Identify critical gaps in knowledge or uptake, to indicate the significance of these gaps to current land and water management, to identify the end-users of new information which might be generated and to specify R&D activities which might overcome those deficiencies.

6. Make recommendations as to work which might appropriately be funded by Phase 3 of the MRC's North Australia Program, taking account of the need to improve adoption of ecologically sustainable resource management systems and their profitable utilisation.
7. Prepare a draft report and present it for review by a forum of northern Australian beef producers and other with responsibilities in natural resource management in northern Australia.
8. Following that consultative forum and discussions with the MRC's NAP3 program coordinators, prepare a final report which includes a short summary suitable for publication by MRC and circulation throughout the northern Australian beef industry, R&D agencies and relevant scientists.

Report (*The following is the executive summary from the report*)

Extended dry seasons over several years combined with changed cattle production systems have placed increased pressure on native pastures across northern Australia. Over the past twenty years stocking rates in some areas have begun to exceed 'safe' carrying capacities resulting in undesirable changes in pasture composition, and soil degradation. The increases in grazing pressure have coincided with an increasing awareness that the changed processes in the land that lead to pasture and soil degradation, can also affect water quality of the catchment. There is particular concern about the off-shore effects that changes in river water quality may be having. Such effects may involve, for example, increased sediment and nutrient inputs degrading the estuarine breeding grounds of commercial fisheries or changing the ecology of coral reefs. This concern is illustrated by the several conferences and workshops that have been held to discuss the changes in, and effects of, terrigenous inputs to the Great Barrier Reef lagoon, and by the formation in Queensland of the Downstream Effects of Agricultural Practices (DEAP) committee.

There is also increasing awareness of the need for Australian industries to be productive and economically viable, but not at the expense of degrading our natural resources so as to impair their capacity for use, including use by future generations. This need has been enunciated in the principles of ecologically sustainable development. As a result of the increased awareness within the community of the need to maintain the productivity of our natural environment, there are increasing requirements for agricultural commodities to be produced so as not to cause degradation of our biota, and land and water resources. It is becoming more and more incumbent on agricultural industries to demonstrate that their management practices are not degrading the environment.

It is now well understood that catchment water quality and its implications for downstream biota and water use, are the result of all activities within a catchment. This has led to the concept of Integrated or Whole Catchment Management and the development of catchment management groups. The aim of these groups is to develop catchment management strategies and plans to ensure that management is integrated and that the different land uses are not detrimentally affecting other industries. While the management of grazing lands must take place within a whole catchment framework, it is also essential that the off-site effects attributable to particular grazing practices be separated from those caused by other industries, or which occur naturally. By being in possession of the facts, the industry can take proper and realistic responsibility, and develop a strategic position for the future which will enhance its competitiveness, particularly internationally.

These issues are of concern to the Meat Research Corporation and the Land and Water Resources Research and Development Corporation and are being addressed in Phase 3 of the North Australia Program (NAP3). Phase 3 follows Phases 1 and 2, and extends from mid 1996 to mid 2001. The North Australia Program, which is jointly funded by the Meat Research Corporation and the Land and Water Resources Research and Development Corporation, seeks to "improve the profitability, international competitiveness and ecological sustainability of beef production in northern Australia".

International competitiveness has been addressed by examining the determinants of competitiveness and concluding, among other things, that adoption of acceptable environmental standards will be fundamental to the future of the industry. Subprogram 2 of NAP3, Improving Resource Management, aims to increase international competitiveness and hence profitability, by improving the development and adoption of ecologically sustainable resource management systems and their profitable utilization by the northern Australian beef industry.

To assist in developing a relevant program of research for NAP3, the Meat Research Corporation and the Land and Water Resources Research and Development Corporation jointly commissioned a broad overview of current information on the effects of catchment use and management in the grazing lands of northern Australia, on water and nutrient cycles and the downstream fluxes of water, sediment and nutrients. Interactions between grazing management (primarily stocking rates and their variation in time and space), drought, clearing and pasture improvement in producing these effects, were regarded as particularly important. Also important were the effects of these changes on the ecological status of riverine, estuarine and marine ecosystems, although the review was not concerned with impacts upon biological diversity more generally as this has been the focus of another project within NAP3. As well as reviewing current knowledge, the commissioned review was also required to recommend work which might appropriately be funded by NAP3 and to prepare a draft report for review by a forum of northern Australian beef producers and others with responsibilities in natural resource management.

A large amount of research relevant to this topic has been undertaken and it was not possible in the time-frame available to comprehensively review all material. The aim has been to identify major gaps in understanding and knowledge. Most research to date has involved understanding the effects of particular stocking regimes on pasture composition and water, sediment and sometimes nutrient fluxes. Generally, this work has been for plots or small catchments. There has also been some work identifying the effect of clearing and pasture improvement on components of the water balance. The terrestrial inputs from catchments flowing into the Great Barrier Reef lagoon, the fate and effect of these inputs, has also received some attention. Estimations of terrestrial inputs and their change following the introduction of grazing, have been based on fluxes measured for plots or small catchments or on extrapolations from rivers and streams for which sediment concentration and flow data are available. A very limited amount of work is currently underway using coral and sediment cores to investigate temporal changes in terrestrial inputs from catchments on the east coast of Queensland. The issue of the degree to which the introduction of grazing has increased sediment and nutrient fluxes to the marine environment over and above natural inputs, and the effect of this increase, particularly on the Great Barrier Reef, remains equivocal.

Despite the large amount of research that has been undertaken, major gaps in knowledge remain, which is not surprising given the vast area covered by the northern Australian beef industry. Areas of particular concern are:

- the paucity of research investigating the effects of grazing and grazing land management on wetlands and riparian areas; qualitative subjective assessments based on observation are numerous but there are few data that quantify the changes that have occurred;
- the major gaps in our knowledge of the interactions between the various components of the grazing system, their variation for different land types, and in time and space within a given land unit — past work has focussed predominantly on pasture—animal interactions; in future, consideration also needs to be given to vegetation—nutrient—soil biota interactions and soil—pasture condition—water inter-relationships;
- the scant research in processes for areas larger than plot and small catchment — this reflects the ‘grazing trial’ nature of much research carried out to date; for example, apart from studies of the effect of the distribution of watering points, there has been little investigation of animal behaviour and its effect within paddocks, or of the time it takes for local changes in the flux of water, sediments and nutrients as a result of grazing management practices to have an effect on fluxes from the whole catchment;
- the lack of information on components of the water balance and changes in the flux of water, sediment and nutrient, relating to particular landscapes (land with similar climate, geology, topography, regolith and soil, and vegetation); also of concern is the fact that relatively little use seems to be being made of land system data although land information is critical to assessments of land productivity and its inherent susceptibility to degradation; and
- the apparent non-awareness within the grazing industry as a whole, of the need to adjust stocking rates, both in space and time, to match pasture productivity, and of the degradational consequences of not doing so both on the land on which the pastoral enterprise depends, and on the water resources downstream.

Given the large gaps in knowledge in many areas relevant to understanding the effects of the northern Australian beef industry, there are several recommendations which could be made for appropriate work. The following specific recommendations reflect the outcome of discussions arising at the workshop held in Brisbane, to review the draft report.

Recommendations

The first two recommendations are for more preliminary work to be undertaken before development of the final research proposal. The third recommendation relates to the type of research to be undertaken.

Further information on current projects

Current projects related to water and nutrient movement, and catchment management more generally, need to be assessed to identify more specifically the knowledge that is being obtained and any deficiencies of the work. This will require the collection of further details on the problems being addressed, project objectives, methods being used, where the work is being undertaken, the organization that is doing it, the timescale and the sources of funding. NAP2 projects that are being extended into NAP3 need to be included.

Identification of appropriate catchment(s) for research

Given that major research will need to be limited to one or two catchments as a result of funding constraints, an important issue is the catchment(s) in which the research should be done. A scoping study that considers all catchments across northern Australia needs to be undertaken as a matter of priority. As a starting point, the study needs to establish the criteria against which catchments would be ranked and grouped. Some of the suggested criteria are:

- a perceived high potential for the grazing industry to affect land and water quality;
- a catchment community that wants the sort of information that will be generated by the research;
- a catchment that is considered to be important from the point of view of the grazing industry; and
- an effective extension process already in place to pick up research results and incorporate them into catchment planning.

The first criterion requires characterisation of catchments in terms of biophysical attributes, including geomorphology, climate and land use, in an attempt to identify potential vulnerability to degradation and risk of off-site effects. Also important are whether catchments are coastal or inland and whether rivers are regulated or unregulated. It is also recommended that this scoping project assess the land system and other resource mapping information available across northern Australia. Note should also be made of catchments in which NAP3 projects arising from NAP2 projects, are being undertaken.

Recommended research

The third recommendation is to establish a project or projects to identify and measure the significant effects that the north Australian beef industry is having on the movement of water and nutrients within the catchment and the effect of this movement on water quality and the sustainable use of other resources.

It is recommended that the research involve:

- an analysis of the surface hydrology, landforms and patterns of sediment generation, transport and deposition, and the delineation of geomorphic provinces;
- an interpretation of the inherent capacity of the geomorphic provinces to supply sediment and nutrients to the major river systems and the susceptibility of the land within them to degradational processes as a result of specific grazing practices;
- establishing budgets for water and key nutrients at paddock to catchment scales, using the provinces as a guide to major landscapes for which budgets are required;
- examining the extent to which grazing and grazing management practices enhance loss (as distinct from redistribution) of water, sediment, nutrient or organic matter, from local areas (ie, catchment divide to water course); and
- determining the effect any such losses are having on land functioning and productivity, both on and off site.

It was recognized that this project needs to be linked with the biodiversity research that will be funded in NAP3.

Scoping study to identify appropriate catchment(s) for NAP3 funded research

Following on from Rosemary Hook's review, NAP Management commissioned a scoping study with the following broad objectives.

1. Collate and review existing information on current research projects studying water quality and nutrient flow issues as related to grazing management in northern Australia and identify priority issues in need of new or further research within the context of the recommendations provided by R. Hooks review.

2. Assess the relative potential vulnerability of grazed catchments across northern Australia and evaluate perceived risks to water quality and nutrient flows as related to current stocking pressure/grazing management practices and other land uses.
3. Provide MRC and LWRRDC with recommendations on potential focus catchments for research into grazing effects on catchment response and optimum implementation through a major multiagency group.

The core team is coordinated by Dr Christian Roth (CSIRO Land & Water, Townsville) and they will submit a report to NAP Management by 17 April 1998.

PART 3. WORKSHOP REVIEWS AND EVALUATION

Dr Sue McIntyre from CSIRO Tropical Agriculture and Dr Warren Mason, Program Coordinator for the MRC's Southern Sustainability Key Program, who had no direct involvement in any of the projects, were invited to attend and review the workshop. We wanted their personal perspectives on the projects and the sub program. The following guidelines were provided, but essentially we wanted them to be free spirits and not constrained in their thoughts and ideas. Guidelines were -

- Have the project objectives been met? If they have not, were the reasons advanced sufficient to justify their non achievement.
- Only comment on the scientific rigour and methodologies where there are obvious weaknesses or deficiencies.
- Are the conclusions and recommendations valid and justified on the basis of the information presented in the report.
- What is likely to be the major impact of the project in terms of production, sustainability, land/water/vegetation including biodiversity?
- Has the adoption/communication process been thought through and implemented. Is there a clearly defined communication strategy. Is adoption of outputs likely to be rapid? Are clear adoption pathways identified? If not what should be done?
- Is coordination with departments/agencies and the beef industry satisfactory? If not how can it be improved.
- Comment on the interactions between NAP Management and the project teams.
- Comment on future plans and activities, particularly in the areas of coordination and integration between project teams and agencies/departments.
- Comments or recommendations on any other additional aspects of the NAP IRM sub program would be welcomed.

Comments on the NAP3 IRM Sub-Program Review

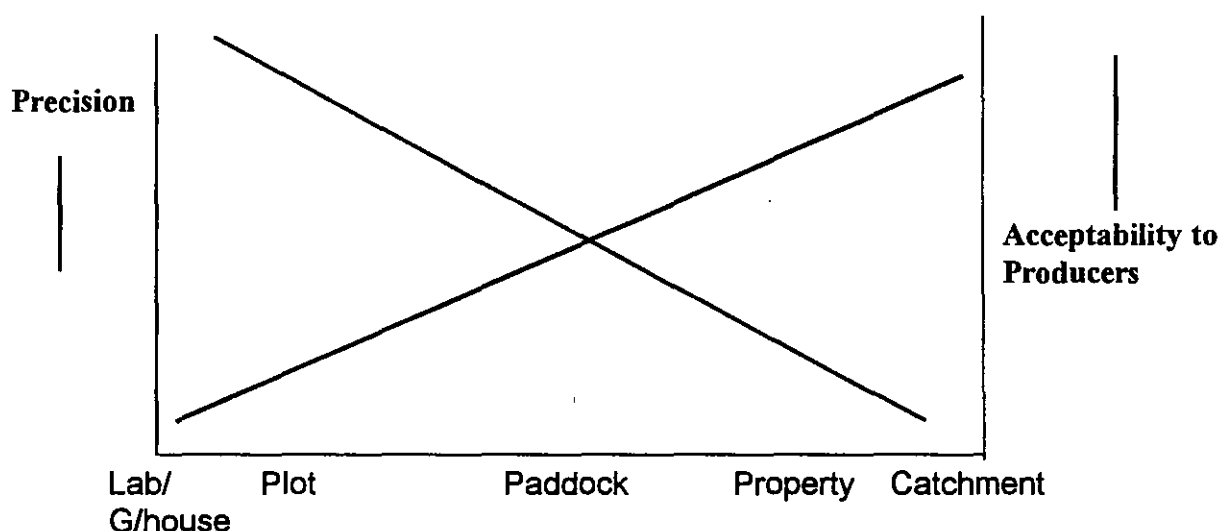
Reviewer:

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The sub-program aimed at "Improving Resource Management" in the cattle industry in Northern Australia contains a good mix of projects that cover the applied end of resource management research, at a range of scales, geographic locations etc. From my limited exposure, I am not in a position to offer constructive comments on the individual projects.

What I hope I can offer is some overview of the sub-program and how it might deliver more than the sum of the individual projects. This has been the driving force in SGS projects – ie how to get more progress across the board than independent projects can provide.

One of the difficulties we face is that the results from an experiment are rarely sufficient to cause a change in behaviour or management at the farm level. The job of developing principles and tools that producers can use to improve the management of their properties must be a joint effort, across the scales shown in the diagram.



The diagram attempts to depict the dilemma between statistical or scientific rigour (which leads to confidence and precision) on one hand, and acceptability of the results to land managers on the other. Clearly scientists want to deliver rigour and precision (we would have problems if they did not), while producers want to see results validated at the property scale where they operate. The distrust by producers of plot scale results is well founded – there are clearly properties of the system they manage that simply do not emerge at the plot scale.

The table on page 2 of this report was our attempt to quantify what SGS was trying to achieve at the different scales, from small plot work (to support the National Experiment), through to farm scale. The conclusion we reached was that we needed projects right across the spectrum of plot to farm, and that work at one scale did not substitute well for work at another. On a purely cost basis, it is important that a project work at the smallest practical scale, but large enough to allow the characters of most interest to be expressed. For example, rates of herbicide can be determined on small plots, while water balance and animal production need larger plots, while enterprise flexibility can only be determined at the farm scale.

The key issue is communication across the range of scales, and improving the flow of information from plot to farm and from farm to plot is where programs such as NAP3 can add value. The Townsville meeting was a good start on this process, but more needs to be done.

Small Plots →	Large Plots →	Paddocks →	Monitor Farms
<p><i>Supplementary Research</i></p> <ul style="list-style-type: none"> • pasture productivity • pasture ecology • soil quality 	<p><i>National Research Sites</i></p> <ul style="list-style-type: none"> • animal performance • pasture performance • soil quality • soil protection • deep drainage • water quality • limited financial 	<p><i>Regional Sites</i></p> <ul style="list-style-type: none"> • animal performance • pasture performance • management skills • partial budgeting • soil protection • land class variation 	<p><i>Farm Scale</i></p> <ul style="list-style-type: none"> • production systems • financial returns • farm performance • land capabilities • management skills • resource resilience • enterprise flexibility • land class variation • soil protection • water quality • biodiversity • riparian management • community interests • off-site effects

In SGS we attempted to build up a picture of a sustainable grazing system as the first step in a collective vision across sites and scales. The outcome of that deliberation is shown in Appendix A.

The second stage was to boil the elements down into six manageable themes viz

1. Animal production and profitability
2. Pasture production, composition and forage quality
3. Soil structure, soil biology and soil loss
4. Water use, including deep drainage and runoff
5. Nutrient use and losses in runoff and drainage
6. Biodiversity and nature conservation in grazing systems.

The value of the themes lies in the fact that we now have a process where 'research' at any scale can contribute to progress, without the expectation that any individual experiment can deliver 'tools' that producers can use. NAP3 needs to develop some process to encourage dialogue between projects and across scales, so that all the projects can contribute to better management on beef properties.

In summing up the workshop, I presented the group with three challenges:-

1. What are you going to do differently as a result of this meeting?
2. What processes are you going to put in place to speed up the development of 'tools' to assist producers manage their properties – not the individual elements, but the whole property?
3. How are you going to integrate your work (the range of projects presented) better?

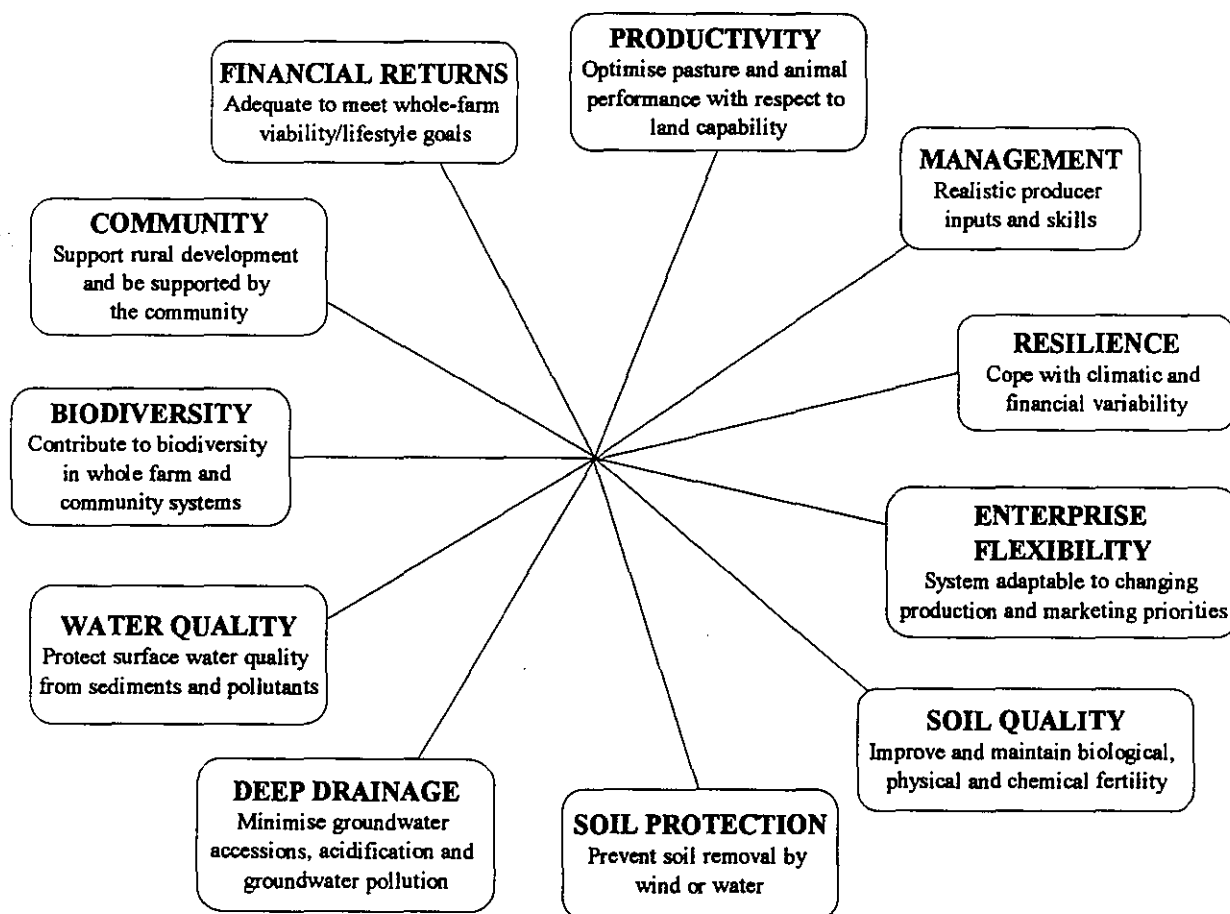
These questions are very specific to NAP3, and I can only add limited value by describing how they have been addressed in SGS. However, the group went home without any answers to the

challenges, and without a process in place to work towards solutions. Future meetings should be structured to facilitate the group answering these types of questions. While there is undoubted value in everyone having the opportunity to present their project to the whole group, I think you can get more out of such a meeting. If the management of NAP3 provides some direction (such as saying "we need to establish a process that will increase the linkages between projects, and speed up the delivery of practical principles to producers"), then the group can focus on the how.

The final point I want to make relates to the similarity (in the resource management area) of the issues between SGS (or southern Australia), and NAP3. The six themes in SGS that range from profitability to biodiversity seem very similar to NAP3. When we were discussing soils (erosion, acidification, organic matter and biology), weeds, grazing management, loss of the desirable perennial grass species, and biodiversity, I could have been in the south. I suggest that we develop some process to ensure there are ongoing linkages between NAP3 and SGS. Possibilities might include someone from NAP3 joining the Steering Group of SGS, attending the annual southern sites meeting, joining theme teams, etc, and of course vice versa.

APPENDIX A

THE ELEMENTS OF SUSTAINABLE GRAZING SYSTEMS



NOTES

Sustainable grazing systems are complex subsets of farms, catchments and regional ecosystems. There is no suggestion that each element in the diagram is of equal importance, and the relative importance of the elements will change with geographic location and with individual perspective.

This is especially true of the environmental issues - for example, rising water tables and salinity are critical issues in some locations, but are not a threat in others; the quality of water in the Murray River is a big issue for suburban Adelaide, but less so for producers in the upper catchment.

1. **FINANCIAL RETURNS** Profitability is the single most important element of sustainability for anyone making their living from the land. However, the financial demands placed by producers on their production systems will depend on many personal, equity, life style and life stage issues. A sustainable system must be able to meet these whole farm/viability/lifestyle goals.

It is often stated that this issue is the key to sustainability - get the profitability right and the rest will follow, or you can't be green while you are in the red! Clearly no system can be sustainable without sufficient financial returns, but it does not always follow that profitable systems are environmentally sustainable. Profitable systems can degrade the resource in the short term (eg soil erosion, rising water tables and river water quality may take decades to have an economic impact), or may cause off farm impacts that never feed back to on-farm profitability (eg downslope salinity, algal blooms, silting of water storages or the loss of biodiversity).

Profitability is essential and must be a major focus of the Sustainable Grazing Systems Key Program, but by itself does not guarantee a sustainable system, so the SGSKP cannot ignore the other elements of sustainable systems.

2. **PRODUCTIVITY** Sustainable grazing systems must produce meat and/or milk and/or wool of the appropriate quality to satisfy market requirements, and in sufficient quantity to meet financial goals. Land capability must be matched with the production system to ensure the optimum pasture and animal productivity. Productive pastures and productive animals, with relative freedom from weeds and feral animal are essential to optimise the production system.
3. **MANAGEMENT** It is reasonable to expect that producers improve their management skills over time, to increase both profitability and sustainability. However, any new or improved systems must be realistic with respect to the time inputs required, and to the expectations placed on the skills and management capabilities of producers.

The issue of improved record keeping on farms was suggested as a key element of future sustainability. Accurate records of inputs and outputs, stocking rates, animal health etc are imperative for monitoring and evaluation.

4. **RESILIENCE** Dramatic changes in climatic conditions and commodity prices are an integral part of Australian agriculture. Systems that cannot cope with such fluctuations are unsustainable and often result in substantial degradation of soils and pastures. Current Government policy promotes individual risk management over subsidies to assist producers during drought or periods of low prices.
5. **ENTERPRISE FLEXIBILITY** The sustainability of an enterprise is likely to increase if the system can respond to changes in markets. Production priorities (eg meat vs wool) may change, or diversification into additional enterprises such as cropping or horticulture may be a solution on some properties. While treated as an element of sustainability in its own right

in the diagram, many would include enterprise flexibility as a sub-set of financial returns.

6. **SOIL QUALITY** As the soil is fundamental to any production system, then protecting the 'quality' of the soil is fundamental to sustainability. Soil quality is taken to include physical aspects such as structure, chemical aspects such as nutrient levels or contaminants, and biological aspects such as soil macro- and micro-organisms.
7. **SOIL PROTECTION** The basic issue is to ensure sufficient protection for the soil surface to prevent the loss of soil from wind or water erosion. As a general rule of thumb, groundcover must always be greater than 70% and cultivation minimised if erosion is to be prevented.
8. **DEEP DRAINAGE** Rainfall that enters the soil and moves below the root zone is called deep drainage. This water joins the local and/or regional watertable. If the drainage contains nitrate ions, then the soil acidifies, and if the drainage contains nutrients or other pollutants, then the groundwater becomes contaminated.

A far more common problem (and probably the most acute sustainability issue for Australian agriculture) is that of deep drainage causing the water tables to rise. Over much of Australia there are high salt loads below the root zone and when water tables rise, the salt is mobilised and salinisation occurs. Typically, the crop and pasture systems we have introduced have a lower water use than the native vegetation, causing greater deep drainage. The generic call to plant more trees is in response to the increase in deep drainage that has followed clearing and agricultural development.

9. **WATER QUALITY** The high rainfall zone provides most of the surface water for domestic consumption and irrigation in southern Australia. While the issue of protecting the soil from erosion has already been mentioned, it is equally important to protect the quality of surface run off. Algal blooms have become a common feature of rivers and water storages and agriculture is often blamed for estuarine and reef degradation. Turbidity (suspended soil particles), nutrients (especially phosphorus) and chemical pollutants have all been implicated.
10. **BIODIVERSITY** Biodiversity has already been reduced in areas dominated by agricultural production. The recently released "State of the Environment" report (the first ever comprehensive assessment of the status of the Australian environment) concluded that the loss of biodiversity is the most serious environmental problem in Australia. While there is no possibility of complete restoration of the original biodiversity, there is a strong community feeling that we should not reduce biodiversity any further, and that we should increase it where possible.

Biodiversity is not a major issue within a highly productive, improved pasture that is based on exotic species. However, it is increasingly important for sustainability at the landscape scale and we can expect increased community pressure to increase the opportunities for biodiversity at the whole farm level through vegetation corridors, riparian areas etc.

11. **COMMUNITY** Sustainability is not just a resource management issue for land managers. Rural communities, urban communities and our trading partners are increasingly insistent that agricultural production systems meet community standards - though these standards are not well developed or articulated at this stage. To be sustainable then, grazing systems must be seen to be supporting rural/community development and be supported by the community. These 'community' expectations rarely consider the productivity or profitability needs of producers.

Comments on the NAP3 IRM Sub-Program Review

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The following issues were identified by the reviewers as being generally relevant to the projects presented at the meeting, although there is variation in their pertinence to individual projects.

Integrating NAP research results into an appropriate framework to address sustainable management

The objective of NAP sub-program 3 is to improve the development and adoption of ecologically sustainable management systems for beef production in the north. This concerns the management of whole production ecosystem and the people in it. Ecological sustainability requires all components of the biological system to be considered (but not necessarily the need to study them all). It also means that single site studies need to be put in the context of the broader landscape, including consideration of the property and catchment as spatial units of biological and social significance. This does not mean that new data necessarily needs to be collected. It may be more effective for researchers to draw from existing information in their own, and other, disciplines. The implications of NAP research results then needs to be considered in the context of the broader ecological and social fabric.

Ecological sustainability

The reviewers noted a tendency for researchers to adopt the narrower concept of sustainability - that of sustained pasture yield and soil condition. Although there is continuing debate around the definition of sustainability, the reviewers saw the need for NAP3 projects to widen their concept of sustainability to include the management of the broader range of ecological processes that support people and the production systems e.g. pest control, maintenance of water quality and quantity, landscape amenity, maintenance of plant and animal diversity.

Short-term production gains vs longer-term management and production issues

A consistent pattern of results is emerging from NAP research in which management for production gains can lead to longer-term management problems e.g.

- Not burning exotic shrub increases; unwanted changes to pasture composition.
- High stocking rates soil degradation; unwanted changes to pasture composition.
- Excessive tree clearing salinization; wildlife decline; non-viable tree populations.
- Sown legumes decline in pasture grasses; soil acidification.

These processes are consistent with our theoretical understanding of ecosystems. It is recognised that if more energy is diverted to human uses (in this case the conversion of solar energy to pasture to meat for consumption), then less energy is available to for biophysical processes that stabilise the structure and function of the grazing lands.

It is necessary to demonstrate to producers that very intensive land uses can lead to lower production in the long-term, or at least losses of ecosystem function that will reduce management options in the future. This presents a considerable communication challenge for the following reasons:

1. With short-term studies, it is not often possible to demonstrate longer-term production declines;
2. Although we have a reasonable understanding of principles and trends, it is not possible to be specific about future changes and outcomes for specific sites and regions e.g. demonstration trials may produce variable outcomes;
3. In some cases intensive production can be maintained through high inputs. Although there may be some changes to ecosystem status (e.g. loss of water quality and loss of species) these may be externalities to a producer who is primarily interested in production. However, they are of concern to the wider community;
4. When short-term economic survival is the preoccupation of producers, longer-term production and sustainability issues are discounted.

Communication - identifying realistic goals and true barriers

The points above need to be considered by NAP3 researchers in the communication of their results. The development of a land stewardship ethic seems a necessary prerequisite for producers to act, in the face of uncertainties and externalities listed in points 1-3. At the meeting, there was debate as to whether reduced stocking rates could translate immediately into improved economic gains. In general, it will be difficult to convince producers that the broader range of practises generally recommended for sustainable management (e.g. reduced stocking, reduced vegetation clearing, protection of waterways) will not have some short-term economic cost.

The challenge for communication of our research is to identify realistic goals that identify the trade-off between quality of communication and numbers of people reached. Simple information provision will not change peoples' value systems. High quality communication in a learning environment will enable producers to better judge the situation and have ownership of the issues. Researchers are able to achieve this for a limited number of people, but more comprehensive programs are also needed.

It is also necessary to recognise circumstances where there are true barriers, where no amount of goodwill on behalf of researchers and producers will result in more sustainable management. Point 4, describes an economic imperative that presents a real barrier to adoption of sustainable practises. Policy instruments such as financial incentives may be needed to effect change in some areas.

Short-term information gains vs long-term knowledge gains

With increased demands on communication of research results to the end user, researchers are under pressure to process data quickly and present results to land managers and R&D organisations. It takes a much longer period of reflection and

careful documentation for researchers to present the experimental results to their scientific peers who need detailed information before assessing the results. The scientific publishing process is a laborious, but an effective means of quality control. Data are screened before entering the pool of facts that is accumulating over time to form a continuously developing knowledge base. The state of this knowledge base for northern Australia will have a bearing on the future understanding and quality of management of its grazing lands. There is a continuing trend to underplay the necessity for publication of research results in peer-reviewed journals. Indeed, it is vital for information to be accessible to, and understood, by land managers and this has received insufficient attention in the past. At the same time we stress the need for scientific publications that enable the intellectual outcomes of the research to be captured for long-term benefit. Discussions are needed to consider mechanisms by which both forms of communication can be fostered as part of the research contracting process.

Workshop Evaluation

1 Evaluation by participants

During the final session of the workshop, participants were asked to complete a short evaluation sheet. The sheet asked participants to rate administrative and technical aspects of the workshop and preparation for it, and to provide comments where appropriate. The following notes are direct transcriptions of feedback provided on evaluation sheets and they have been grouped according to the nature of the comment and issues addressed.

i. Administration

- Congratulations on a well organised workshop.
- Very good.
- Emailing papers enables last minute report writing, but is a nuisance for the receivers ie. 14 independent printing tasks, then multiply by the number of attendees.
- Not all papers circulated.
- Emailing of reports prior to the meeting was a good idea, but a number of reports were never received.
- Graphs and charts in colour do not present well in the B&W circulated reports.
- Accommodation expensive for quality provided.
- Venue fairly costly, especially after the extra ferry costs.
- Venue/accommodation over-priced and under standard.
- Lack of satisfactory screen for projected transparencies.
- A little disappointed in service for cost of venue.
- Good location, good meeting rooms, etc.

ii. Workshop format

- Good size etc., with people comfortable enough to comment.
- Very good participation.
- Suggest the time for individual presentations could certainly be increased in some cases.
- A bit rushed.
- Length of presentations limited detail of results etc.
- Inadequate time for presentation of big projects, or if full review not required, just ask for summary or update.
- Many presentations poorly presented – did not summarise topics within available time.
- Many presentations were poorly prepared and presented: Too much material, insufficient attention to main messages/issues.
- Some presenters tried to present too much data - therefore confusing the presentation, not allowing a clear story to be put across.
- Problems with presentations – trying to present too much info. in time available, poor overheads – colour & size of print, rushed presentations with too much information on one OHT.
- Important issues raised during question time were often not revisited and were lost rather than discussed further and resolved.
- As a producer, I felt that at times there was too much 'pushing of barrows' by researchers.
- If possible, include more extension officers in participants.
- Producers were perhaps a little under-represented.

iii. Overall assessment

- I certainly benefited from this exercise. It was one of the most stimulating I have attended.
- An excellent initiative.
- Thank you, it was very interesting.
- Not sure why so many DPI people here when so few opened their mouths.
- Difficult to get technical feedback in short period of time.
- Would like to have the opportunity to suggest and input into ongoing work, instead it was just discussing issues.
- The time for each talk did not really allow for peer review. It mostly allowed for updating people on what work is going on.
- I thought the peer review would be more intense, however, it developed into discussions on communications in NAP.
- In some cases, I did not particularly feel that the full attention of the invited referees was directed to improving NAP3

iv. Other comments

- Although discussion and interesting views came out, I wonder if a 30 minute formal process of documenting some directions or common ground would have been useful.
- Biodiversity – a dirty word to most producers – it tends to intimidate – a ‘greenie’ word.
- Biodiversity is an important component of sustainable land management. As ‘grass mechanics’ we measure a range of aspects of the biodiversity of a system and we are therefore a store of information for that system, but we can’t be expected to measure all the components ie. we are already addressing issues of biodiversity within our field of expertise. The term ‘biodiversity’ seemed to be over-emphasised at the meeting. Unfortunately, this created division and antagonism that wasn’t necessary. Producers and grass mechanics (production oriented) felt accused of being causes of reduced biodiversity and responded in a defensive way – could have been handled better!
- Too much time on biodiversity, for too little detailed discussion/feedback on project issues.
- Warren Mason gave useful overviews and challenged the group.
- WM addressed project integration and this was a good suggestion
- Both peer reviewers failed to do what I believed to be their task.
- Outside expertise – I felt one of the “reviewers” tended not to review, but lecture on biodiversity.
- Stocking rate was listed for discussion. SR is the most important resource management issue of northern Australia – it was not even discussed.
- Would strongly suggest re-visiting outcomes/recommendations from this workshop at the start of next year’s workshop to look at progression over the 12 months.
- I had a feeling that some of the comments were restrained, particularly regarding the monitoring project.
- Biennial reviews – Year 1: All projects; Year 2: Focussed projects eg. all grazing woodland type projects; Year 3: All projects together again, etc.
- This was a good initiative. There is a need to be more prescriptive about the need for formal publication if detailed annual reports are no longer required. I don’t know how to guarantee this except by moral (professional) persuasion. (It remains a tension that it is better to write one paper of substance in lieu of 3+ papers on the same subject of piecemeal content).

- Need both workshop and written reports. Not sufficient time per presenter to put a really clear picture across of what they are doing and why. Prior to meetings, perhaps as a normal part of project proposals and reports, may be useful for people in the same sub-programs to pass on proposals and reports to others.
 - Include reports, both annual and final in a bound book eg. PDS Annual Report.
 - I feel both peer review and annual written reports are essential.
 - Peer review provided much better feedback for the effort put forward.
- v. **Evaluation scores (number assessed = 26)**
(Rated by participants on a scale of 0-5)

Administration

	Preparations	Circulation of papers	Venue	Travel plans	Accommodation
Mean	4.23	3.69	3.77	4.12	3.96
Min.	3	2	0	2	0
Max.	5	5	5	5	5

Workshop

	Overall format	Presentation length	Outside expertise	Participation	Chairing
Mean	3.88	3.35	3.64	4.27	4.04
Min.	3	1	1	3	2
Max.	5	5	5	5	5

Overall usefulness

	Usefulness to project	Research comments	Producer Comments	Workshop/ Written reports
Mean	3.71	3.45	3.59	4.24
Min.	2	2	2	2
Max.	5	5	5	5

2. Comment by NAP Management

- We would like to thank all participants for their contributions to the workshop.
- Overall we were very pleased with the workshop and the good ratings provided by participants. We shall continue with this process next year.
- The major fault was that too much was attempted in the one workshop. However, as this was the first workshop it was important to have all the projects presented, so that everyone had an appreciation of all the IRM work going on.

This meant that by trying to cover all issues, the workshop lacked specific focus. In future we intend having several meetings each year, with each meeting concentrating on a cluster of similar projects. This should enable more in depth and meaningful discussions.

- Although the quality of reporting could be improved, we thought that the e-mail system to circulate reports generally worked well. A revised set of report preparation guidelines will be prepared for future meetings.
- The change of reporting to one annual progress milestone report to the workshop each year was widely welcomed as a replacement for the more frequent written reporting, with only one participant expressing an outright preference for the previous system.
- With the reduced work load of milestone reporting there should be more time available for writing up data for journal publication. There is a considerable amount of information which should be published and researchers should give greater priority to doing this.
- Talk presentations were from poor to excellent. This is an obvious area that needs to be improved. In future workshops, some rating system on presentations will be included.
- Producers and extension staff were poorly represented at the meeting. This was because the number attending the workshop had to be restricted to about 35 people. A larger group would have precluded interactive discussion. For future meetings, with each looking at fewer projects, the number of producers and extension staff will be increased.
- With regard to discussions the 80:20 rule applied, with about 20% of participants contributing 80% of the debate. In future there has to be an understanding and commitment that all participants should contribute to the discussions. Probably some of the discussions would be more fruitful if they were done in smaller groups and they then reported back to plenary sessions. Consideration will be given to setting aside time to do this.
- The discussions after individual papers were on the whole very good. However, because of the time constraints and the wide diversity of subject matter, there was not good in depth discussions on a number of key issues. Both more detailed critique of papers presented and discussion of more generally applicable research and management issues (eg managing grazing pressure; questions of interpretation of results in relation to scale (small plot up to whole property); managing landscapes; whole property management and the identification of the main profit and sustainability drivers; integration of different technologies eg grazing management and fire; etc) is desirable.
- It was quite evident that most of the issues raised at the May 1996 review of NAP2 projects are still foreign to many researchers and they are very uncomfortable with them (see pages 8 and 9 of this report). Future workshops will be considering these issues and the relevance of on-going projects in relation to them.

- The external reviewing process went reasonably well. Again this suffered from the lack of overall focus due to too many issues being covered at the workshop. However, the reviewers did raise some very pertinent and real issues that should be taken on board. In particular, they emphasised the value of the systems approach and that all aspects of the health of the different ecosystems should be considered.
- Communication strategies were mentioned frequently, but only three projects had effective strategies in place at the time of the workshop. This is obviously an area that needs to be urgently addressed. When developed communication plans will be reviewed annually as an integral part of the peer review process.

LIST OF APPENDICIES

- I. NAP IRM Workshops and Conferences**
- II. Final Reports of NAP IRM Project reports since July 1991**
- III. Reports of producer case studies and LBP activities**
- IV. Publications related to NAP projects, activities and workshops**
- V. Meeting program for the annual review of NAP Improving Resource Management projects**
- VI. Guidelines for milestone reporting**
- VII. List of participants and their e-mail and fax numbers**

Appendix I

NAP IRM Workshops and Conferences

1. Workshops

Woody weed control workshop (1988) QDPI organised workshop held in Emerald in July 1988. Workshop papers prepared. The information has been further refined and initially was published as a series of Ag Notes. More recently the information has been incorporated into the **Woody Weed Adviser** DSS available from Paul Back, QDPI, Tropical Beef Centre, Rockhampton.

Phosphorus and beef production in northern Australia (1988) Proceedings of an AMLRC workshop held in Townsville in June 1988, edited by Peter C. Kerridge. Papers published in *Tropical Grasslands* 24, 129-255.

Sown pastures for the seasonally dry tropics (1989) Proceedings of a workshop held on the Atherton Tablelands in June 1989. Edited by Ian J. Partridge and C.P. (Joe) Miller. *Queensland Department of Primary Industries Conference and Workshop Series QC91002*.

Sown pastures for the brigalow lands. (1991) Proceedings of a workshop held on Bribie Island, southern Queensland in 1991. Edited by Ian J. Partridge, Bill (W.H.) Burrows and Errol J. Weston. *Queensland Department of Primary Industries Conference and Workshop Series QC94005*.

Tropical pasture establishment (1992) Proceedings of a workshop held at Brian Pastures Research Station, Gayndah, in June 1992. Convenor – David Gramshaw. Papers published in *Tropical Grasslands* 27, 257-419.

State and transition models for rangelands (1993) Proceedings of a workshop held at the Forestry Training Centre, Gympie, Queensland, September 13-14, 1993. Edited by John Taylor, Neil MacLeod and Andrew Ash. *Tropical Grasslands* 24, 193-283.

Parthenium weed: Workshop Report (1993) Proceedings of a workshop held in Rockhampton, Queensland, Australia, October 1993. Edited by G.G. White. Cooperative Centre for Tropical Pest Management, Brisbane, Australia.

Beef production from ponded pastures (1993). Proceedings of a workshop held in Yeppoon, Queensland, April 1993. Edited by Pam A. Pittaway, John H. Wildin and Cam McDonald. *Tropical Grassland Society of Australia Occasional Publication No.7*

Total Ranch Management - Strategic Management of Range Ecosystems (1994). A MRC funded workshop held at Emerald in June 1994 and run by Professor Larry D. White, Texas Agricultural Extension Service, College Station, Texas.

Integrated management for sustainable forage-based livestock systems in the tropics (1995) The manual was prepared for a short training course on tropical forage resources and livestock production held at Atherton, North Queensland, in June 1995. Edited by David Gramshaw. *Tropical Grassland Society of Australia Occasional Publication No.6*.

Fire in the management of northern Australian pastoral lands (1996). Proceedings of a workshop held in Townsville, Queensland. April 31-May 2, 1996. Edited by Tony C. Grice and Sonja M. Slatter. *Tropical Grassland Society of Australia Occasional Publication No.8*.

International research and development on *Stylosanthes* (1996). Proceedings of a workshop held at the CSIRO Davies Laboratory, Townsville, Queensland in April 1996. Papers published in *Tropical Grasslands* 31, 385-526.

Measuring and monitoring vegetation on pasture lands in northern Australia for sustainable use (1996). Proceedings of a workshop held at University of Queensland, Gatton College Campus in October 1996. Edited by Ian Partridge and J.C. Tohill. *Tropical Grassland Society of Australia Occasional Publication No.9.*

Adoption of whole property sustainable grazing management systems (1996). Workshop held in Townsville in December 1996. Workshop Report for MRC prepared by Mick Quirk and Mark Stafford Smith.

Biodiversity workshops in northern Australia (1997). MRC report on five scoping workshops to determine the key biodiversity issues and the most effective ways of managing them across northern Australia prepared by Judy Lambert.

2. Conferences

Meat Research Corporation funding supported the following national and international conferences

17th International Grassland Congress Palmerston North, New Zealand and Rockhampton, Australia, February 1993.

8th Biennial Conference of the Australian Rangeland Society, Katherine, Northern Territory, July 1994.

5th Tropical Pasture Conference, Atherton, Queensland, June 1995.

9th Biennial Conference of the Australian Rangeland Society, Port Augusta, South Australia, September 1996.

10th Biennial Conference of the Australian Rangeland Society, Gatton College, University of Queensland, December 1997.

Appendix II

Final Reports of NAP IRM Project reports since July 1991

- Ahern, C.R., Shields, P.G., Enderlin, N.G. and Baker, D.E. (1994). Soil fertility of central and north-east Queensland grazing lands. *Information Series Q194065. Department of Primary Industries, Queensland.* (DAQ.075)
- Brown, J.R. and Ash, A. (1996). Managing woodlands: Developing sustainable beef production systems in systems in northern Australia (CS.197/NAP3.205) - (Report to June 1996; project continues in NAP3).
- Brown, J.R. and Grice, A. (1996). Exotic woody weed invasion in tropical woodlands: sustaining productivity (CS.219/NAP3.206) - (Report to June 1996; project continues in NAP3).
- Brown, J.R. (1997). Attacking the causes of land degradation: a field course for land managers (CS.276). Course notes prepared; project completed.
- Burrows, W.H. (1996). Effects of stocking rate, legume augmentation, supplements and fire on animal production and stability of native pastures (DAQ.080/NAP3.207) - (Report to June 1996; project continues in NAP3).
- Burrows, W.H. (1996). Woodland management and weed control for Queensland's beef pastures (DAQ.094/NAP3.210) - (Report to June 1996; project continues in NAP3).
- Chamberlain, J. (1996). Grazing management to enhance pasture and beef production through parthenium weed control (DAQ.088) - (Final Report)
- Clark, R.A. (1996). Sustainable beef production systems project (DAQ.073) - (Final Report).
- Dyer, R. (1996). Developing sustainable beef production systems for the semi-arid tropics of the NT (NTA.022/NAP3.211) - (Report to June 1996; project continues in NAP3).
- Jones, R.J. (1993). The effect of stocking rate on pasture and animal production from native pasture and native pasture oversown with Indian couch (*Bothriochloa pertusa*). Final Report MRC Project CS.PO20.
- Jones, R.M. (1993). Beef production from Cassia/buffel grass pastures in sub tropical Queensland (CS.P011) - (Final Report).
- Kernot, J. (1996). Sustainable beef production systems - using the LCD technique (DAQ.092/NAP3.306) - (Report to June 1996; project continues to December 31, 1997).
- Lambert, J. (1997). Biodiversity workshops in northern Australia (NAP3.215). Report to MRC.
- McIntyre, Sue (1996). Sustainable and profitable native grass-legume pastures for southern spear grass lands (CS. 80/CS.195) (Final Report).
- McIvor, J.G., Noble A.D. and Orr, D.M. (1996). Stability and productivity of native pastures oversown with tropical legumes. A report for the Meat Research Corporation's North Australia Program (NAP3.203). (Report completed).
- Noble, A.D. (1996). Soil acidification research in the semi-arid tropics (CS.277). - (Final Report).

- Novelly, P.N. (1997). Grazing systems and management guides for Kimberley rangelands (DAW.051/NAP3.212) - (Final Report).
- Paton, C. (1996). Mechanisms of pasture change and strategies for restoring the productivity of spear grass and *Aristida/Bothriochloa* grasslands (DAQ.091/NAP3.209) - (Report to June 1996; project continues in NAP3).
- Quirk, M.F. and Stafford Smith, M. (1997). Workshop on adoption of whole property sustainable grazing management systems, held in Townsville in December 1996 (NAP3.204) - (Workshop Report)
- Quirk, M.F. (1996). Study tour of the East Kimberley grazing lands. Final Reports by Grazier and QDPI participants.
- Silcock, R.G. (1996). Enhancing pasture stability and profitability for producers in the *Aristida/Bothriochloa* woodlands (DAQ.090/NAP3.208) - (Report to June 1996; project continues in NAP3).
- Thompson, W.P and Shields, P.G. (1996). Research Impact Assessment. Land Resource Assessment and Management Pty Ltd (LRAM). A decision support system with manual for project evaluation developed for the Meat Research Corporation.
- Tothill, J.C. and Gillies, C. (1992) The pasture lands of northern Australia - Tropical Grassland Society of Australia. Occasional Publication No. 5.
- Tothill, J.C. and Partridge, I. P. (eds). (1992). Monitoring pasture lands in northern Australia. *Tropical Grassland Society of Australia Occasional Publication No.9.*

Appendix III

Reports of producer case studies and LBP activities

1. Brigalow management

Sown pastures for the brigalow lands. (1994). Proceedings of a workshop held on Bribie Island, southern Queensland in 1991. Edited by Ian J. Partridge, Bill (W.H.) Burrows and Errol J. Weston. *Queensland Department of Primary Industries Conference and Workshop Series QC94005.*

Archer, David and Carol (1994). Commercial development of 'Kyewong', Dysart, Northern brigalow region. 69-71.

Ford, Roy and family (1994). Commercial development of 'Forest Home', Capella. Northern brigalow region. 72-74.

Delforce, Rex and Marilyn (1994). Commercial development on 'Billabong', Arcadia Valley. Central brigalow region. 75-76.

Sparke, R.L. and E.E. (1994). Commercial development of 'Wirranda', Moura. Central brigalow region. 77-79..

Clark, Adam (1994). Commercial development on 'Bimbadeen', Taroom. Central brigalow region. 80.

Cameroon, Brian (1994). Commercial development on 'Howqua', The Gums, Tara Shire. Southern brigalow region. 81-82.

Green, Ralph (1994). Commercial development on 'Coonardoo', Roma. Southern brigalow region. 82-83.

2. Sown pastures for the seasonally dry tropics

Sown pastures for the seasonally dry tropics (1991). Proceedings of a workshop held on the Atherton Tablelands in June 1989. Edited by Ian J. Partridge and C.P. (Joe) Miller. *Queensland Department of Primary Industries Conference and Workshop Series QC91002.*

Zone A: Northern high rainfall (more than 1200 mm)

Wincen, Bob (1991) Commercial development on 'Sudley', via Weipa. 37-41.

Zone B: Reliable moderate rainfall (800-1200 mm)

Arnold, Gordon (1991). Commercial development on 'Wrotham Park', via Chillagoe (1963-1988). 44-48.

Hart, Ted (1991). Commercial development on 'Hodgson River' via Katherine. 48-52.

Zone C: Unreliable marginal rainfall (600-800 mm)

Barrett, Rodney (1991). Commercial development on 'Salisbury Plains', Bowen. 54-58.

Rebgetz, Ian (1991). Commercial development on 'Thalanga', Balfes Creek via Charters Towers. 59-60.

Zone D: Moderate rainfall (600-1200), Central Queensland

Chapman, Bruce (1991) Commercial development on 'Rowanlea', Calliope. 62-69.

Bethel, Geoff (1991) Commercial development on 'Willinga', via Nebo. 69-74.

Zone E: High rainfall (more than 1200 mm), east coast

McLean, Roy (1991) Commercial development on 'Kuttabal', via Mackay. 75-79.

3. *Stylosanthes* management

International research and development on *Stylosanthes* (1997). Proceedings of a workshop held at the CSIRO Davies Laboratory, Townsville, Queensland in April 1996. Papers published in *Tropical Grasslands* **31**, 385-526.

Chapman, Tom (1997). Grazier experience with *Stylosanthes* technology. I. The use and significance of *Stylosanthes* on Wycherproof. *Tropical Grasslands* , **31**, 515-518.

Barrett, Rodney (1997). Grazier experience with *Stylosanthes* technology. II. More than a way of life. *Tropical Grasslands* , **31**, 519-521.

Arnold, Gordon (1997). Grazier experience with *Stylosanthes* technology. III. Wrotham Park, 1963-1988. *Tropical Grasslands* , **31**, 522-526.

4. Fire management

Fire in the management of northern Australian pastoral lands (1997). Proceedings of a workshop held in Townsville, Queensland, Australia April 31-May 2, 1996. Edited by Tony C. Grice and Sonja M. Slatter. Tropical Grasslands Society of Australia Occasional Publication No.8.

Fagan, Graeme (1997). The role of fire on 'Marrakai' and 'Woolner' in the Top End of the Northern Territory. 50-51.

Harding, Michael (1997). The role of fire on 'Gorrie Station' in the Katherine area of the Northern Territory. 51

Fielder, Brian (1997). The role of fire on 'Brooking Springs Station' in the Kimberley region of Western Australia. 51-52.

Landsberg, Roger (1997). The role of fire in pastoral management on 'Trafalgar' in the Charters Towers district. 52-53.

Ritchie, Mark (1997). The role of fire on 'Boomarra' and 'Coolullah. 53-56.

McClelland, Bob (1997). Fire as a management tool in the Queensland gulf country. 56-57.

Dean, Frank (1997) Why burn mitchell grass? 58-59.

Heelan, John (1997). The use of fire in the Clermont district. 60-61.

Piggott, Bradley (1997). The use of fire on 'Christmas Creek', south of Emerald. 61-62.

Grimes, Stephen (1997) The role of fire at 'Corrunovan' in the Burnett district. 62.

McGown, Gus (1997). The role of fire in the mulga lands of south-west Queensland. 63.

5. Ponedged pastures for beef production

Beef production from ponded pastures (1995). Proceedings of a workshop held in Yeppoon, Queensland, April 1993. Edited by Pam A. Pittaway, John H. Wildin and Cam McDonald. Tropical Grassland Society of Australia Occasional Publication No.7

Lyons, J. (1995), Developing ponded pastures at 'Wambiana', Charters Towers. 10-12.

Bahnisch, R. (1995). The role of ponded pastures in drought mitigation at 'Ayrshire Park', Avon Downs. 13-14.

Geddes, B. (1995). Poned pastures at 'Doonside', Milman. 30-32.

Smith, E.G. (1995). Poned pastures at 'Strathmuir', Marlborough. 33.

Hall, M. and B. (1995). Poned pastures on 'Laurel Hills', Clermont. 34-35.

6. Local Best Practice Groups

Central Queensland

Clark, R.A. (1996) Sustainable beef production systems central Queensland project (DAQ.073). Series of publications of producers knowledge on beef property management and sustainable grazing for the following areas.

Black speargrass – St. Lawrence, Kunwarara, Marlborough, Momish, Gogango, Raglan, Mount Larcom, Dululu, Calliope River, Bororen, Miriam Vale, Ubobo, Rosedale, Gaeta and Moolboolaman.

Brigalow – Pasha, Valkyrie, Collaroy, Barmount, Mistake Creek, Middlemount, Mount Stuart, Capella, Avoca-Portwine, Lochington, Comet, Baralaba, Biloela, Bauhinia, Banana, Theodore and Arcadia.

Inland forest and desert uplands – Mount Mica, Alpha/Jericho, Camarvon, Lake Buchanan and Lake Dunn.

North Queensland

Kernot, J. (1996) Sustainable beef production systems - using the Local Best Practice technique (DAQ.092/NAP3.306). Series of publications of producers knowledge on beef property management and sustainable grazing for the Georgetown Granite, Gilbert River, Upper Einasleigh, Croydon area, Southern McBride Basalt, Mt Garnet area, Chillagoe/Almaden area, Atherton Tableland, Lower Mitchell, Palmer/Mitchell Junction, Kimba district, Coen district, Greenvale area, South-East of Flinders Shire, Basalt Tableland, Lake Buchanan area, Mingela/Ravenswood district, Lower Cape River catchment, Belyando Crossing district, Leichhardt Range area.

7. Producer demonstration sites

Since 1987 there have been almost 300 producer demonstration sites established across northern Australia. Of this total about 35% have dealt with sown and native pasture management and production issues.

8. Study tours and conference reports

Davies, T., Condon, N., Rebgetz, R., Nicholas, D. and Bethel, J. (1996). Study tour of the East Kimberley grazing lands. Report by Grazier participants. Report to the Meat Research Corporation. 18 pages.

McCartney, A. (1997). Report on the 2nd Australasia Pacific Extension Conference. Managing change – building knowledge and skills. November 1997, Albury, New South Wales.

Tucker, L. (1997). Kimberley aboriginal pastoralist group study tour to the northern Territory.

Appendix IV

Publications related to NAP projects, activities and workshops

- Ahern, C.R., Shields, P.G. and Baker, D.E. (1995). Mean bicarbonate phosphorus of Central and North-east Queensland. 1:1 000 000 colour map, Queensland Department of Primary Industries, Reference No 94-NEG-1-P3034.
- Ahern, C.R., Shields, P.G., Enderlin, N.G. and Baker, D.E. (1994). Soil fertility of central and north-east Queensland grazing lands. Information Series Q194065. Department of Primary Industries, Queensland.
- Ahern, C.R., Shields, P.G. and Myers, J.K. (1995). Grazing land types and landscape units of Central and North-east Queensland. 1:1 000 000 colour map, Queensland Department of Primary Industries, Reference No 94-NEG-1-P3007.
- Ahern, C.R., Weinand-Craske, M.M.G. and Baker, D.E. (1995a). Mean exchangeable potassium of surface soils in of Central and North-east Queensland. 1:1 000 000 colour map, Queensland Department of Primary Industries, Reference No 94-NEG-1-P3035.
- Ahern, C.R., Weinand-Craske, M.M.G. and Baker, D.E. (1995b). Phosphorus mapping in N.E. Queensland grazing lands. First National Soil Phosphate Conference, November 1995. Wagga Wagga, NSW. Australian Society of Soil Science Incorporated.
- Anderson, E.R. (1993). Plants of Central Queensland. Information Series Q192037. Department of Primary Industries, Queensland.
- Anderson, E.R., Back, P.V., Rutherford, M.T., Conway, M.J. and Myles, D.J. (1993). Dynamics of *Stylosanthes scabra* in a tropical savanna woodland in eastern Australia after treatment with tebuthiuron. *Proc. XVIIth International Grassland Congress* pp. 1927 - 1928.
- Anderson, E. R., Burrows, W. H., Back, P. V. and Hoffmann, M. (1997). Land clearing practices and associated impacts on the land use change and forest inventory. IPCC Workshop on Biomass Burning, Land-Use Change and Forestry, Rockhampton, Australia.
- Anon. (1996). Sustainable grazing in the subtropics. *Rural Research*, 172 (Spring1996), 4-8.
- Anon. (1996). Towards a strategy for sustainable pastures. *ECOS, No 87 Autumn 1996*, 26-30.
- Ash, A.J., Bellamy, J.A. and Stockwell, T.G.H. (1994). State and transition models for rangelands. 4. Application of state and transition models to rangelands in northern Australia. *Tropical Grasslands* 28, 223-228.
- Ash, A.J. and Brown, J.R. (1996). Grazing and the tropical savannas of northern Australia. Proceedings of a workshop on Land Management research for the Army's Townsville Field Training Area (TFTA). Land and Water Resources Research and Development Corporation Occasional Paper Series, 35a-35d.
- Ash, A.J., Brown, J.R. and Cowan, D.C. (1996). Transitions between vegetation states in tropical tallgrass: falling over cliffs and slowly climbing back. In: *Proceedings of the 9th Biennial Australian Rangeland Conference* (Eds. L.P. Hunt and R. Sinclair) 219-220. Australian Rangeland Society, Port Augusta.
- Ash, A.J., Brown, J.R., Grice, A.C. and McIvor J.G. (1996). Herbaceous change in Australia's tropical woodlands: landscape processes. In: *Rangelands in a Sustainable Biosphere* (Ed. N.E. West) 17-18. Society for Range Management, Denver.
- Ash, A.J., Howden, S.M. and McIvor, J.G. (1996). Improved rangeland management and its implications for carbon sequestration. In: *Rangelands in a Sustainable Biosphere* (Ed. N.E. West). 19-20. Society for Range Management, Denver.

- Ash, A.J., McIvor, J.G., Mott, J.J. and Andrew, M.H. (1997). Building grass castles: integrating ecology and management of Australia's tropical tallgrass rangelands. *The Rangeland Journal* 19: 123-144.
- Back, P.V. (1991). Control of corkwood wattle (*Acacia bidwillii*) in Central Queensland using various herbicide as individual plant treatments. *Australian Weeds Research Newsletter*. 39, 41-44.
- Back, P.V. (1992). The use of basal bark spraying for woody weed control in coastal Central Queensland. *Proc. 2nd. Queensland Weeds Symposium*. 26-28. (Australian Weeds Society: Townsville).
- Back, P.V. (1997). Control of currant bush in developed brigalow country. DPI NOTE Agdex 643.
- Back, P.V., Anderson, E.R., Burrows, W.H., Kennedy, M.J.J. and Carter, J.O. (1997). TRAPS - Transect Recording and Processing System. (QDPI : Rockhampton) (Manual and supporting software).
- Back, P.V., Burrows, W.H. and Anderson, E.R. (1996). The effect of increasing tree basal area on pasture production following various woodland development strategies at "Wandobah", Dingo. *Tropical Grasslands* 30, 161.
- Back, P.V. and Lambert, G. (1996). Woody weeds (management and control) In: *Sown Pasture Notes Central Queensland* (eds G. Lambert and T.W.G. Graham) (QDPI Rockhampton).83-87.
- Baker, D.E., Ahern, C.R. and Weinand-Craske, M.M.G. (1995). Regression relationships between two extractable phosphorus methods. *First National Soil Phosphate Conference, November 1995. Wagga Wagga, NSW*. Australian Society of Soil Science Incorporated.
- Baker, D.E., Weinand-Craske, M.M.G. and Ahern, C.R. (1996). Soil phosphorus levels of the Fitzroy catchment. *'Downstream Effects of Land Use Conference - Programs and Abstracts'*. Rockhampton, April 1995. Department of Primary Industries: Brisbane, Queensland.
- Barker, M.J., Dorney, W.J., Lindsey, A.M. and Vitelli, J. (1996). Environmental factors influencing the establishment and growth of *Acacia nilotica* and *Prosopis pallida*. 223-236. Eleventh Australian Weeds Conference Proceedings.
- Bellamy, J.A. and Brown, J.R. (1994). State and transition models for rangelands. 7. Building a state and transition model for management and research on rangelands. *Tropical Grasslands* 28, 247-255.
- Bellamy, J.A., Lowes, D., Ash, A.J., McIvor, J.G. and MacLeod, N.D. (1996). A decision support approach to grazing management for spatially heterogeneous rangeland paddocks: an application in the tropical savanna woodlands. *The Rangeland Journal* 18: 370-391.
- Brown, J.R. (1994). State and transition models for rangelands. 2. Ecology as a basis for rangeland management: Performance criteria for testing models. *Tropical Grasslands* 28: 206-213.
- Brown, J.R. and Ash, A.J. (1996). Managing resources: Moving from sustainable yield to sustainability in tropical rangelands. *Tropical Grasslands* 30:47-57.
- Brown, J.R. and Ash, A.J. (1996). The ecological basis for public concern about sustainability in grazed rangelands. *Animal Production in Australia* 21: 63-64.
- Brown, J.R., Grice, A.C., McIvor, J.G. and Ash, A.J. (1996). Herbaceous change in Australia's tropical woodlands: management implications. In: *Rangelands in a Sustainable Biosphere* (Ed. N.E. West). 70-71. Society for Range Management, Denver.
- Brown, J.R. and Jennifer Carter. (1997). Spatial and temporal patterns of exotic shrub invasion in an Australian tropical grassland. *Landscape Ecology* (in press)
- Brown, J.R. and Jackson, J. (1997). Attacking the causes of land degradation. A manual prepared for a field course for land managers. CSIRO, Townsville.

- Brown, J.R., Scanlan, J. and McIvor, J.G. (1997). Herbaceous competition as a limiting factor in shrub increase: a test with different growth forms. *Journal of Vegetation Science* (accepted).
- Brown, J.R., Stafford-Smith, M. and Bastin, G. (1998). Monitoring and resource management. In: *Monitoring grazing lands in northern Australia* (eds John C. Tothill and Ian J. Partridge). *Tropical Grassland Society of Australia Occasional Publication No.9*. (In press).
- Burrows, D.M. and Burrows, W.H. (1992). Seed production and litter fall in some eucalypt communities in Central Queensland. *Aust. J. Bot.* **40**: 389-403.
- Burrows, W.H. (1989a). Keeping trees and making room for cattle too. *Prime Beef Producer* **2**, 4-20.
- Burrows, W.H. (1989b). Problems of overclearing. *The Pasture* **1**(2), 3.
- Burrows, W.H. (1989c). Management of grazed woodlands for pastoral production in Queensland. In: *"Management for sustainable farming"* (ed. R.J. Hampson). (Australian Farm Management Society: Gatton). 191-201.
- Burrows, W.H. (1990a). Prospects for increased production in the north-east Australian beef industry through pasture development and management. *Agri. Sci.* **3**: 19-24.
- Burrows, W.H. (1990b). Conservative rangeland management in Australia: a personal viewpoint. *Proc. 6th Australian Rangeland Soc. Conf.*, Carnarvon, W.A. 22-37.
- Burrows, W.H. (1991a). Sustaining productive native and improved pastures - an ecological perspective. *Tropical Grasslands*. **25**: 153-158.
- Burrows, W.H. (1991b). Tree clearing in Australia - a question of balance. *Search* **22**: 46-48.
- Burrows, W.H. (1992a). Cell grazing: overseas experience less than favourable. *Prime Beef*. **4**: 54-56.
- Burrows, W.H. (1992b). Conservative rangeland management in Australia: A personal viewpoint (with a Queensland bias and additional notes on cell grazing). *Proc. North West Australia Pastoral Conf.*, Katherine, N.T. 103-127.
- Burrows, W. H. (1993). Deforestation in the savanna context: problem and benefits for pastoralism. *Proc. XVIIth International Grassland Congress* pp. 2223 - 2230. (Note: Also published in "Grasslands for our World" (ed. M.J. Baker). SIR Publishing: Wellington. 839 - 846).
- Burrows, W.H. (1995). Greenhouse revisited - an alternative viewpoint on land use change and forestry from a Queensland perspective. *Climate Change Newsletter*. **7**: 6 - 7.
- Burrows, W.H. (1995). Dynamics of the tree - grass balance in Queensland's grazed woodlands. *Proc. Queensland Landcare Conf., Longreach*. (eds G. Penton, B. Ruthedge, B. Peterkin). 83 - 85.
- Burrows, W.H. (1996). Queensland's grazed woodlands - an enormous anthropogenic carbon sink demanding recognition. Technical Report. 'Vegetation Thickening Workshop.' (DEST International Panel Review: Canberra). October 1996.
- Burrows, W.H. and Back, P.V. (1993). The role of fire in timber regrowth control. In: "The Burning Question" (ed. G. Elphinstone). (S.E. Region Landcare: Gympie). 17 - 19.
- Burrows, W.H. and Vercoe, J.E. (1995). Sustainability of stocking and grazing in northern Australia. *Focus* **88**: 8-12.
- Burrows, W.H., Anderson, E.R. and Back, P.V. (1995). Management of woodland systems in Queensland with special reference to the beef industry. In: "Queensland: The State of Science" (eds R.W. Johnson and C.R. King) (Royal Soc: Brisbane). 149 - 157.
- Burrows, W. H., Anderson, E. R., Back, P. V. and Hoffmann, M. (1997). Regrowth and woody plant thickening / invasion impacts on the land use change and forest inventory. IPCC Workshop on Biomass Burning, Land-Use Change and Forestry, Rockhampton, Australia.

- Burrows, W.H., Carter, J.O., Scanlan, J.C. and Anderson, E.R. (1990). Management of savannas for livestock production in north-east Australia: contrasts across the tree- grass continuum. *J. Biogeog* 17: 503-512.
- Burrows, W.H., Carter, J.O., Scanlan, J.C. and Anderson, E.R. (1991). Management of savannas for livestock production in north-east Australia: contrasts across the tree- grass continuum. In: "Savanna Ecology and Management: Australasian Perspectives and Intercontinental Comparisons" (ed. P. Werner). Chap. 25. (Blackwells: London). (Note: Also published in *J. Biogeog*).
- Burrows, W.H., French, A.V. and Robbins, G.B. (1994). Managing sown pastures In: *Sown pastures for the brigalow lands*. (eds. I.J. Partridge, W.H. Burrows, E.J. Weston). (QDPI: Brisbane). 39-42.
- Burrows, W.H., McKeague, E.J., Newman, S., Silbence, M.N. and Vercoe, J.E. (1996). Innovation and responsiveness will be the hallmarks of the tropical beef industry. *Pro. Aust. Soc. Anim. Prod.* 21: 48-54.
- Campbell, S. (1998). Farming for a thousand years. In: *Monitoring grazing lands in northern Australia* (eds John C. Tothill and Ian J. Partridge). *Tropical Grassland Society of Australia Occasional Publication No.9*. (In press).
- Carter, J., Brook, K., Day, K., Howden, M. and McKeon, G. (1998). What attributes to monitor. In: *Monitoring grazing lands in northern Australia* (eds John C. Tothill and Ian J. Partridge). *Tropical Grassland Society of Australia Occasional Publication No.9*. (In press).
- Chamberlain, J., Filet, P. and Burrows, W.H. (1996). Pasture management. In: *Sown Pasture Notes-Central Queensland*. (eds. G. Lambert and G. Graham). (QDPI: Rockhampton). 71-72.
- Clark, R.A. (1995). Beef industry constraints and opportunities. In *Integrated management for sustainable forage-based livestock systems in the tropics*. Ed, D. Gramshaw. Tropical Grassland Society of Australia. Occasional Publication No. 6.
- Clark, R.A. (1996). Local Best Practices in Central Queensland. In *Effective and efficient strategies to support industry learning*. Authors E.J. Woods and J.A. Coutts. Proceedings of the Australian Society of Animal Production Conference, Brisbane.
- Clark, R.A. and Filet, P.G. (1994). Local best practice, participatory problem solving and benchmarking to improve rangeland management. Australian Rangelands Society. 8th Biennial Conference. Katherine. N.T. 70-76.
- Clark, R.A., Bourne, A.W.D., Cheffins, R.C., Gillespie, R.L., Lawrence, D.N., Murphy, K.J., Esdale, C.R. (1992). Using local consensus data technique to develop, improve, and enhance the adoption of sustainable grazing land management systems. In: Proceedings of the 7th international Soil Conservation Organisation, Sydney.
- Clark, R.A., Davis, G.P., Cheffins, R.C. and Esdale, C.R. (1992). Integrating cattle breeding technology into beef property management. *Proc. Aust. Assoc. Anim. Breed. Genet.* Vol. 345-348.
- Clark, R.A., Filet, P.G., Bourne, A.W.D., Bourne, G.F., Chamberlain, H.J., Cheffins, R.C., Dodt, R.M., Esdale, C.R., Gillespie, R.L. and Murphy, K.J. (1993). Utilising local wisdom to achieve sustainable beef production. In: 'Gearing up for the future'. Proceedings of the Department of primary Industries extension Conference. Ed. R.F. Fell. Brisbane.
- Clark, R.A., Bourne, A.W.D., Cheffins, R., Dodt, R., Gillespie, R., Hielscher, R., Murphy, K., Reeve, J., and Ritchie, M. (1993). Improving beef returns and Landcare. Calliope Shire. DPI. Rockhampton.
- Clark, R.A., Anderson, E.R., Bourne, A.W.D., Bourne, G.F., Cheffins, R.C., Day, K.J., Esdale, C.R., Filet, P.G., Gillespie, R.L., Graham, T.W.G. and Hielscher, R.W. (1996). Guidelines for applying methods in the sustainable beef production systems project. Department of Primary Industries. Rockhampton.

- Clem, R.L., Wildin, J.H. and Larsen, P.H. (1993) Tropical pasture establishment. 12. Producer establishment practices and experience in central Queensland. *Tropical Grasslands* 27: 373-380.
- Coates, D.B., Miller, C.P., Hendricksen, R.E. and Jones, R.J. (1997). Stability and productivity of *Stylosanthes* pastures in Australia. II. Animal production from *Stylosanthes* pastures. *Tropical Grasslands* 31: 494-502.
- Cook, S.J. (1990). Band Seeder boost for animal production. Farm Magazine, July 1990.
- Cook, S. J., Clem, R. L., MacLeod, N. D. and Walsh, P. A. (1993). Tropical pasture establishment. 7. Sowing methods for pasture establishment in northern Australia. *Tropical Grasslands* 27: 335-343
- Cook, S.J., Gilbert, M.A. and Shelton, H.M. (1993). Tropical pasture establishment. 3. Impact of plant competition on seedling growth and survival. *Tropical Grasslands* 27: 291-301.
- Cook, S.J., MacLeod, N.D. and Walsh, P.A. (1992a) . Reliable and cost-effective legume establishment in black speargrass grazing lands. (K.J. Hutchinson and P.J. Vickery. Eds.) Looking Back-Planning Ahead. *Proceedings of the 6th Australian Society of Agronomy Conference*. Armidale. 406-409.
- Cook, S.J., MacLeod, N.D., and Walsh, P.A. (1992b). Band seeding: A technological breakthrough for seeding rangelands. *Proceedings of the 7th Biennial Conference of Australian Rangeland Society*, Cobar. 307-308.
- Cox, P.G., MacLeod, N.D., Ridge, P.E. and Shulman, A.D. (1996). Re-engineering agricultural R,D&E to support management decision-making problems and prospects. *Proceedings of the 8th Australian Agronomy Conference*, Australian Agronomy Society, Toowoomba. 168-171.
- Davies, T., Condon, N., Rebgetz, R., Nicholas, D. and Bethel, J. (1996). Study tour of the East Kimberley grazing lands. Report by Grazier participants. Report to the Meat Research Corporation. 18 pages.
- Day, K.A., McKeon, G.M. and Carter, J.O. (1997). Evaluating the risks of pasture and land degradation in native pasture in Queensland. Final Project Report for Rural Industries and Research Development Corporation project DAQ124A, 119 pages.
- Dyer, R. , Craig, A. and Grice, A.C. (1997). Fire in northern pastoral lands. Fire in the management of northern Australian pastoral lands; *Proceedings of a workshop held in Townsville, Queensland, Australia April 31-May 2, 1996*. Edited by Tony C. Grice and Sonja M. Slatter. Tropical Grassland Society of Australia Occasional Publication No.8. 24-40.
- Edye, L.A. (1997). Cultivar development with *Stylosanthes* in Australia. . *Tropical Grasslands*, 31: 503-508.
- Filet, P.G. (1994). State and transition models for rangelands. 3. The impact of the state and transition model on grazing lands research, management and extension: a review. *Tropical Grasslands* 28: 214 -222.
- Filet, P.G. and Hall, T.J. (1994). Developing grazing management strategies for the *Aristida - Bothriochloa* grasslands of Queensland. Working Papers 8th bienn. Conf. Aust. Rangeland Soc., Katherine July 1994, 211-212.
- Filet, P.G., McCosker, J.C. and Osten, D. (1996). Management indicators for production and conservation in grazed woodlands of Queensland: a case study. In Proc."Conservation outside of Nature Reserves", Brisbane February 1996.
- French, A.V. and Clarke, S.P. (1993). Tropical pasture establishment. 14. Producer establishment practices and experience in southern inland Queensland. *Tropical Grasslands* 27: 387-390.
- Gramshaw, D., McKeon, G.M. and Clem, R.L. (1993) Tropical pasture establishment. 1. A systems perspective of establishment illustrated by legume oversowing in the subtropics. *Tropical Grasslands* 27: 261-275.

- Grice, A.C. (1996). Managed fire to control the impacts on northern Australian plant communities of the invasive shrub *Cryptostegia grandiflora*. *Proceedings of Conference on Conservation Outside Nature Reserves*. 356-358. University of Queensland, Brisbane.
- Grice, A.C. (1996). Seed production, dispersal and germination in *Cryptostegia grandiflora* and *Ziziphus mauritiana*. *Australian Journal of Ecology* 21: 324-331.
- Grice, A.C. (1997). Post fire regrowth and survival of the invasive tropical shrubs in *Cryptostegia grandiflora* and *Ziziphus mauritiana*. *Australian Journal of Ecology* 22: 49-55.
- Grice, A.C. (1997). Fire for the strategic management of rubbervine (*Cryptostegia grandiflora*), an invasive shrub. 239-244. In: Proceedings of the Australian Bushfire Conference.
- Grice, A.C. and Brown, J.R. (1996a). An overview of the current status of weed management in Australian rangelands. 195-204. In: Eleventh Australian Weeds Conference Proceedings.
- Grice, A.C. and Brown, J.R. (1996b). Fire and the population ecology of invasive shrubs in the tropical woodlands. In: Floyd, R.B., Sheppard, A.W. and P.J. De Barro (1996) *Frontiers of Population Ecology*, CSIRO Publishing, Melbourne. 589-597.
- Grice, A.C. and Brown, J.R. (1996c). Repeated fire in the management of invasive tropical shrubs. Proceedings of 9th Biennial Conference of the Australian Rangelands Society. 171-172.
- Grice, A. C. and McIntyre, S. (1995). Speargrass (*Heteropogon contortus*) in Australia: dynamics of species and community. *The Rangeland Journal* 17: 3-25.
- Grice, A.C. and MacLeod, N.D. (1994). State and transition models for rangelands. 6. State and transition models as aids to communication between scientists and land managers. *Tropical Grasslands* 28: 241-246.
- Grice, A.C., McIvor, J.G., Ash, A.J. and Brown, J.R. (1996). Herbaceous change in Australia's tropical woodlands: plant processes. In: *Rangelands in a Sustainable Biosphere* (Ed. N.E. West). 187-188. Society for Range Management, Denver.
- Gramshaw, D. (editor) (1995). Integrated management for sustainable forage-based livestock systems in the tropics. An educational manual on key principles for grazing land management and livestock production. *Tropical Grassland Society of Australia Occasional Publication No.6*.
- Hall, T.J., Filet, P.G., Banks, B. and Silcock, R.G. (1994). State and transition models for rangelands. 11. A state and transition model of the *Aristida - Bothriochloa* pasture community of central and southern Queensland. *Tropical Grasslands* 28: 270-73.
- Hall, W. B., McKeon, G. M. and Day, K. A. (1996). Simulation studies of Galloway Plains animal production. Draft Internal report.
- Hall, W., Day, K., Carter, J., Paull, C. and Bruget, D. (1997). Assessment of Australia's grasslands and rangelands by spatial simulation. Proceedings of MODSIM 97: International Congress on Modelling and Simulation (Eds A.D. McDonald and M. McAleer), Volume 4, Hobart. 1736-41.
- Hamblin, A. (1998). Summary. In: *Monitoring grazing lands in northern Australia* (eds John C. Tohill and Ian J. Partridge). *Tropical Grassland Society of Australia Occasional Publication No.9*. (In press).
- Henry, D.R., Hall, T.J., Jordan, D.J., Milson, J.A., Scheffe, C.M. and Silcock, R.G. (1995). Pasture Plants of Southern Inland Queensland. Qld Dept Prim. Ind. Inform. Series Q195016, pp.261. (Publication funded by the National Landcare Program).
- 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.
- Holt, J.A., Grice, A.C. and Brown, J.R. (1996). Patchiness in herbaceous vegetation: relationships with soil microbial biomass. In: *Proceedings of the 9th Biennial Australian Rangeland Conference* (Eds. L.P. Hunt and R. Sinclair). 143-144. Australian Rangeland Society, Port Augusta.

- Howden, S.M., McKeon, G.M., Walker, L., Carter, J.O., Conroy, J.P., Day, K.A., Hall, W.B., Ash A.J. and Ghannoum, O. (1997). Integrating global change impacts on native pastures in the Burnett Region of Queensland. Modsim '97 International Congress on Modelling and Simulation Proceedings, 8-11 December, University of Tasmania, Hobart (Eds McDonald, D.A. and McAleer, M.). Modelling and Simulation Society of Australia, Canberra. 123-130.
- Howden, S.M., McKeon, G.M., Scanlan, J.C., Carter, J.O., and White, D.H. (1993). Changing stocking rates and burning management to reduce greenhouse gas emissions from northern Australian grasslands. *XVII International Grassland Congress*, Palmerston North, New Zealand. 1203-5.
- Hook, R.A. (1997). Catchment management, water quality and nutrient flows as they relate to the Northern Beef Industry - An overview of literature and current research. A report for the Meat Research Corporation's North Australia Program (NAP3).
- Hopkinson, J.M. (1993). Tropical pasture establishment. 2. Seed characteristics and field establishment. *Tropical Grasslands* 27: 276-290.
- Hopkinson, J.M. and Paton, C. (1993). Tropical pasture establishment. 6. Treatment of Seca stylo seed to reduce hard seed content. *Tropical Grasslands* 27: 327-334.
- Hu, Fengduo (1995). Competition and allelopathic effects of the introduced grasses *Bothriochloa pertusa* and *Urochloa mosambicensis* when grown in association with *Stylosanthes hamata* cv. Verano and *Stylosanthes scabra* cv. Seca. Thesis submitted for the Degree of Doctor of Philosophy in the Department of Botany and Tropical Agriculture, James Cook University of North Queensland. 391pages.
- Hu, F.D. and Jones, R.J. (1997a). Effect of phosphorous fertiliser on the competition between two tropical grasses and two tropical legumes. Proceedings of the XVIII International Grassland Congress, Canada, Session 7, 73.
- Hu, F.D. and Jones, R.J. (1997b). Effects of plant extracts of *Bothriochloa pertusa* and *Urochloa mosambicensis* on seed germination and seedling growth of *Stylosanthes hamata* cv. Verano and *Stylosanthes scabra* cv. Seca. *Australian Journal of Agricultural Research* 48: 1257-64.
- Ison, R.L. and Humphreys, C.F. (1993). Evaluation of "Sustainable beef production systems in Central Queensland" project. Report to the Meat Research Corporation.
- Jackson, J. and Ash, A.J. (1998). Tree-grass relationships in open eucalypt woodlands of north eastern Australia: influence of trees on pasture productivity, forage quality and species distribution. *Agroforestry Systems* (in press).
- Jamieson, A, Lambert, G., Back, P.V., and Henderson, P. (1992). Woody Weed Adviser: A computer management aid. CQ Farm Business Management Project. (QDPI: Rockhampton)
- Johnson, R.W. and Burrows, W.H. (1994). *Acacia* open-forests, woodlands and shrublands. In "Australian Vegetation" 2nd edit. (ed. R.H. Groves). (Cambridge University Press: London). 257 - 290.
- Jones, P. and Burrows, W.H. (1994). State and transition models for rangelands, 13. A state and transition model for the mulga zone of south-west Queensland. *Tropical Grasslands* 28: 279-283.
- Jones, R.J. and Coates, D.B. (1992). The effect of age on steer liveweight gain on continuously stocked tropical pastures. *Proceedings of the Australian Society of Animal Production*, 19: 39-42.
- Jones, R.J. (1997). Steer gains, pasture yield and pasture composition on native pasture and on native pasture oversown with Indian Couch (*Bothriochloa pertusa*) at three stocking rates. *Australian Journal of Experimental Agriculture* 37, 755-65.
- Jones, R.J., McIvor, J.G., Middleton, C.H., Burrows, W.H., Orr, D.M. and Coates, D.B. (1997). Stability and productivity of *Stylosanthes* pastures in Australia. I. Long term botanical changes and their implications in grazed *Stylosanthes* pastures. *Tropical Grasslands* , 31: 482-493.

- Jones, R.M., McDonald, C.K. and Silvey, M.W. (1995). Permanent pastures on brigalow soil: the effect of nitrogen fertiliser and stocking rate on pastures and liveweight gain. *Tropical Grasslands* 29: 193-209.
- Kelly, A.M. (1997). Multivariate analysis of ecological data. M. Agr. Sc. Thesis, Univ. of Qld
- Kernot, J.C., Shaw, K.A., Quirk, M.F. and Rolfe, J.W. (1996). Study tour of the East Kimberley grazing lands. Report by QDPI participants. Report to the Meat Research Corporation. 15 pages.
- Lambert, G. and Graham, T.W.G.(eds). (1996). Sown pasture notes – Central Queensland; Queensland Department of Primary Industries.
- Lambert, J. (1997). Healthy environments for beef production in northern Australia. ADDRESS TO THE 13TH Annual Conference of the NT Cattlemen's Association. Alice Springs, 11 April 1997. 6 pages.
- Loch, D.S. (1993). Tropical pasture establishment. 5. Improved handling of chaffy grass seeds; options, opportunities and value. *Tropical Grasslands* 27: 314-326.
- McArthur, S.R., Chamberlain, H.J. and Phelps, D.G. (1994). State and transition models for rangelands, 12. A general state and transition model for the mitchell grass, bluegrass-browntop and Queensland bluegrass pasture zones of northern Australia. *Tropical Grasslands* 28: 274-278.
- McCosker, Terry and Winks, Lyle (1994). PHOSPHORUS NUTRITION of beef cattle in northern Australia. Meat Research Corporation and Department of Primary Industries, Queensland. Information Series QI94012. 86 pages.
- McDonald, C.K., Jones, R.M. and Silvey, M.W. (1995). Detailed pasture and animal data from a long-term grazing trial on brigalow soil. *Tropical Agronomy Technical Memorandum No 86*, CSIRO Division of Tropical Crops and Pastures, Brisbane.
- McDonald, C.K., Jones, R.M. and Silvey, M.W. (1996). Effect of seasonal soil moisture, nitrogen fertiliser and stocking rate on unsown species in a sown subtropical pasture. *Tropical Grasslands* 30: 319-329.
- McIntyre, S. (1996). Grasses that come and go. *The Growing Idea*, Autumn 1996. Official Newsletter of Greening Australia. 4-5.
- McIntyre, S. and Filet, P.J. (1997). Choosing appropriate taxonomic units for ecological survey and experimentation: the response of *Aristida* to management and landscape factors as an example. *Rangeland Journal*. 19: 26-39.
- McIntyre, S. MacLeod, N.D., and Taylor, J.A. (1995) Landscape position as a determinant of floristic change and animal production in sub-tropical *Heteropogon contortus* pastures of eastern Australia. *Proceedings of the 5th International Rangelands Congress*, Salt Lake City, Utah. 354-355.
- McIvor, J.G., Ash, A.J., Brown, J.R. and Grice, A.C. (1996). Herbaceous change in Australia's tropical woodlands: community processes. In: *Rangelands in a Sustainable Biosphere* (Ed. N.E. West). 356-357. Society for Range Management, Denver.
- McIvor, J.G., Jones, R.M. and Taylor, J.A. (1993). Tropical pasture establishment. 4. Population dynamics of sown species in developing pastures. *Tropical Grasslands* 27: 302-313.
- McIvor, J.G. and McIntyre, S. (1996). Impact of grazing on species densities at small scales in rangelands. *Proceedings of the IX Australian Rangelands Conference*, Port Augusta, South Australia. 245-246.
- McIvor, J.G., Noble A.D. and Orr, D.M. (1996). Stability and productivity of native pastures oversown with tropical legumes. A report for the Meat Research Corporation's North Australia Program (NAP3). 65 pages.

- McIvor, J.G. and Scanlan, J.C. (1994). State and transition models for rangelands. 8. A state and transition model for the northern speargrass zone. *Tropical Grasslands* 28, pp. 256-259.
- McIvor, J.G., Singh, V., Corfield, J.P. and Jones, R.J. (1996). Seed production by native and naturalised grasses in north-east Queensland: effects of stocking rate and season. *Tropical Grasslands* 30:262-269.
- McKeon, G.M., Stafford-Smith, M., Ash, A., Burrows, W.H., Clewett, J.F., Rebgetz, Z., Scanlan, J. and Silburn, M. (1997). Simulation of grazing strategies for beef production in north-eastern Queensland. *Drought Plan Working Paper No. 8*. (QDNR: Brisbane).
- MacLeod, N.D. (1993). A simple cost-benefit analytical model to assess the economic value of pasture based R and D projects. *Tropical Agronomy Technical Memorandum No 81*, CSIRO Division of Tropical Crops and Pastures, Brisbane.
- MacLeod, N.D., Cook, S.J. and Walsh, P.A. (1991a). An economic evaluation of legume establishment technologies for the improvement of native pastures in Australian sub-tropical woodlands. *Proceedings of the IVth International Rangelands Congress*, Montpellier, France. Service Central d'Information Scientifique et Technique, Montpellier, France. 789-793.
- MacLeod, N.D., Cook, S.J. and Walsh, P.A. (1991b). An economic comparison of three legume establishment technologies for speargrass dominant pastures. *Tropical Grasslands* 25: 225-226.
- MacLeod, N. D. and McIntyre, S. (1996). Production performance of steers grazing droughted black speargrass (*Heteropogon contortus*) dominant pastures. *Proceedings of the IX Australian Rangelands Conference*, Port Augusta, South Australia. 104-105.
- MacLeod, N. D. and McIntyre, S. (1997). Stocking rate impacts on the production and economic performance of steers grazing black speargrass pastures.. *The Rangeland Journal* 19: 174-189.
- MacLeod, N.D. and Taylor, J.A. (1992). Perceptions of sustainable grazing systems. (K.J. Hutchinson and P.J. Vickery Eds.) Looking Back-Planning Ahead. *Proceedings of the Australian Society of Agronomy*. Armidale. 169-171.
- MacLeod, N.D. and Taylor, J.A. (1993). Sustainable grazing practices in Queensland. *Australian Farm Manager* 3: (6), 6-9.
- MacLeod, N. D. and Taylor, J. A. (1994). Perceptions of beef cattle producers and scientists relating to sustainable land use issues and their implications for technology transfer. *The Rangeland Journal* 16: 238-253
- MacLeod, N.D., Taylor, J.A. and Van Beek, P.G.H. (1992). Group Perceptions of sustainable grazing practices in Queensland. *Proceedings of the 18th National Conference Workshop of Australian Farm Management Society*, Roseworthy Agricultural College. 1.1-1.11.
- MacLeod, N. D., Taylor, J. A., Van Beek, P. G. H. and Vance, P. N. (1993). Technology transfer strategies for products of environmental Research and Development projects. *Proceedings of the XVIII International Grassland Congress*. 639-640.
- MacLeod, N.D. and Van Beek, P.G.H. (1993). Rural R&D moving towards systemic approaches: The 'GLASS' sustainable grazing project - A case study. *Proceedings of the 37th Conference of International Society For The System Sciences*. University of Western Sydney, Hawkesbury Campus, Richmond. 536-45.
- MacLeod, N.D., Van Beek, P.G.H., Taylor, J.A. and Vance, P.N. (1992). Can rangeland management be changed?: A model for transferring complex R&D technologies to potential end-users. *Proceedings of the 7th Biennial Conference of Australian Rangeland Society*, Cobar. 386-87.
- MacLeod, N. D., Walsh, P.A., Cook, S.J. and Ciem, R.L. (1993). Tropical pasture establishment. 16. Economic considerations for pasture establishment. *Tropical Grasslands* 27: 396-405.
- Middleton, CH., Furphy, K.J., Blight, G.W. and Hansen, Vicki-Lee (1993). Large-scale property demonstrations of the effect of Secco stylo and phosphorus on beef cattle growth in central

- Queensland, Australia. *Proceedings of XVII International Grassland Congress*. 1994-1996. Dunmore Press, New Zealand.
- Middleton, C.H., Smith, P., Tyler, R., Knights, P. and Chamberlain, J. (1996). Producer Demonstration Site Final Report 1986-1996 - Parts 1 & 2. Project Summary (60 pages) plus Appendix and Attachments.
- Middleton, C.H., Smith, P., Tyler, R., Knights, P. and Chamberlain, J. (1996). Producer Demonstration Site Final Report 1986-1996 – Part 3. Compendium of Site Final Reports 1986-1996 (420 pages).
- Middleton, C.H., (1990). Seca stylo lifts liveweight gains. In: Focus on Beef (March 1990). 28.
- Miller, C. P., Taylor, J. A. and Quirk, M.F. (1993). Tropical pasture establishment. 8. Management of establishing pastures. *Tropical Grasslands* 27: 344-348.
- Miller, C.P., Rains, J.P., Shaw, K.A. and Middleton, C.H. (1997). *Stylosanthes* in the northern beef industry. *Tropical Grasslands*, 31: 509-514.
- Miller, E.N. (1996). A property level economic assessment of prickly acacia (*Acacia nilotica*) on the Mitchell grass downs of Queensland. 227-230 In: Eleventh Australian Weeds Conference Proceedings
- Miller, E.N. and J.C. Scanlan. (1997). Linking ecology and economics for woody weed management in Queensland's rangelands. *Proc. Ann. Conf. Australian Agricultural and Resource Economics Society*.
- Murphy, K.J. and Hendricksen, R.E. (1998). Supplementation of breeding cows grazing pastures on serpentinite alluvium soils in Central Queensland. *Proc. Australian Society of Animal Production* 22: 251.
- Noble, A. D., Cannon, M., and Muller, D. (1997). Evidence of accelerated soil acidification under *Stylosanthes* -dominated pastures. *Australian Journal of Soil Science* 35: 1309-1322.
- Noble, J.C. The potential for using fire in northern Australian pastoral lands. Fire in the management of northern Australian pastoral lands; *Proceedings of a workshop held in Townsville, Queensland, Australia April 31-May 2, 1996*. Edited by Tony C. Grice and Sonja M. Slatter. *Tropical Grassland Society of Australia Occasional Publication No.8*. 41-48.
- O'Rourke, P.J., Winks, L. and Kelly, A.M. (1992). North Australia Beef Producer Survey 1990. Queensland Department of Primary Industries and Meat Research Corporation Report.
- Orr, D.M. (1992). Using fire to manage species composition in *Heteropogon contortus* (black speargrass) pastures. Working paper, 5th Queensland Fire Research Workshop, Charleville.
- Orr, D.M. (1998). A life cycle approach to the population ecology of two tropical grasses in Queensland, Australia. In "Population Ecology of Grasses", Ed. G. Cheplick, Cambridge University Press (in press).
- Orr, D.M., Burrows, W.H., Rutherford, M.T. and Myles, D.J. (1997). Seca stylo pastures require special management. Working paper, 10th Biennial Conference, Australian Rangeland Society, Gatton.
- Orr, D.M., McKeon, G.M. and Day, K.A. (1991). Burning and exclosure can rehabilitate degraded *Heteropogon contortus* pastures. *Tropical Grasslands* 25: 333-6.
- Orr, D.M. and Paton, C.J. (1993a). Seca stylo (*Stylosanthes scabra* cv. Seca) populations increase faster under light grazing. *Proc. XVIIth International Grassland Congress*. 1906-1908.
- Orr, D.M. and Paton, C.J. (1993b). Impact of grazing pressure on the plant population of *Heteropogon contortus* (black speargrass) in subtropical Queensland. *Proc. XVIIth International Grasslands Congress*. 1908-1910.

- Orr, D.M. and Paton, C.J. (1993c). Fire and grazing interact to manipulate pasture composition in *Heteropogon contortus* (black speargrass) pastures. *Proceedings XVIIIth International Grassland Congress*, 1910-11.
- Orr, D. M. and Paton, C. J. (1996). Dynamics of *Heteropogon contortus* in relation to stocking rate and land class. *Proceedings of the 9th Biennial Conference of Australian Rangeland Society*, Port Augusta. 106-7.
- Orr, D.M. and Paton, C.J. (1997). Using fire to manage species composition in *Heteropogon contortus* (black speargrass) pastures 2. Enhancing the effects of fire with grazing management. *Australian Journal of Agricultural Research* **48**: 803-10.
- Orr, D.M., Paton, C.J. and Blight, G.W. (1996). An improved method for measuring the germinable soil seed banks of tropical pastures. *Tropical Grasslands* **30**:201-205.
- Orr, D.M., Paton, C.J. and Lisle, A.T. (1997). Using fire to manage species composition in *Heteropogon contortus* (black speargrass) pastures 1. Burning regimes. *Australian Journal of Agricultural Research* **48**: 795-802.
- Orr, D.M., Paton, C.J. and McIntyre, S. (1994). State and transition models for rangelands. 10. A state and transition model for the southern black speargrass zone of Queensland. *Tropical Grasslands* **28**: 266-269.
- Orr, D. M., Paton, C. J., Rutherford, M. T. and Taylor, J. A. (1995). Does lack of rainfall or lack of seed limit recruitment of *Heteropogon contortus*? *Proceedings of the 5th International Rangelands Congress*, Utah. 416-417.
- Osten, D. and Schefe, C. (1994). The native pastures of the eucalypt woodlands of inland central and southern Queensland. -2. *Working Pap. 8th Bienn Conf Aust Rangeland Soc., Katherine July 1994*. 161.
- Partridge, I.J. (ed.) (1996). Tropical pasture seed production – a training manual. QDPI, Brisbane.
- Partridge, I.J., Burrows, W.H. and Weston, E.J. (eds.) (1994). Sown Pastures for the Brigalow Lands. *Queensland Department of Primary Industries Conference and Workshop Series QC94005* .).
- Partridge, I.J., Knights, P.T. and Elphinstone, G. (1993). Tropical pasture establishment. 15, Experiences with the band-seeder in commercial pastures. *Tropical Grasslands* **27**: 391-395.
- Partridge, I.J., Middleton, C.H. and Shaw, K.A. (1996). Stylos for better beef. Queensland Department of Primary Industries. Brisbane.
- Partridge, I.J. and Miller, C.P. (eds) (1991). Sown pastures for the seasonally dry tropics. Proceedings of a workshop held on the Atherton Tablelands in June 1989. *Queensland Department of Primary Industries Conference and Workshop Series QC91002*.
- Pressland, A.J. and Anderson, E.R. (1993). Woody weeds in Queensland - their extent, trends and containment. pp 15-25. In: "Woody weed management strategy". Proceedings of a National Workshop, Cobar. (Department of Agriculture: Sydney).
- Quirk, M.F. (1997). Range management in the USA/Canada (including XVIII International Grasslands Congress). Study Tour and Conference Report. Report to the Meat Research Corporation. 16 pages.
- Quirk, M.F., Ash, A.J. and McKillop, G. (1996). A case study of Dalrymple Shire north-east Queensland. In: *Sustainable Habitation in Rangelands - Proceedings of a Fenner Conference on the Environment* (Eds. N. Abel and S. Ryan). 71-83. CSIRO, Canberra.
- Rains, J.P., Hopkinson, J.M. and Tregea, S.P. (1993). Tropical pasture establishment. 10. Satisfying industry's pasture seed requirement. *Tropical Grasslands* **27**: 359-366.
- Ritchie, M. and Anderson, E.R. (1998). How to monitor vegetation and soils. In: *Monitoring grazing lands in northern Australia* (eds John C. Tothill and Ian J. Partridge). *Tropical Grassland Society of Australia Occasional Publication No.9*. (In press).

- Sallaway, M. M. and Waters, D. K. (1994a). Spatial variation in runoff generation in granitic grazing lands. *Proceedings of the International Hydrology and Water Resources Symposium, Institute of Engineers, Adelaide*. 3: 485-489.
- Sallaway, M. M. and Waters, D. K. (1994b). Management of grazing pressure to maximise water intake and minimise soil movement. *Proceedings of the VIII Australian Rangelands Conference, Katherine, Northern Territory*. 219-220.
- Sallaway, M. M. and Waters, D. K. (1995). Management of grazing lands to minimise runoff. *9th Queensland Hydrology Symposium, Institute of Engineers, Brisbane*. 13.
- Sallaway, M. M. and Waters, D. K. (1996). Spatial variation in land degradation due to changes in grazing pressure during drought. *Proceedings of the IX Australian Rangelands Conference, Port Augusta, South Australia*. (In press).
- Sallaway, M.M., Waters, D.K., Bridge, B. and Wandera, F.P. (1993). Variation in hydrological characteristics of the soils associated with grazed patches in granitic landscapes in northern Australia. *Proc. XVIIth International Grasslands Congress. 1900-1902*.
- Scanlan, J.C. (1992). A model of woody-herbaceous biomass relationships in eucalypt and mesquite communities. *J. Range Management*. 45: 75-80.
- Scanlan, J.C. (1994) State and transition models for rangelands. 5. The use of state and transition models for predicting vegetation change in rangelands. *Tropical Grasslands* 28: 229-240.
- Scanlan, J.C. (1998). Why monitor grazing land? In: *Monitoring grazing lands in northern Australia* (eds John C. Tothill and Ian J. Partridge). *Tropical Grassland Society of Australia Occasional Publication No.9*. (In press).
- Scanlan, J.C. and Burrows, W.H. (1990). Woody overstorey impact on herbaceous understorey in *Eucalyptus* spp. communities in Central Queensland. *Aust. J. Ecol.* 15: 191-197.
- Scanlan, J.C. and McKeon, G.M. (1990). GRASSMAN - a computer program for managing native pastures in eucalypt woodland (QDPI: Brisbane).
- Scanlan, J.C. and McKeon, G.M. (1993a). Tropical pasture establishment. 18. The potential for computer-based decision support systems to improve establishment success for sown tropical pastures. *Tropical Grasslands* 27: 414-419.
- Scanlan, J.C. and McKeon, G.M. (1993b). Competitive effects of trees on pasture are a function of rainfall distribution and soil depth. *XVII International Grassland Congress, Palmerston North, New Zealand*. 2231-2.
- Scanlan, J.C., Wilson, B.J. and Anderson, E.R. (1991). Sustaining productive pastures in the tropics. 2. Management of woody vegetation in grazing lands. *Tropical Grasslands* 25: 85-90.
- Shaw, K.A. and Tincknell, I.W. (1993) Tropical pasture establishment. 11. Producer establishment practices and experience in north Queensland. *Tropical Grasslands* 27: 367-372.
- Shields, P.G. and Anderson, E.R. (1989). The soil fertility of Capricornia grazing lands. *Queensland Department of Primary Industries, Project Report QO89025*.
- Silcock, R.G. and Johnston, P.W. (1993). Tropical pasture establishment. 9. Establishing new pastures in difficult tropical environments. *Tropical Grasslands* 27: 349-358.
- Stanton, J.P. (1977). The role of fire: a conservation manager's perspective. Fire in the management of northern Australian pastoral lands; Proceedings of a workshop held in Townsville, Queensland, Australia April 31-May 2, 1996. Edited by Tony C. Grice and Sonja M. Slatter. *Tropical Grassland Society of Australia Occasional Publication No.8*. pp. 48-49.
- Smith, L. and Novelly, P.E. (1996). The assessment of resource capability in Rangelands. LWRRDC Final Report (Daw20). Land and Water Resources Research and Development Corporation. 48 pages.

- Stockwell, T.G.H., Andison, R.T., Ash, A.J., Bellamy, J.A. and Dyer, R.M. (1994). State and transition models for rangelands. 9. Development of state and transition models for pastoral management of the golden beard grass and limestone grass pasture lands of NW Australia. *Tropical Grasslands* 28: 260-265.
- Stone, R.C. and McKeon, G.M. (1993). Tropical pasture establishment. 17. Prospects for using weather prediction to reduce pasture establishment risk. *Tropical Grasslands* 27: 406-413.
- Taylor, J. A. and Cook, S. J. (1993). Management and use of complex landscapes: some implications of spatial variation for pastures and animal production. *Proceedings of the XVIII International Grassland Congress*. 1932-1934.
- Thompson, W.P. and Shields, P.G. (1996). Northern Australia Program Research and Development Package. Research Impact Assessment. Land Resource Assessment and Management Pty Ltd. (Manual and supporting software).
- Tothill, J.C. and Gillies, C. (1992). The pasture lands of northern Australia – Their condition, productivity, and sustainability. *Tropical Grassland Society of Australia Occasional Publication No.5*.
- Tothill, J.C. and Partridge, I. P. (eds). (1992). Monitoring pasture lands in northern Australia. *Tropical Grassland Society of Australia Occasional Publication No.9*.
- Trollope, W.W. (1997). A brief overview of the ecology of fire in pastoral lands. In -Fire in the management of northern Australian pastoral lands. *Tropical Grassland Society of Australia Occasional Publication No.8*. 6-8.
- Trollope, W.W. (1997). Behaviour, effects and use of fire in the savannas of Southern Africa. Fire in the management of northern Australian pastoral lands. *Tropical Grassland Society of Australia Occasional Publication No.8*. 9-23.
- Vance, P.N., Van Beek, P.G.H. and MacLeod, N.D. (1993) Sustainable grazing communication project. *Proceedings of the QDPI Extension Conference - 'Gearing Up To The Future'*, Rockhampton. Queensland Department of Primary Industries, Brisbane. 182-184.
- Vance, P.N., MacLeod, N.D. and Van Beek, P.G.H. (1993) Improving research through extension. *Proceedings of the Australian-Pacific Extension Conference*, Surfers Paradise October. 180-182.
- Walker, B. (1991). Sustaining tropical pastures – Summative address. *Tropical Grasslands* 25: 219-223.
- Walker, B., Jocelyn Baker, Marion Becker, Brunckhorst, R., Heatley, D., Simms, J. Skerman, D.S. and Walsh, S. (1997). Sown pasture priorities for the subtropical and tropical Beef Industry. *Tropical Grasslands* 31: 266-272.
- Wandera, F.P. (1993). Patches in a *Heteropogon contortus* dominated grassland in southeast Queensland – their characteristics, probable causes and potential rehabilitation. *PhD. Thesis*, University of Queensland.
- Wandera, F. P., Kerridge, P. C., Taylor, J. A. and Shelton, H. M. (1993). Changes in productivity associated with replacement of *Heteropogon contortus* by *Aristida* species and *Chrysopogon fallax* in the savannas of south east Queensland. In: *Proceedings of the XVIII International Grassland Congress*. 352-353.
- Waters, D. K. and Sallaway, M. M. (1994). Simulation of runoff under different management options using digital terrain modelling. *Proceedings of the International Hydrology and Water Resources Symposium*, Institute of Engineers, Adelaide. 75-80.
- Waters, D. K. and Sallaway, M. M. (1995) Runoff simulation using digital terrain modelling. *9th Queensland Hydrology Symposium*, Institute of Engineers, Brisbane. 8.
- Weinand-Craske, M.M.G., Baker, D.E. and Ahern, C.R. (1996). Techniques for locating and quantifying potential phosphorus sources to the Fitzroy River. *National Conference on the*

Downstream Effects of Land Use Conference – Selected Papers. Rockhampton, April 1995.
Department of Primary Industries: Brisbane, Queensland.

- Whalley, R.D.B. (1994) State and transition models for rangelands. 1. Successional theory and vegetation change. *Tropical Grasslands* 28: 195-205.
- Wheaton, T. (ed.) (1994). Plants of the Northern Territory. NT Department of Lands, Housing and Local Government. Darwin.
- White, G.G. (1994). Parthenium weed: Workshop Report. *Proceedings of a workshop held in Rockhampton, Queensland, Australia, October 1993.*. Cooperative Centre for Tropical Pest Management, Brisbane, Australia.
- White, L.D. (1994). Total Ranch Management - Strategic Management of Range Ecosystems. Notes for a MRC Workshop held at Emerald in June 1994.
- Wicksteed, L.T., Webber, R.J., Kernot, J.C. and Shaw, K.A. (1996). Computer simulation in small group extension: Towards sustainable grazing systems in Australia's tropical savanna. Proceedings of the 6th International Congress for Computer Technology in Agriculture. Wageningen, The Netherlands.
- Willcocks, J. and Filet, P. (1993). Assessing the productivity of pastures in the Central Highlands region of Queensland, Australia. Proc XVII Int. Grassld Congress. 367-68.
- Wilson, A.D. and MacLeod, N.D. (1991) Overgrazing in the rangelands: present or absent? *Journal of Range Management* 44: 475-482.
- Wright, J.W., Crosthwaite, I.C., Geissler, P., Campbell, W., Brown, R., Brown, G. and Fleischfresser, B. (1993). Tropical pasture establishment. 13. Producer establishment practices and experience in near-coastal southern Queensland. *Tropical Grasslands* 27: 381-386.

Appendix V

Meeting program for the annual review of NAP Improving Resource Management projects

Venue Magnetic International Resort

Dates 11, 12 and 13 August 1997

Monday 11 August

6.00 pm Registration, introductions, drinks and buffet dinner at 7 pm

Tuesday 12 August

8.30 am Opening comments detailing the aims, format and scope of the meeting, plus "housekeeping details" (Barry Walker).

8.50 am Where we are with MRC and NAP - David Skerman

9.10 am Session 1 - Managing tropical savannas
(Chairman - Barry Walker)

9.15 am Woodland management and weed control for Queensland's beef pastures - Bill Burrows and Paul Back

10.00 am Smoko

10.30 am Exotic woody weed invasions in tropical woodlands - Joel Brown, Tony Grice and Shane Campbell

11.15 am Developing sustainable beef production systems for the semi-arid tropics of the Northern Territory - Rodd Dyer and Linda Cafe

12.00 noon General discussion and summing up.

12.20 pm Lunch

1.10 pm Session 2 - Managing tropical savannas
(Chairman - David Skerman)

1.15 pm Managing woodlands: Developing sustainable beef production systems for northern Australia - Joel Brown and Andrew Ash

2.00 pm Effects of stocking rate, legume augmentation, supplements and fire on animal production and stability of native pastures - Bill Burrows, David Orr and Mark Sallaway

2.45 pm Restoring the condition of degraded speargrass pastures in the southern speargrass zone - Col Paton, Vicki-Lee Hansen and Russ Tyler

3.15 Smoko

3.30 pm Enhancing pasture stability and profitability for producers in the Aristida/Bothriochloa woodlands - Richard Silcock, Paul Jones and David Waters

4.15 pm Grazing systems and grazing management guides for the Kimberley rangelands - Paul Novelty

5.00 pm Discussion and summing up

5.30 pm End of Day 1

6.30 pm Drinks

7.00 pm Workshop dinner

Wednesday 13 August

8.00 am Session 3 - Monitoring, LBP, soil acidification
(Chair - Judy Lambert)

8.05 am Review of previous day's presentations and discussions

8.20 am Determining productive capability of your land to develop sustainable management practices - Shane Walsh, Roger Landsberg and Claire Rodgers

8.50 am LBP in Northern Queensland - Jim Kernot, Kev Shaw and Joe Rolfe

9.10 am LBP in the VRD - Rodd Dyer

9.30 am LBP discussion and summing up

9.45 am Managing soil acidity associated with *Stylosanthes* based pasture systems in northern Australia - Andrew Noble

10.30 am Smoko

11.00 am Session 4 - Biodiversity and catchment reviews
(Chair - Annmarie Watt)

11.05 am Report and actions from the biodiversity review - Judy Lambert

- 11.35 am** Report and actions from the catchment management review -
Judy Lambert
- 12.05 pm** Discussion and summing up
- 12.30 pm** Lunch
- 1.15 pm** Session 4 - Property management and general
discussion
(Chairman - Barry Walker)
- 1.20 pm** Whole property management - Shane Blakeley, Barry Walker and
Judy Lambert
- 2.00 pm** Comments by Warren Mason and Sue McIntyre
- 3.00 pm** General discussion on a range of issues
- 3.45 pm** Meeting closed

Appendix VI

Guidelines for milestone reporting

A copy of the report either on disc, or sent via email, and one copy of each publication are required. These should be sent to the Program Coordinator (Dr Barry Walker).

Headings, layout and content for annual milestone reports

Project outline (Page 1)

Project title

MRC project number/Project duration/Date for milestone report

List Principal investigators, organisations, location, phone, fax and email numbers.

Project objectives (For those NAP2 projects still being developed for NAP3, address the objectives as provided in the latest submission to MRC)

Project summary (of c.100 words)

Project report (Pages 2 to 5)

Detail results/achievements addressing the agreed objectives. For those NAP2 projects still being developed for NAP3, address the objectives as provided in the latest submission to MRC.

Only brief coverage of the methodology is required, except where the investigator considers it to merit special mention.

Report whether or not milestones and achievement criteria have been met and any necessary explanation.

Detail plans for the coming year and mention any proposed changes or modification to the project.

Provide other relevant comments

Last page (this could be page 3,4,5 or 6, depending on the length of the project report)

List papers, reports or media articles published in the previous 12 months and submit one copy of each to MRC.

Financial and human resource issues should be dealt with separately in a letter sent directly to the Program Coordinator.

Page layout

Margins of each page: top, 2.5cm; inside, 2.5cm, outside 2.0cm; and bottom 2.5 cm. The project title should be in 14 point sans serif bold-faced type, in caps and lower case and centred. Leave two spaces after the title or section title. Cross heads or subheads should be in 12 point sans serif type, in caps and lower case, bold-faced and flush with the left hand margin. Body text copy must be in an 11 point serif typeface and single spaced with double spaces between paragraphs. Paragraphs should not be indented. All copy should be left justified and printed on one side only.

Appendix VII

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