MALLEE GRAIN & GRAZE

FINAL REPORT

November 2008

Prepared by Nicole Dimos and Roy Latta

With contributions from Darryl Pearl, Chris McDonough, Graeme McIntosh and Gupta Vadakattu

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Executive Summary

The Mallee Grain & Graze project was managed and coordinated by Mallee Sustainable Farming Inc (MSF). The Mallee is a region of approximately 7 million hectares straddling the three states of New South Wales, South Australia and Victoria. It is a low rainfall farming area with less than 350mm rainfall per annum. It is renowned for its mixed farming enterprises, predominantly cereal crops and beef/sheep livestock.

The overall objective of the Mallee Grain & Graze program was stated as:

> *By 30 June 2008, through research, development and extension activities, the project will have had at least 500 producers in the Mallee region participate in Grain & Graze activities with at least 180 of them adopting practices that can be shown to result in a 10% increase in farm profitability (comprising a 10% lift in profitability in the livestock component and a 5% lift in the profitability of the cropping component), a move towards achieving targets set out in regional catchment management plans, and improved confidence and pride of the people and communities involved in and around mixed farming.*

To achieve this objective a number of strategies were developed and implemented which included:

- Validating techniques of growing cereals and/or forage crops to address an autumn/winter and late spring feed gap through development of research and demonstration sites.
- Demonstrating the value of feed lotting sheep in containment areas to maintain livestock numbers in adverse seasonal conditions and reduce environmental impact.
- Improving livestock producer's knowledge and skills in animal nutrition.
- Highlighting the value of using perennials to improve out of season forage production, water use, land protection and/or rehabilitation and sustain crop production through research and demonstration.
- Developing and validating grazing strategies to enhance productivity, soil protection and biotic biodiversity through research and demonstration, and
- Implementing a range of communication, extension and participation activities to achieve participation rates and on farm adoption of recommended practices.

The research and development components of the program demonstrated that:

- In low rainfall conditions a sown forage cereal (triticale) outperforms native and volunteer pasture paddocks (early dry matter production increased by 50%, 1.5 t/ha compared to 1 t/ha) increasing livestock gross margins by $40/ha.
- With sown forages of triticale, wheat, pea, oat or barley, a winter lambing enterprise would require no supplementary grain/hay at up to 4 times current regional stocking rates. Sown forage crops produced 8-10 kgDM/day in May-June and 30–60 kgDM/day for July-August.
- Stock containment strategies are essential to ensure the protection of the land irrespective of pasture components.
- Visual assessment of stock condition is not effective and weighing is necessary.
- Lucerne establishment can be enhanced through reduced seedling damage from wind and sand blasting with the protection from a cover crop (in the absence of crop stubble) and by sowing the cover crop at a low rate, in alternate rows.
- Lucerne as a forage supplement could increase stocking rates by 50% compared to an annual pasture.

- Lucerne increased water-use in response to episodic rain events and delayed the loss of groundcover and soil exposure to wind erosion due to grazing in periods of low rainfall.
- The aboveground grazing and cropping system does impact the below ground microbial biodiversity and carbon turnover. Grazing and specifically overgrazing impacts negatively on soil biota and diversity.
- Old man saltbush is a productive and sustainable forage addition to a livestock enterprise when used as autumn feed gap material when grown on soils constrained by salinity.
- Animal production and product delivery can be improved through the accurate assessment of pasture composition and FOO (food on offer) >100 more Mallee livestock producers are now able to assess pasture dry matter quantity, quality and the grazing potential.

The extension and communication components of the program resulted in a total participation by Mallee farmers in Grain and Graze activities of around 2,300. While many farmers would have participated in more than one event it is estimated that around 1,260 individual farmers participated, well exceeding the target participation rate of 500.

While it is not possible to provide specific on farm adoption rates of specific recommended practices, an number of evaluation activities provide evidence of rates of on farm change that clearly exceeded the target number of 180.

Evaluation results undertaken at a number of Grain & Graze events conducted in 2007 consistently showed a high proportion of farmers had changed their farm planning or practices (62-71%), had improved confidence in on farm decision making (79-86%), or were intending to change their farm planning or practices in the future (76-81%) as a result of the Grain and Graze program and virtually all would like a similar project to continue in the future.

Around 70% of a sample of farmers indicated that their involvement had improved business profitability and 60% indicated that the program had influenced how they ran their farming enterprise.

An evaluation study undertaken to assess the adoption rates of three recommended Grain & Graze practices (containment areas for sheep, sowing pastures and forage crops and grazing cereals) showed that 80% of respondents are either using, thinking about or trialling each of the three currently recommended practices, with around 50% currently using them on their own farms. Notably, 50% of all respondents indicated that the Grain & Graze program had helped them make decisions that enabled them to make a practice change and around 40% of farmers had changed other practices on their farms in some way as a result of their involvement.

The program also demonstrated a move towards achieving targets set out in regional catchment management plans. The increases in the use of containment areas for sheep, sowing pastures and forage crops and use of deep rooted perennial pastures all contribute to enhanced protection of vegetation resources, erosion control, decrease in recharge and increased biodiversity. The region has seen an increase in the use of stock containment areas increase from 100 to over 250, reduced soil erosion and falling ground water levels.

Success in this project was achieved via the use of a comprehensive suite of extension tools supported by scientific research and development specific to the low rainfall Mallee. A key component of the Mallee Grain & Graze project was the identification of six monitor farms in which community engagement was maximised through farm demonstrations, farm walks and

field days. These provided an excellent vehicle for staging many events using an array of “tactics” identified from the National Change on Farm Strategy.

The target of a 10% improvement in farm profitability was only partially achieved with a profitability increase of 6%. This was due predominantly to continuing drought conditions throughout the duration of the project. However the project did have the highest benefit: cost ratio compared to all other participatory regions at 4.22 : 1.

Grain & Graze provided an excellent opportunity for the Mallee farming community that recognised the environmental and social issues associated with profitable mixed farming. The lessons learnt will undoubtedly continue to be adopted by farmers and thus improve the rural resilience of farming in the Mallee.

Acknowledgements

This project was made possible by the generosity and commitment by all the farmers and landholders who allowed the Mallee Grain & Graze team onto their properties. To the farmers who contributed in steering committee and attended the many meetings and represented the farming community, your time and efforts are duly recognised. The participation, availability, support and willingness to be involved in this project is greatly appreciated. Additionally, to the farmers who attended the many events and workshops, your support for such activities is greatly acknowledged and it is hoped that the lessons learnt have added to the on-going success of your farm enterprise.

This project was also made possible through the financial support of;
Australian Wool Innovation Ltd (AWI)
Grains Research and Development Corporation (GRDC)
Land and Water Australia (LWA) and
Meat and Livestock Australia (MLA)

The in-kind contributions and support from the Victorian Department of Primary Industries, New South Wales Department of Primary Industries and the South Australian Research and Development Institute and the Lower Murray Darling Catchment Management Authority, Mallee Catchment Management Authority and South Australian Murray Darling Basin Natural Resource Management are duly acknowledged and the enormous efforts and assistance in participating in the project are indescribable.

The contributions of the Grain and Graze national office, in particular Dr. Richard Price and Ms Gill Stewart, who always offered support and assistance in ensuring the Mallee project could be completed. Their professionalism and knowledge was an asset to the success of the overall Grain & Graze project.

Finally, the work of the Mallee Grain & Graze Implementation Officer, Zubair Shahzad and the past and current MSF staff, and in ensuring that the Mallee project was able to deliver and conduct a highly complex project with due professionalism and dedication is acknowledged. Special thanks to Victoria Adams whom assisted in proof reading and editing this document.

Abbreviations

ABS	Australian Bureau of Statistics
AWI	Australian Wool Innovation Limited
BiGG	Biodiversity in Grain and Graze
B:C	Benefit Cost ratio
C	Carbon
CLPP	Community Level Physiological Profiling
CMA	Catchment Management Authority
CP	Crop-Pasture
CSIRO	Commonwealth Scientific Industrial Research Organisation
DECC	Department of Environment and Climate Change
DM	Dry Matter
DPI	Department of Primary Industries
DSE	Dry Sheep Equivalent
DWLBC	Department of Water, Land, Biodiversity and Conservation (SA)
GRDC	Grains Research Development Corporation
EP	Eyre Peninsula
EMS	Environmental Management System
FLN	Free-living nematode
H’	Shannon diversity index
ha	Hectare
IC	Intensive Cropping
KASA	Knowledge, Attitudes, Skills, Aspirations
kg	Kilogram
LMD	Lower Murray Darling
LWA	Land and Water Australia
ME	Metabolysable Energy
MJ	Megajoule
MLA	Meat and Livestock Australia
m	metre
mm	millimetres
MSF	Mallee Sustainable Farming Inc.
N	Nitrogen
NLP	National Landcare Program
NRM	Natural Resource Management
NSW	New South Wales
PAW	Plant Available Water
PC	Pasture Crop
PIRSA	Primary Industries and Resources South Australia
PP	Permanent Pasture
R, D & E	Research, development and extension
RIRCs	Rural Industries Research Corporations
RMCG	Rendell McGuikan Consulting Group
RV	Remnant Vegetation
SA	South Australia
SAMDBNRM	South Australian Murray Darling Basin Natural Resource Management
SFS	Southern Farming Systems
SWOT	Strengths, Weaknesses, Opportunities, Threats
t	Tonne
TBL	Triple Bottom Line
Vic	Victoria
WFP	Whole Farm Planning
WUE	Water Use Efficiency

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1. Why did we do it?

Historically, the Mallee farming system was based on a mixed farming enterprise with cropping paddocks sown to cereals in rotation with pasture/stubble paddocks for grazing livestock and often in heavier soil types a third year of long-term fallow to achieve weed and disease control and water storage benefits.

In the last decade, the Victorian Mallee has seen a shift in the enterprise mix with a reduced livestock component and an increased cropping component **(Figures 1 and 2).** This trend is also apparent in the NSW Mallee, with area under crop increasing from approximately 30,000 hectares (ha) to up to 50,000ha over the same period (DECC, 2005; McIntosh, Annual Crop Surveys, 2003-2007). With this increase, there has been a decrease in stock numbers (sheep and cattle) of approximately 30% in this region (ABS, 2005-2006). This assessment of land use has been further supported with results from recent survey work (Wakefield, 2007 pers. comm.) with results showing that approximately 80% of arable land over the 2007 growing season was sown to annual field crops, predominantly cereals. A small proportion of the field crops may have been sown for grazing.

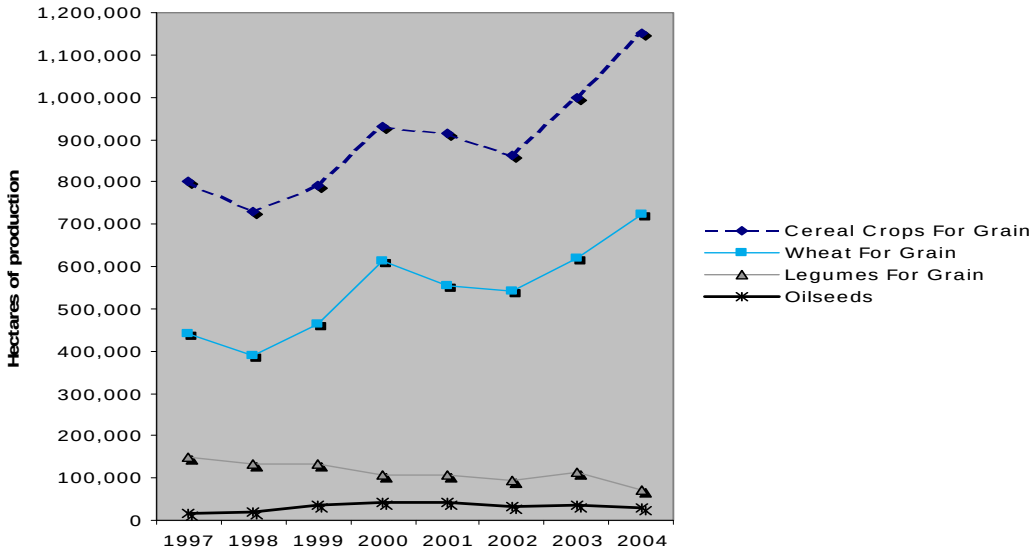

Figure 1. Trends in areas of cereal crops, wheat, grain legumes and oilseeds grown in the Victorian Mallee 1997 – 2004 Source: McRobert J (2008) adapted from Agricultural Survey, ABS.

This shift demonstrates that Mallee farmers, rightly or wrongly, believed that cropping systems offered the greatest opportunities for productivity and profitability, along with meeting their environmental and social goals. Large capital investments in cropping equipment also saw a desire to maximise return on this investment.

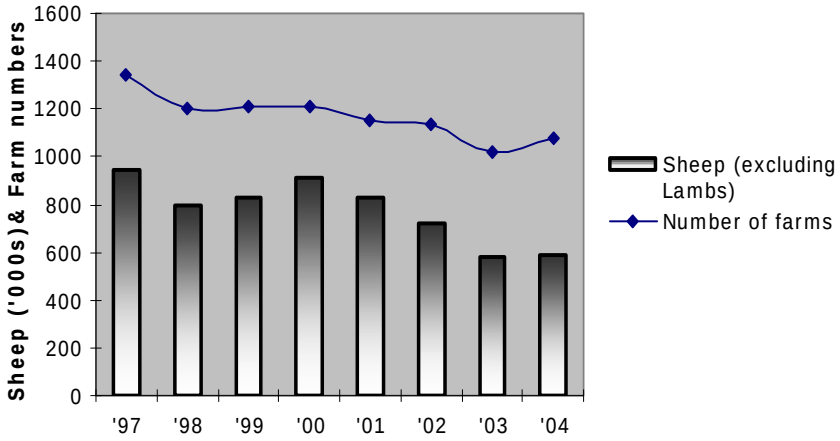

Figure 2. Trend in sheep numbers and numbers of producers raising sheep Source: RMCG 2008 adapted from Agricultural Survey, ABS

However, this trend is in contrast to the study by Ewing and Flugge (2004) who suggested there have been recent periods of economic advantage in the livestock component over the cropping component of the mixed enterprise.

Farm benchmarking analyses have shown the changing fortunes of different enterprises with dual purpose Merino based lamb and prime lamb producing enterprises being more profitable than other livestock enterprises and cropping in recent years (Sackett and Francis, 2005). Furthermore, issues such as herbicide resistant weeds and sustainability issues are forcing wider consideration of forage phases or perennial based pasture linked to livestock production (Ewing and Flugge 2004).

Studies by Robertson (2005a) has shown the potential for doubling stocking rates from the current Mallee regional <1 ewe/winter grazed hectare (Robertson and Wimalasuriya, 2004). For example Robertson (2005b) espoused the underutilised value of crop stubbles as a feed source in Mallee mixed farming systems. Latta and Carter (1998) found that increasing stocking rates on annual medic based pastures in a pasture crop rotation resulted in higher subsequent cereal grain yields and quality. However, there is concern about the environmental impact of increased livestock numbers on soil stability and potential erosion. Maintaining >50% plant groundcover is required (Leys *et al*, 2004).

The Grain & Graze program provided an opportunity to investigate and promote opportunities to better integrate and capitalise on the livestock component of the mixed farming enterprise in the Mallee.

The Grain & Graze mission was;

> *"To provide mixed farming enterprises with new "whole farm" knowledge, tools, and capability to adopt management changes that will increase production of crops, pastures and animals; while maintaining or enhancing biodiversity and the catchment resources that maintain them"*

In response to this mission, Mallee Sustainable Farming (MSF) undertook an extensive mapping and consultation process. The meetings aimed to identify research, development and extension issues, opportunities and needs in the context of existing Mallee funded programs and the "Grain & Graze" objectives.

Four meetings attended by farmers, researchers, environmental authorities and extension staff sought to answer two key questions. These questions were;

1. What combinations and rotations of livestock with annual and perennial crops, pastures and vegetation will increase profit; increase production; reduce leakage; maintain soil condition and on-farm biodiversity and help achieve catchment targets for the condition of natural resources?;
2. What information, decision support tools, learning processes and incentives are needed to help with these issues and implement appropriate responses?

A key outcome from these consultations was that while farmers would continue to increase the proportion of their farms to cropping, they still wished to continue to run mixed farms as they felt stock were essential to their enterprise (Cummins, 2003). An influential factor for retaining stock is that it has provided a financial safeguard for periods when grain production was compromised due to poor environmental conditions resulting in failed crops. These crops provided a feed source for stock and although market prices have been low, at least some amount of income was generated.

Based on the identified issues raised, the Grain & Graze project designed an extension strategy based on the National Change on Farm Strategy **(Appendix 1)**. This strategy highlights the practice change model and uses the combination of six key extension tools (tactic areas). This strategy supported the approach undertaken in the Mallee as there was a strong desire from participants to focus on participatory learning to gain new and existing information. The main methods employed were sound farm demonstration sites at different locations across the Mallee, field walks, information days and experiential tales of successful practices already employed by other farmers in the Mallee low rainfall region (mentoring and exchange). These methods, including the focus on progressive farmers in participatory processes, are common in the agricultural sector and have been extensively researched (Vanclay, 2004; Howden *et al*., 1998; Aslin *et al*., 2006).

Based on this situation analysis, MSF on behalf of the Mallee farming community and government agencies aimed to deliver the Grain & Graze mission. To achieve this, a comprehensive suite of extension tools supported by scientific research and development specific to the low rainfall Mallee was identified and a strategic learning plan developed and implemented.

The key areas for further investigation, development and promotion to enhance the livestock component and environmental management were:

1. Grow cereals and/or forage crops to address the autumn/winter and late spring feed gap

Integrating crops with livestock production addresses a number of issues that restrict livestock production, and therefore stocking rates, in the Mallee. Apart from the potential to produce more early feed to address the winter feed gap there were also a number of production, environmental and social questions. A Mallee farmer survey (Latta and Weston, 2006) found that the trend towards increased cropping is in part being driven by new cropping technologies and less by economic considerations. There are cropping extension packages well suited to the low rainfall cropping regions. The poor performance of pastures within crop rotations was considered a catalyst for declining stock numbers, as was the perception that livestock do not fit with direct drill seeding systems.

2. Feed lotting sheep in containment areas to maintain livestock numbers in adverse seasonal conditions

The impact on soil erosion of the grazing animal in periods of adverse seasonal conditions is considered to have been a major catalyst for a reduction in livestock numbers in the Mallee region. Concern for soil health, partly due to dry seasonal conditions and personal preferences based on workload, skills and social demands are also important factors. The financial and technical support to successfully integrate containment areas into the livestock

production system provides the opportunity to address the social, including animal welfare, and environmental concerns.

3. Improving livestock producer's knowledge and skills in animal nutrition.

There have been very limited opportunities for Mallee livestock producers to learn pasture assessments skills and the associated relationships with animal performance. There is little local expertise to deliver the technology. There was an identified need to provide some ongoing support tools along with providing some experts to deliver the best available animal nutrition information.

4. Introducing perennials to improve out of season forage production, water use, land protection and/or rehabilitation and sustain crop production.

Lucerne was seen as a valuable addition to Mallee farming systems in the 1950s and 1960s. McClelland and Wells (1968) measured increased wheat yields and grain protein contents on sandy soils following two years lucerne compared with wheat following two years annual pasture. The control of skeleton weed (*Chondrilla juncea*) by lucerne competition on the sand hills was a major catalyst for this improvement with Wells (1969) reporting an average 84% decline in skeleton weed rosettes after 2 to 3 lucerne pasture years.

Four decades later lucerne remains a minor component of Mallee farming systems. Robertson and Wimalasuriya (2004) reported that in 1999, of 29 Mallee livestock producers, six grew an average 24 hectares of lucerne, approximately 1% of the average property size. The value of lucerne in agricultural systems relies partly on improved production from livestock industries. In north-eastern Victoria the ability to increase stocking rates by 50% with lucerne pastures compared to annual pastures was shown by Crawford and Macfarlane (1995).

Robertson and Wimalasuriya (2004) suggested current stocking rates are <1 ewe/winter grazed hectare but with much potential for an increase. The producers believed that increased adoption of lucerne would support an increased stocking rate. However, there is concern about the environmental impact of increased livestock numbers on soil stability and potential erosion in the Mallee and maintaining >50% plant groundcover is strongly recommended (Leys *et al*, 2004).

Apart from the livestock production aspects an opportunity to address rising saline water tables and salinity is based around replacing annual crops and pastures with perennial plants to increase total annual water-use. Latta *et al.* (2001; 2002) measured increased water-use, pasture and crop productivity over a 3-year lucerne, 2-year crop rotation in the low rainfall Western Australian cropping belt. They found the opportunity to grow a lucerne phase within the cropping rotation had numerous potential benefits. Mopping up excess soil water in response to summer rain events, additional soil nitrogen, control of summer weeds, high quality summer forage, and soil stabilisation.

5. Improved grazing strategies to ensure productivity, soil protection and biotic biodiversity

Diverse microbial communities are generally linked to ecosystem stability, productivity and sustainability, with plants being the major source of available carbon for biological activity, especially in low fertility Australian soils. The availability of carbon in pasture systems is largely attributed to grazing management, which has been shown to greatly impact on the diversity of the microbial community and the complex relationship between catabolic diversity, above-ground plant productivity and functional capabilities (eg. N mineralization) in low fertility Mallee soils.

These five key areas provided the basis of implementing the Mallee Grain & Graze program.

2. What did we intend to achieve?

The Mallee Grain & Graze project aim was:

"By 30 June 2008, through research, development and extension activities, the project will have had at least 500 producers in the Mallee region participate in Grain & Graze activities with at least 180 of them adopting practices that [could] demonstrate a 10% increase in farm profitability, a move towards achieving targets set out in regional catchment management plans, and improved confidence and pride of the people and communities involved in and around mixed farming".

The specific objectives of the project were:

1. To lift mixed farm productivity in the Mallee by 10 percent by assessing and extending the role of annual and perennial pastures in order to increase pasture productivity, livestock profitability and subsequent crop yields.

2. To decrease water recharge and salinity, and increase biodiversity by incorporating pastures into mixed farming systems, thereby contributing to the achievement of catchment target levels.

3. Engage, through communication, extension and participation activities **(Appendix 2)**, at least 500 producers in the Mallee region's Grain & Graze activities between 2004-2008 with a view to adoption on farm of recommended Grain & Graze practices on at least 180 farm businesses.

This project concept was developed together with associated consultative work by Cummins (2003), who interviewed farmers and identified the appropriate independent research work already underway (or recently completed) at the time in which the Mallee was addressing productivity, environmental and capacity building issues. Grain & Graze offered the opportunity in a single project to help in the integration of all three of these facets **(Figure 3)**.

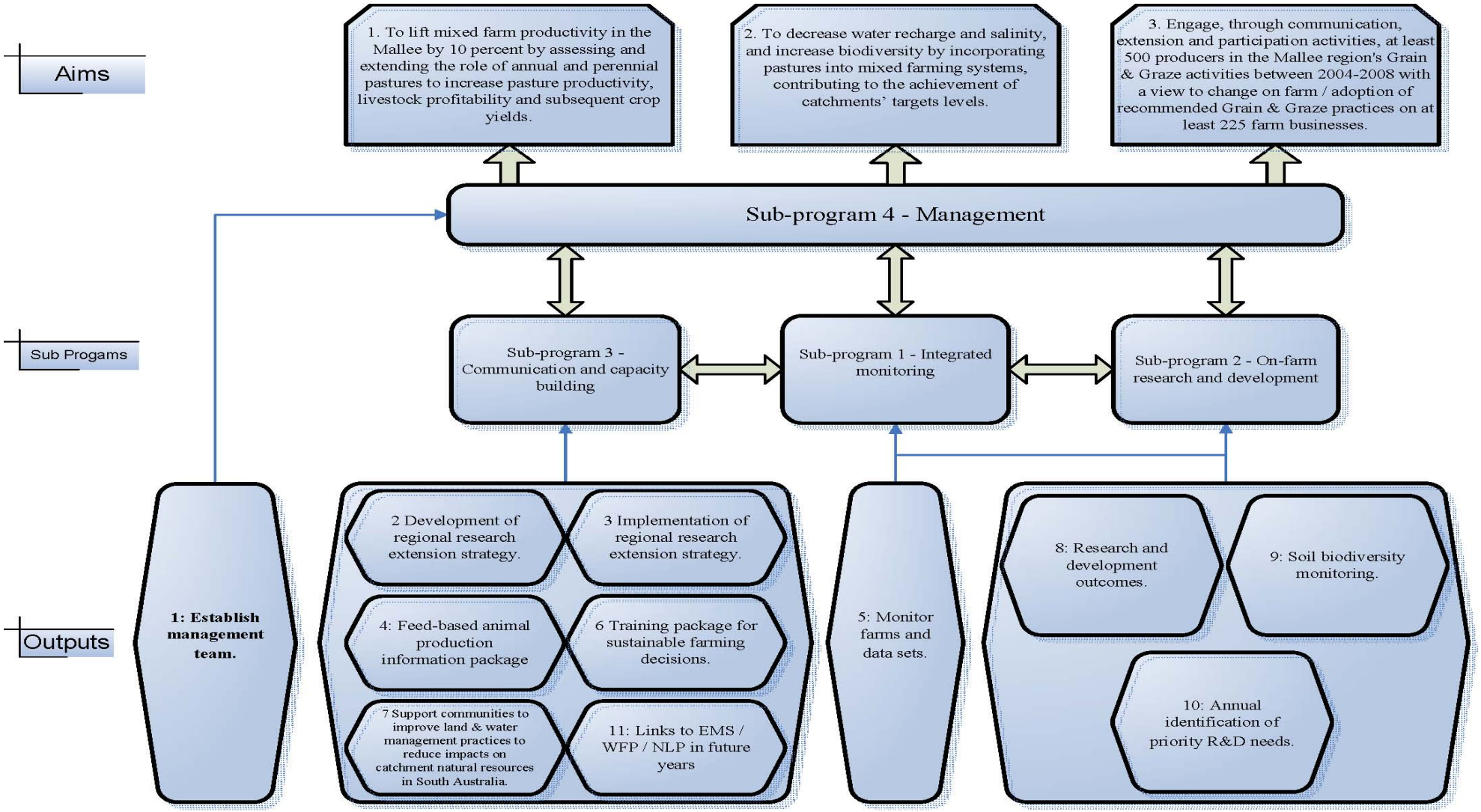

Figure 3. Schematic diagram of aims, sub-programs and output deliverable targets proposed by the Mallee for participation in the Grain and Graze program.

Farmers within the Mallee saw an opportunity to improve their skills and knowledge in livestock production to the same level as that of cropping. Specifically, there was *"……a general desire to see the farming community's understanding about pastures, animal breeds, animal genetics and animal husbandry lifted to the level of understanding that is now common for crops"* (Cummins, 2003). Farmers in the Mallee were environmentally conscious and were seeking local answers about retaining livestock in a way that was not detrimental to the environment. Increased knowledge was sought on topics such as stock containment areas, pastures on non-arable land, soil improvements (water and nutrient), strategies for managing risk (erosion and land use) and strategic grazing management techniques (grazing stubbles, alternative fodder crops and supplementary farming). Farmers also wanted to generate greater returns per unit of labour and capital resource (eg. farm equipment).

A key focus of the Grain & Graze program was to develop and validate technical practices that integrated cropping and grazing activities to better match livestock nutritional requirements with available feed and to encourage on farm adoption of those practices.

The following schematic shows how the various Grain & Graze program components could be integrated into the mixed farming enterprise to modify available feed to enhance productivity.

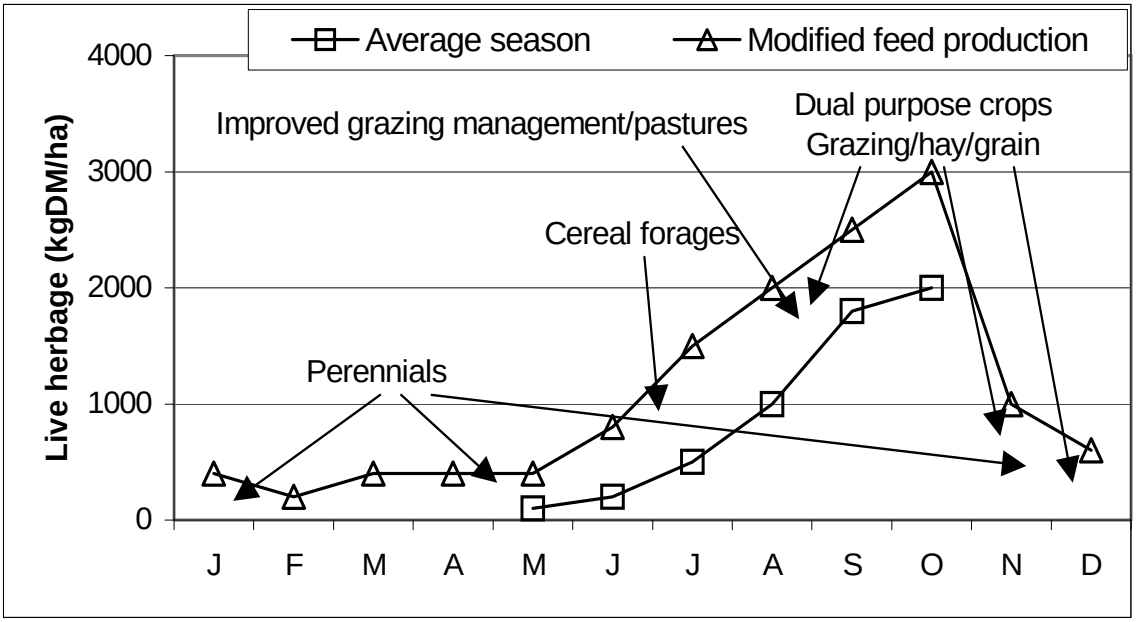

Figure 4 Modified feed production in the Mallee by adopting Grain and Graze opportunities

Both farmers and extension staff believed there was sufficient research information already available to ensure the Grain & Graze project would achieve its objectives in the Mallee, however on-farm demonstrations were needed to convince farmers of the merits and practicality of incorporating this information into their production systems. This existing research information was based on existing robust research conducted via MSF over the previous ten years and also research knowledge produced from other low rainfall mixed farming regions in Australia. Past projects include intensive cropping systems (Roget, 2003), Mallee fallow management (Leys *et al*, 2004); and lucerne in the Mallee (Schipp *et al*, 2004). Project planners in the Mallee were confident that this knowledge would be adopted through Grain & Graze as the local farmers had:

- demonstrated the skills needed to evaluate new techniques through workshops and field walks;

• access to working examples of successful mixed-farming techniques in their local and nearby areas, as well as an understanding of the reasoning behind them; and
• shown a high degree of willingness to become involved in on-farm demonstrations.

The very nature of the Mallee, straddling three State borders, makes collaborative programs difficult to plan and implement and complex ones such as Grain & Graze that deal with the triple bottom line even more difficult to manage. However, the experience of Mallee Sustainable Farming Inc and the regional Grain & Graze steering committee, together with the willingness of partners to collaborate, meant that the region was able to come to grips with these complex issues and successfully report against them in this report.

Contrary to some public perception, Mallee farmers are highly aware of the need to protect their resources and manage their farm in a sustainable manner as, indeed, their survival depends on it. As such, an important element of the Grain & Graze work in the region was the soil health work that was to be undertaken through several strands of the Grain & Graze project.

The following list highlights the major activities carried out to address the project aims:

- Integrated monitoring program which helped identify farming systems, future research needs and to support decision making on-farm against all aspects of the triple bottom line.
- Monitor and analyse six selected farms, the farming and grazing systems already in place and/or innovative systems which could be implemented as a result of local research.
- Benchmarking surveys of six monitor farms which evaluated various farm management changes including animal, pasture and crop performance as well as soil-water and nutrient attributes in order to establish physical and financial benchmarks.
- Extension activities including Farmtalk fact sheets, and facilitated events such as annual field walks and training programs to achieve capacity building for farmers within the Mallee region. The communications program provided sound knowledge of how to incorporate conservation farming practices and to best match livestock production with crop production for maximum profitability and sustainability using the existing Mallee Sustainable Farming Inc tri-state extension strategy
- Research undertaken in knowledge gap areas such as feed-base animal production information packages and soil biodiversity monitoring.

3. What Did We Do?

Project management: The Mallee Grain & Graze sought involvement in this project from key stakeholders to ensure on-going development and execution. This was achieved by establishing a management team which comprised of a diversity of partners and co-investors including;

- CMAs (Vic. – Mallee, NSW - Lower Murray Darling and SA - Murray Darling Basin Natural Resource Management)
- CSIRO
- Farmers
- State government agencies (NSW DPI, Rural Solutions - Plant Industries Research SA, Victorian DPI)

Representation from all groups was maintained through their membership on the steering committee. The Steering Committee was established as a sub-committee of MSF Inc and had delegated authority to make decisions related to management of the project, with recommendations made to the MSF Board in regard to major project policy and funding arrangements. The Steering Committee was chaired by MSF Inc, and was responsible for operational management of the project. According to recommendations from Grain & Graze, the farmer representatives were members who had successfully implemented a systems approach that related to the Grain & Graze objectives. These producers informed the research planning process.

Two staff were employed on behalf of Mallee Sustainable Farming Inc: the Program Manager, whose responsibilities included project management and reporting to the Board on project progress; and a full time Grain & Graze Implementation Officer whose key responsibilities included coordination of RD&E activities across all agencies and all states through the development and implementation of a Tri-State Extension Agreement.

Communication and capacity building: Background work undertaken in the Mallee identified RD & E needs that were consistent with the aims of Grain & Graze; however, the knowledge and information products from existing research efforts were often directed to a single commodity or not coordinated between states.

MSF Inc. developed a Tri-State Extension Agreement in co-operation with relevant agency service providers which supported the following:

- Identification and clarification of regional research and extension priorities;
- Creation of a participatory environment for knowledge exchange and Tri-State peer support;
- Identification and development of regional extension messages;
- Identification and implementation of effective information exchange processes;
- Broadening and strengthening of communication networks; and
- Targeted packaging and regional delivery of information.

To meet the objectives of Grain & Graze, MSF expanded its already successful extension program. This expansion:

- Provided coordination of the linkages between information outputs from research projects shown in this proposal as co-investment, and Grain & Graze objectives
- Developed packages for extension of research information outputs
- Maintained the communication between relevant agencies for successful implementation of the Regional Research & Extension Agreement.

- Included mixed farming enterprises in the coordinated delivery of outcomes. This was in partnership with the three states and with those agencies with specific responsibility to achieve Grain & Graze outcomes.

The attached Communication Strategy **(Appendix 2)** and Change on Farm Template **(Appendix 3)** outlines the planning for engaging producers across the Mallee region in three states to achieve the Grain & Graze targets for participation and adoption of sustainable mixed farming practices aimed at achieving environmental, economic and social outcomes.

The Mallee Grain & Graze project had an emphasis on research (including on-farm demonstrations). To further identify relevant research themes, annual assessments were undertaken. These were facilitated by the Grain & Graze Implementation Officer, and helped identify gaps in the existing knowledge base for future research investment. This included a process of review of priority research and extension needs in consultation with project partners and the farming community. The annual needs assessment also assisted in setting priorities for future CMA/ NRM investments.

Plate 1. Annual identification of R & D needs workshop

In SA, a number of projects (funded through the SAMDBNRM) were proposed to compliment the Mallee Grain & Graze project in terms of communication and capacity building.

As described in the following research activities, a number of production, profitability and environmental measurements were collected in each project which had an impact on the Mallee producers triple bottom line (TBL).

Integrated monitoring program (Monitor farms): The integrated monitoring program was designed to help identify farming systems, future research needs and support decision-making on-farm. This component set out to monitor and analyse six selected farms, the farming and grazing systems already in place, and/or innovative systems that could be implemented as a result of local research. Monitor farm participants had the opportunity to assess the financial implications of a particular strategy using gross margin calculations. The implementation of this strategy was then monitored under the Grain & Graze project. It is important to note that the leading farmers in the steering committee were separate from the producers involved in the Mallee Grain & Graze monitor farms project.

Delivery agencies in each state (DPI – Vic; DPI – NSW; Rural Solution, SA) were responsible for the on-ground monitoring on the six farms. Extension activities were carried out with the assistance of these six farmers (two from each state) in line with the Regional Research Extension Strategy. MSF provided support and coordination of these activities including mail outs, training workshops, field days, and farm walks. In this way, other farmers were encouraged to incorporate Grain & Graze systems to benefit their TBL.

A brief description of the monitor farm research activities are detailed below;

Table 1. Monitor farm activities

Strategy	Methodology	Data collection
High input grazing cereals	A 36ha paddock was divided into 3 management zones; • District practice: sown cereal for pastures (58kg/ha triticale) + 58kg/ha fertiliser • High seeding rate a: 90kg/ha triticale + 58kg/ ha fertiliser • High seeding rate b: 90kg/ha triticale + 90kg/ha fertiliser Rotational grazing through the 3 areas for three months.	• Rainfall • Economic analysis ($/ ha) • Feed quality • Root disease bioassays
Lucerne establishment	• Four varieties established based on varied winter activity ratings • Four establishment methods were trialled; -1.2kg/ha lucerne + 23kg/ ha oats -1.2kg/ha lucerne + 23kg/ha oats followed by chemical spray out of oats -1.2kg/ha lucerne + 12.5kg/ha oats (using skip row sowing technique) -1.2kg/ha lucerne (sown into prepared seed bed)	• Plants/m^2 • Lucerne production (kgDM/ha) • Plant available water and water use efficiency, • Soil analysis, EC and pH • Rainfall • % groundcover • Wind erosion assessments
New rotations	Fodder crops sown dry. - 50 kg/ha peas + 23 kg/ha oats - 75 kg/ha peas + 23 kg/ha oats - 100 kg/ha peas + 23 kg/ha oats - 150 kg/ha peas + 23 kg/ha oats - 92 kg/ha lathyrus + 23 kg/ha oats - 50 kg/ha oats	• Establishment (plts/m^2) • Dry matter (tDM/ha) • Feed quality • Grain yield (kgDM/ ha) • Rainfall (mm) • WUE (kg/ha/mm) • Stocking capacity (DSE/ha) • Value ($/DSE)
Phase farming with perennials	Trial A Four paddock comparison. 1. Veldt grass sown as a permanent pasture 2. Intensive cropping. No-till practices. Paddocks are non-nutrient limiting and has adequate summer weed control 3 and 4. District practice 2 course crop/pasture system . Trial B Three paddock comparison 1. Sown cereal pasture with high inputs (120kg/ha seed + 90kg/ha fertiliser) 2. Sown cereal pasture with 'district practice' rates of fertiliser (60kg/ha + 45kg/ha) 3: Volunteer pasture	1 DM production, carrying capacity, feed quality and erosion assessment 2, 3 and 4. Soil nutrient and moisture, disease levels, microbial activity, summer weeds, crop yield, grain quality and economic analysis Biomass production (kgDM/ha) Economic analysis ($/ha) Root disease bioassays Soil analysis

Strategy	Methodology	Data collection
Strategic management options for seasonal variation	• Livestock managed according to single or multiple lambing. • Assessment of best quality livestock rations. • Saltbush, cereal grain mix, oats, lucerne and annual medic all grown as feed sources Five forage crops were evaluated • Forage barley (50 kg/ha) • Forage barley (100kg/ha + 46kg N/ha) • Oats (50kg/ha) • Hay oats (25 kg/ha) • Hay oats (50 kg/ha + 46 kg N/ha) • Forage brassica (2kg/ha) • Peas (60 kg/ha) • Peas and oats (25kg/ha + 25kg/ha) • Vetch (30 kg/ha) • Vetch + Oats (15kg/ha + 25kg/ha)	• Ewe pregnancy testing • Soil analysis • Pasture evaluation (kg DM/ha) and feed tests (fodder and grain) • Gross margins ($/ha) • Rainfall (mm) • WUE (kg/ha/mm) • DSE/ha • Value $/DSE • Feed test • Yield (kg DM/ha)

Research and Development

The Mallee Grain & Graze project optimised the impact of existing research by contributing on-farm demonstration and trial sites with further investment to fill identified research gaps. Future research needs were identified by pre-project industry consultation, analysis of the monitor farm data and annual R & D planning forums.

In terms of farm management there was a need for a more productive feed phase and decreasing reliance on long-term fallows (a major cause of recharge and soil erosion problems) by increasing the use of break crops and perennials in the farming system. Gaining better information on animal performance was also a priority.

Project 1. Feed-based animal production information package

This project evaluated the production impact of different management decisions, incorporating a variety of feed scenarios to deliver information to farmers about the importance of feed in effective animal production. The production of a photographic ute guide specific for sheep production in low rainfall areas was to be produced as well as a research report which used data primarily collected from the Mallee Research Station between 2000 to 2005.

Project 2. The effect of stocking rate on sheep and cereal production

Project Aims:

- To define and promote the production responses of sheep and pastures at different stocking rates and utilising lucerne as 10 % of the pasture area.
- Additionally, measuring the subsequent impact on crop profitability.

Methodology:

Table 2. Sheep stocking rates grazing on annual pastures and lucerne in 2005 study.

1.25 ewe/ha annual pasture	2.5 ewes/ha annual pasture + lucerne	2 ewes/ha annual pasture
8 ewes + lambs/7 ha	9 ewes + lambs/4 ha	8 ewes + lambs/4 ha

In 2006; the experimental design altered whereby; 6 ewes+ 6 lambs grazed under the following pasture systems.

- Treatment 1- Rotation from 3 ha annual pasture to 3 ha pasture paddock with chemical grass control
- Treatment 2 - Rotated from 3ha annual pasture to 1ha sown cereal forage crop
- Treatment 3 - Rotated from 3ha annual pasture to 1ha lucerne

In 2007, the whole area was sown to Yipti wheat at a rate of 65kg/ha.

Measurements in response to stocking rate treatments:

- Ewe and lamb production (2005 and 2006) (kgs)
- Comparative pasture production (2005 and 2006) (t DM/ ha) and % groundcover
- Subsequent wheat yields and quality (2007) (t/ha and protein %)
- % groundcover

Project 3. Impact of grazing on biodiversity and function of soil microbiota in Grain & Graze systems in Mallee soils

Project Aim:
To compare differences between pastures under different management and intensive cropping systems in relation to the diversity of functional groups of microbiota involved in C turnover and identify links with nutrient (N) availability on Mallee soils over a four year period.

Methodology and assessments:
Project 1.
Collection of surface soil samples (0-10cm) from two treatments,

- pasture-wheat and
- continuous crop

Soil samples were collected from 8 different locations in each treatment plot and bulked to obtain a composite sample. All the samples were prepared by gentle sieving through a 2mm sieve to remove large pieces of stubble and stones followed by moistened to field capacity and incubated at 25 ^{0}C for 7 days prior to using various analyses.

The three types of laboratory methods to measure the diversity of soil microbial communities involved in C turnover include:
1. BIOLOG-GN plate methods,
2. Substrate induced respiration method using microresp-soil method or
3. McCartney bottle SIR method.

In order to determine the resilience of microbial communities, sub-samples of soils from both treatments were incubated for 21 days followed by the diversity measurements. Resilience of the communities was estimated based on the loss of community ability to respond to added C substrates.

Project 2.
Soil samples collected from the 5 farming systems were analysed for various microbial properties. They included Intensive cropping (IC), Permanent pasture (PP), Pasture-Crop (PC), Crop-Pasture (CP) and Remnant Vegetation (RV) systems. Samples were collected from closed wire cages installed to exclude inputs from sheep.

Samples were analysed for soil microbial diversity involved in C turnover based on community level physiological profiling (CLPP) laboratory methods. Surface soils from nearby remnant vegetation were assessed for comparison. Resilience of the communities was estimated based on the loss of community ability to respond to added C substrate following a six week incubation period.

Non- Grain & Graze funded research

A number of existing research projects added value to the implementation of the Grain & Graze project in the Mallee. Descriptions of their research plans and outputs will not be described in this report. These projects included:

- High water use farming systems that integrate crops with perennial pastures
- New rotations for low rainfall environments
- National annual pasture improvement program
- Identifying and overcoming biophysical constraints limiting profitability of Mallee farming systems
- Identifying herbicide impacts on N fixation of pulses
- Soils cropping and recharge monitoring.

4. What were the results?

The following pages describe the key outcomes from the monitor farms and research and development program. While it presents the key findings which support mixed farming in the Mallee, there are also a number of opportunities identified that need further investigation. These may provide additional benefits to the mixed farm enterprise to support the benefits and risks with a high degree of confidence. These opportunities are also stated.

A number of *Farmtalk* publications were produced based on the trials and results obtained through the Grain & Graze project **(Appendix 4)**.

Monitor farms **(Appendix 5)**

High input grazing cereals

Key Results

- High input grazing cereals paddocks produced more feed. There was little difference between the district practice and high seeding rate treatments in terms of Kg DM /ha
- High seeding rate performed best ($121/ha) economically, while district practice was the poorest performer ($46/ha).
- District practice and high input treatment required greater supplementary feeding rations.

Lucerne establishment

Key Results

- The most reliable method in relation to establishment was the skip row method
- Establishing lucerne into a prepared seedbed without cover resulted in less than 50% cover and therefore a high risk of erosion
- No clear impact on ground cover can be attributed to variety
- Variety and sowing method had no influence on aggregation levels
- Poor establishment and poor growth (due to low rainfall), resulted in no reduction of PAW to 6 metres resulting in no net reduction of deep drainage risk that can lead to recharge.

The pre-requisites for a good stand of lucerne are:

(i) Good paddock selection (low weed burden)
(ii) Adequate pre-sowing moisture in April
(iii) Adequate follow up rains in the first 12 months
(iv) Effective weed control
(v) Insect control at seeding and seedling stage (especially redlegged earthmite and lucerne flea control).

New Rotations – fodder crops

Key Results

- *Lathyrus* has low dry matter production
- A field pea / oat mixture produces excellent quality and quantity of biomasss, however, cost of establishment is high, thus making this option marginal
- Oats have shown a WUE of 40kg/ha/mm is achievable in the Mallee. They require little management and are a reliable and productive forage option in Mallee environments.

Phase farming with perennials

Key Results

- Veldt grass established slowly not providing a feed source until late Spring
- The continuously cropped paddock achieved a higher gross margin than the cropping phase of the perennial system,
- Volunteer pasture provided less ground cover, increasing the risk of wind erosion.
- A high input system produced approximately 40% more biomass than the district practice (volunteer pasture)..

Strategic management options for seasonal variation

Key Results

- Oats were the most productive forage crop grown, yielding 24% more DM than any other forage crop
- Vetch was the worst yielding forage crop.
- Utilising pregnancy and feed quality testing has increased lamb marking percentage and wool growth
- Soil testing can help lift the profitability of the cropping enterprise.
- For mixed farming, the use of poor cropping areas for saltbush plantings with a managed feed program can produce good results.

Table 3. TBL for monitor farms

Productivity targets	**NRM targets**	**Social Impact**
• Increased feed levels off less land can support more stock and improve lambing numbers • Continuous cropping is more productive and profitable. • Cereals and grasses provided feed in the feed gap period • Gross margins improve through the knowledge gained on alternative forages and management of these feed sources	• The increased biomass means more ground cover, therefore, decreasing soil erosion. • Increased pasture production per paddock led to increased WUE and decreased recharge. The same applies to increased cropping paddocks. • Stubble retention provides microbial activity • Cereals and grasses increased soil protection and reduced wind erosion.	• The on-farm trials were decided in consultation with local farmer groups with a focus on how the decisions were made and how it may work on other farms • Reduced labour inputs from a number of practices • Active participation was well received across the farming community

Opportunities for the future

- Sustainable use of less productive land with saltbush.
- To increase areas of multi-purpose crops.
- Reducing the risk with perennial crop establishment.
- Identification of different early grazing crops (including pastures) and alternate non-cereal feed sources
- More rigorous financial analysis (eg mixed system and continuous cropping; lot-feeding and grazing cereals)
- Improved understanding of how to cope with climate variability
- Lucerne for feed and recharge

Research and development

Impact of grazing on biodiversity and function of soil microbiota in Grain & Graze systems in Mallee soils (Appendix 6)

Diverse microbial communities are generally linked to ecosystem stability, productivity and sustainability, with plants being the major source of available carbon for biological activity, especially in low fertility Australian soils. The availability of carbon in pasture systems is largely attributed to grazing management, which has been shown to greatly impact on the diversity of the microbial community and the complex relationship between catabolic diversity, above-ground plant productivity and functional capabilities (eg. N mineralization) in low fertility Mallee soils. The observations and results from this project suggest that grazing systems in the Mallee region need to take into account grazing impact on the below-ground microbial diversity and functions.

- Microbial diversity measurements based on C-Substrate Utilization profiles provided a functional-based assessment of the status of soil microbial communities. General biological measurements such as short-term microbial activity measurements are more variable, weakly sensitive and difficult to link to farming system differences and environmental variables.
- Grazing induces significant changes in the size, composition (catabolic diversity) and functional capability of microbial communities in Mallee soils. These changes can be attributed to altered quantity and quality of below ground C inputs through roots and rhizodeposition. Heavy grazing under lower plant biomass systems caused losses in catabolic diversity & functional capability (N mineralization potential) and impacted on its resilience. Pasture systems with increased above ground dry matter, i.e. 'double sown', seem to support higher levels of microbial functions involved in C and N turnover. N mineralization capacity was highest in soils under permanent pasture followed by Pasture-Crop rotation and lowest in Intensive crop soils.
- The reduced microbial activity and catabolic potential under intensively grazed and low plant biomass systems can impact on surface soil structure through reduced aggregate stability and reduced cover thereby increasing the potential for wind erosion losses.
- Above ground plant diversity and not the amount of plant biomass seem to influence the populations and trophic composition of free-living nematode (FLN) populations, eg. populations of FLN were greater in numbers in volunteer pasture system compared to grazing cereal systems.
- Analysis of soils from BiGG program showed the largest difference in microbial community diversity between soils from 'Remnant Vegetation' and 'cropped' fields. In general, the Shannon diversity values (H') were highest for soils under 'RV' followed by Permanent Pasture and lowest in crop fields.
- Microbial catabolic diversity differences between farms within a region were greater under native vegetation compared to other agricultural systems (eg. cropped versus pasture-crop systems). The effects of regional differences on microbial diversity are still unknown.

Table 4. TBL for biodiversity studies

Productivity targets	**NRM targets**	**Social Impact**
The greater the DM production, the higher the microbial function.	Benefits derived from soil stability, biodiversity and nitrogen supply.	Increased awareness of the consequences of grazing impacts of soil biota

Opportunities for the future

- Increased local industry understanding.
- Continual assessment of changes under mixed farming systems
- Evaluation under new researchable crops for the Mallee area

The effect of stocking rate on sheep and cereal production (Appendix 7)
The grazing study comparing annual pastures with forage crops and lucerne supplements found

- There is an opportunity for the Mallee region of SE Australia to capture economic benefits through increasing stocking rates.
- Rotating ewes and lambs from an annual pasture onto a lucerne or forage crop pasture supported a 50% increased stocking rate compared to rotating onto an annual pasture.
- Grazing the forage crop and lucerne maintained similar weight profiles with less supplementary grain than animals on the annual pasture.
- The annual pasture groundcover was reduced to approximately 20% irrespective of stocking rate and grazing period prior to crop stubbles becoming available for grazing.
- The results of study indicate the opportunity to double current stocking rates is viable but requires stock containment strategies to ensure the protection of the land resource.
- Wheat yields were responsive to previous pasture type systems, with yields highest when grown after lucerne, and lowest when grown after cereal forage.

The study supported the findings of Robertson (2004, 2005b) (but in a more controlled system) that it is feasible to increase stocking rate either through increasing sheep numbers or maintaining current numbers on less winter grazed hectares. The risk factors in terms of fodder deficit or soil protection were not altered.

Feed-based animal production information package (Appendix 8)

- A photographic guide to annual pastures for low rainfall sheep production was developed. A series of 26 photos depicts annual pastures of varying quantity and estimates the growth rates of different classes of sheep for each pasture. This tool assists farmers in grazing management and supplementary feeding decisions to help achieve target growth rates for different classes of sheep.

Plate 2. Farmers learning how to use the photo guide.

Plate 3. Participants inspecting forage crop growing on the South Australia monitor farm.

Table 5. TBL for sheep and crop production study

Productivity targets	NRM targets	Social Impact
• Gross margins were greatest on the highest stocking rate treatment • Crop yields are maximised in pasture-crop rotations involving pastures or lucerne.	• Regardless of stocking rates, groundcover % was not compromised, thus increase in soil erosion was not seen	• Development of a user friendly visual guide to the production value of annual pastures in terms of stock responses, stocking rate and stocking period • Support document for farmers “Managing Sheep Production from a changing feedbase in the Mallee”

Opportunities for the future

- Provide support and additional exposure for future utilisation of booklets
- Assessment for other livestock enterprises engaged in the Mallee eg. cattle

5. What do the results mean for how we manage mixed farms?

The key outcomes from the monitor farms and research and development programs provide some clear implications for mixed farming systems in the Mallee.

A number of *Farmtalk* publications were produced based on the trials and results obtained through the Grain & Graze project **(Appendix 4)**. Along with peer reviewed publications and field day and media extension outputs they provide the outcomes and what they mean or the opportunities they provide for mixed farming enterprises.

1. Grow cereals and/or forage crops to address the autumn/winter and late spring feed gap

The project results show that grazing cereals and forage crops do have a role in managing the winter feed gap and seasonal variation in the livestock industry in the Mallee. Oats have an understood agronomy and are a reliable and productive system in the Mallee environment while the cost of establishing pulses limits their role. Oats were the best forage crop grown, yielding more DM than any other forage crop on monitor farms in all three states

Hay and grain production can also be produced from forages determined by seasonal conditions. Forage crops may also provide a disease break and nitrogen input benefit for the subsequent grain crops. However the use of grass selective herbicides in legume forage crops has been shown to significantly reduce nodulation and nitrogen fixation. This means that growers need to identify the primary reason for growing pulses, weed control or N fixation. If it is N fixation growers need to be aware they may be under achieving their aim.

Sowing grazing cereals with higher inputs can produce up to 40% more early biomass compared to the production cereals with low seeding rates and without applied N. In practise this meant that the collaborating farmers were able to target specific stock for specific timely markets, having this good early cereal feed on hand allowed them to increase the value of 200 weaner lambs, from an offer of $30/head prior to grazing, to achieving $47.50 after 35 days of grazing. The farmers will continue to sow grazing cereal pastures for his own use.

The production from the volunteer pasture, which has shown very poor regeneration after 3 years of cropping, produced less than half of the sown cereal. This farmer is using sown cereals in conjunction with his feedlot as opposed to relying on volunteer pastures to produce prime livestock for an early market niche.

The measurement of comparative pasture qualities (protein, energy and DDM) provides information on optimum grazing strategies to maximise production of lambs or lactating ewes. The results of this trial recommend that having a portion of the fodder crop sown to high protein forage such as peas could improve the productivity of livestock. Once the cereal portion of the crop dropped below the optimum protein level, livestock could graze the higher quality legume forage. If lambs are weaned, they could graze the legume forage and the dry ewes with a much lower forage quality requirement can remain grazing the poorer quality cereal.

Ewe pregnancy testing in association with pasture quality and quantity assessments was shown to increase lambing percentage. Farmers used the information to provide extra nutrition for twin lambs along with segregating dry ewes.

Therefore the potential exists to utilise a range of fodder crops rather than only one species. That is, if oats are the only fodder crop currently sown, replacing a portion of the area sown with the faster growing Rufus triticale would significantly improve the early dry matter production and increase the amount of early feed produced at a time when it is usually most

limiting. Sowing an additional portion to Morgan field pea may have multiple benefits in terms of improved feed quality and nitrogen accumulation for subsequent crops.

Including forage crops in the mixed farm system have shown additional benefits other than only improving livestock production. Forage crops may be used for hay production or sprayed out during spring which can greatly reduce weed burdens and store spring and summer rainfall for subsequent grain crops. Legume crops also input nitrogen into the soil. Furthermore, legumes and brassica crops provide a disease break from many cereal specific diseases. Therefore, there is potential for the use of forage crops as low risk break crops in mixed farming systems.

This work is demonstrating the value of higher production pastures that can provide quality feed earlier. It also mean that fewer paddocks are required to produce more feed, with a decreased risk of wind erosion, to retain a viable livestock enterprise in the face of increased proportions of cropping on farm.

2. Feed lotting sheep in containment areas to maintain livestock numbers in adverse seasonal conditions

The promotion, extension and demonstration program covering the feeding and maintenance of livestock within containment areas has resulted in widespread uptake. This has meant that that a major constraint restricting and limiting the role of livestock in Mallee farming systems is met. This was supported by a Mallee farmer survey (Latta and Weston, 2006) who found that the trend towards increased cropping as opposed to mixed systems is in part being driven by concern for soil health, partly due to dry seasonal conditions. The use of containment technology has addressed that issue.

Robertson and Wimalasuriya (2004) Robertson in a survey of mixed sheep/wheat farmers in the Victorian Mallee found the main factors that limit sheep production under current conditions were rainfall or feed availability, relative profitability of sheep compared to cropping, and labour issues. In the hypothetical situation where sheep were as profitable as cropping, and pasture production could be increased, labour/lifestyle issues were most commonly cited, but the need to manage variation in pasture supply between years were also important factors limiting sheep numbers. Thus the importance of containment areas.

3. Improving livestock producer's knowledge and skills in animal nutrition.

The outcomes are an improved capacity of livestock producers in the Mallee to assess the quality and quantity of forage biomass as it relates to animal production. There is an ability to either individually or through accessing technology place a dollar value on the available resource be it pasture, hay or grain.

With increases in the proportion of livestock in the mixed enterprise, it is even more important that producers understand and implement sound nutritional management practices. The use of stock containment areas, separate management of single and twin lambs and recognition of the importance of weighing sheep to assess nutritional requirements are all important considerations in maximising the returns from the livestock component of the system.

4. Introducing perennials to improve out of season forage production, water use, land protection and/or rehabilitation and sustain crop production.

At the commencement of the Mallee Grain & Graze project establishing the opportunities of perennials was a key issue for determination. The outcomes from the RD&E mean that lucerne in the Mallee will extend the availability of forage with high nutritive value. Lucerne

will produce quality year round forage and provide an excellent “break” for pests and diseases.

To achieve the production benefits lucerne requires management inputs to ensure persistence. Also a consideration for the broad acre cereal farmer is the need to maintain a reasonably intensive livestock enterprise to ensure the economic viability of lucerne.

Lucerne will use more water than an annual system and the placement of lucerne on areas of high recharge potential provides the opportunity to reduce recharge to near pre-European levels, 0-5 mm/annum, as compared to the 0-40 mm/annum under the current annual systems.

However the results also showed where the dry soil profile following the lucerne phase will result in reduced grain yields. To further exacerbate the reduced grain yield potential in seasons of low rainfall, lucerne was quite difficult to remove in preparation for the cropping phase.

Observed as part of the RD&E outcomes was the rate of lucerne establishment failure. This means that there is another associated risk with establishing lucerne in the low rainfall cropping regions, the economic cost of establishment failure. The establishment studies found that lucerne will emerge both with and without a cover crop, however success (>10 plant/m^2 at the break of the following season) is controlled by late spring competition for soil water. This means that lucerne must be isolated from the cover crop either in alternate rows, cross sown or sown as a monoculture.

Alternative perennials were evaluated with limited outcomes. Veldt grass can provide a useful early summer feed source following a wet spring, even after a poor establishment and the use of non productive poor cropping areas for saltbush plantings with a managed feed program can produce good results, both in terms of land protection and production.

5. Improved grazing strategies to ensure productivity, soil protection and biotic biodiversity

The grazing study found that rotating ewes and lambs from an annual pasture onto a lucerne or forage crop pasture supported a 50% increased stocking rate compared to rotating onto an annual pasture. Grazing the forage crop and lucerne maintained similar weight profiles with less supplementary grain than animals on the annual pasture. However irrespective of the stocking rate and grazing period the annual pasture groundcover was reduced to approximately 20% prior to crop stubbles becoming available for grazing. This suggests that the opportunity to increase current stocking rates is viable, with the inclusion of supplementary forage sources, but requires stock containment strategies to ensure the protection of the land resource.

The project has emphasised the importance of environmental targets to control wind erosion and dryland salinity. The dry conditions encountered during the project have meant that the relevance of targets including farm land retaining 50% ground cover has been demonstrated and as ground cover reduces soil aggregation or the % of soil particle size >1mm becomes more important.

The impact of farming systems including no-till and grazing biodiversity and function of soil microbiota have been extensively studied in the Mallee Grain & Graze project. No-till systems reduce the rate of nitrogen mineralisation compared to cultivation, which creates a flush in microbial activity and N mineralisation. Therefore no-till systems normally require increased inputs at seeding but have much more potential to mineralise N throughout the season.

In terms of grazing the management and utilisation of soil microbial functions is a key component of nutrient supply. Microbial activity and function is dependant on the level of carbon inputs, as biomass increases the opportunity for benefits from soil microbial functions also improves.

Therefore the availability of carbon in grazed systems is mediated strongly by grazing management through above-and belowground plant growth in response to grazing. Plant is the major source of available carbon for biological activity, especially in low fertility Australian soils, hence soil biodiversity and biological activity is more dependant on the quality and quantity of carbon inputs from plants (through root exudation and above- & below ground plant residues).

This suggests:

- Pasture systems with increased above ground dry matter support higher levels of microbial functions involved in C and N turnover.
- N mineralization capacity was highest in soils under permanent pasture followed by Pasture-Crop rotation and lowest in Intensive crop soils.
- The reduced microbial activity and catabolic potential under intensively grazed and low plant biomass systems can impact on surface soil structure through reduced aggregate stability and reduced cover thereby increasing the potential for wind erosion losses.

This project has given farmers the knowledge and confidence to consider retaining and not reducing livestock numbers in the Mallee (as presented in **Figure 1**), by offering practical management options to keep a mixed farm enterprise profitable and sustainable. While many of the options described throughout the report focus on improved utilisation of the grazing paddocks with alternative feed material, the outcomes also show that cereal production can offer the farmer dual-production benefits. For instance, in the SA Mallee where there was slightly more rainfall, cereals were grown both for grazing and cropping purposes. Of course, along with benefits, come associated risks, but it is anticipated that an understanding of how best to manage mixed farms will promote profitable and sustainable enterprises.

The climate variability experienced over the course of the project certainly influenced the success of the Mallee Grain & Graze project. The ability to share knowledge and experiences on how to best to remain viable showed that livestock could provide farm income when cropping results were negative but it needed to be managed appropriately. The improved management strategies extended using the various practice change tactics, showed that mixed farming in the Mallee was a viable option during the drought and produced economic and environmental benefits.

6. To what extent did we achieve what we intended to?

The Mallee Grain & Graze project was highly successful in meeting project objectives and targets.

The specific objectives of the project were:

1. To lift mixed farm productivity in the Mallee by 10 percent by assessing and extending the role of annual and perennial pastures to increase pasture productivity, livestock profitability and subsequent crop yields.

2. To decrease water recharge and salinity, and increase biodiversity by incorporating pastures into mixed farming systems, contributing to the achievement of catchment target levels.

3. Engage, through communication, extension and participation activities, at least 500 producers in the Mallee region's Grain & Graze activities between 2004-2008 with a view to change on farm / adoption of recommended Grain & Graze practices on at least 180 farm businesses.

A number of strategies were developed to meet these objectives which included:

- Developing and validating techniques of growing cereals and/or forage crops to address the autumn/winter and late spring feed gap.
- Demonstrating the value of feed lotting sheep in containment areas to maintain livestock numbers in adverse seasonal conditions and reduce environmental impact.
- Improving livestock producer's knowledge and skills in animal nutrition.
- Demonstrating the value of using perennials to improve out of season forage production, water use, land protection and/or rehabilitation and sustain crop production.
- Developing and demonstrating grazing strategies to enhance productivity, soil protection and biotic biodiversity.
- Implement a range of communication, extension and participation activities to meet the participation and adoption targets.

Table 10 identifies the various strategies and key technical information and practices developed as part of the Grain & Graze program that contribute towards meeting these objectives together with the outcomes and evidence of attainment towards incorporating this knowledge and practices into farming enterprises in the Mallee.

Table 6 Outcomes and evidence of attainment for Specific Strategies

Outcome	Evidence of attainment
Strategy 1 Grow cereals and/or forage crops to address the autumn/winter and late spring feed gap	
Demonstrated that in low rainfall conditions a sown forage cereal (triticale) outperforms native and volunteer pasture paddocks (early dry matter production increased by 50%, 1.5 t/ha compared to 1 t/ha) increasing livestock gross margins by $40/ha.	Results of monitor farm RD&E SA
Concluded that it was more economical to grow cereals or alternative	(Latta 2008b;Latta,

forages than to supplementary hand feed grain to ewes and lambs.	In press)
Confirmed that sown forage crops; triticale, wheat, pea, oat and barley produced 8-10 kgDM/day in May-June. For July August they grew at 30 – 60 kgDM/day depending on species. With sown forages a winter lambing enterprise would require no supplementary grain/hay at up to 4 times current regional stocking rates.	Results of Victorian monitor farm research and MSF Annual Research Results Compendium.
Strategy 2 Feed lotting sheep in containment areas to maintain livestock numbers in adverse seasonal conditions	
Highlighted that stock containment strategies are essential to ensure the protection of the land irrespective of pasture components.	>100 Containments areas established in the Vic Mallee supported with G&G at sheep nutrition days.
Strategy 3 Improving livestock producers knowledge and skills in animal nutrition	
Demonstrated to Mallee livestock producers that visual assessment of stock is not effective and weighing is necessary. Also the necessity of understanding feed analysis such as metabolisable energy, carbohydrate analysis and protein levels.	The Mallee Sheep Nutrition Workshops delivered by San Jolly to 200 farmers
Demonstrated that lambing percentages can be increased from around 80 to 100+% with the use of pregnancy testing techniques and separate nutritional management of singles and twins.	Results of Victorian monitor farm
Strategy 4 Introducing perennials to improve out of season forage production, water use, land protection and/or rehabilitation and sustain crop production.	
Demonstrated that in the absence of crop stubble, the risk of lucerne seedling damage from wind and sand blasting can be reduced with the protection from a cover crop.	NSW monitor farm RD&E
Demonstrated the potential plant soil water competition can be further reduced by sowing the cover crop at a low rate, in alternate rows or desiccating the cover crop once the lucerne is established.	NSW monitor farm RD&E and Victorian DPI research
Recommended that the extensive use of residual sulfonurea herbicides in cereal production systems requires accurate paddock history and chemical use records to ensure that susceptible crops are not sown during the period of herbicide efficacy. This non plant back period can be up to 3 years in the case of lucerne especially in high pH soils.	Chemical registrations
Demonstrated that winter activity ratings selected for lucerne varieties sown in the Mallee are based on the required length of the stand. A rating of 8 and above provides a productive life span of 3-4 years with good winter biomass production. A winter activity rating of below 8 would increase the productive life span but reduce the winter biomass	NSW monitor farm RD&E and Victorian DPI research
Concluded that lucerne as a forage supplement increased stocking rate by 50% compared to an annual pasture	(Latta 2008b;Latta, In press)
Concluded that lucerne increased water-use in response to episodic rain events and delayed the loss of groundcover and soil exposure to wind erosion due to grazing in periods of low rainfall. Biomass and subsequent crop production from annual medic and lucerne 3 year	(Latta 2008a&b; Latta, In press)

pasture-pasture-wheat rotations were comparable.	
Demonstrated that value of Veldt grass in providing biomass to maintain livestock over the May-June period.	Results of monitor farm RD&E SA
Recommended Old man saltbush as a productive and sustainable forage addition to a livestock enterprise when used as autumn feed gap material and grown on soils constrained by salinity	Results of Victorian monitor farm study
Strategy 5 Improved grazing strategies to enhance productivity, soil protection and biotic biodiversity	
Improved animal production and product delivery through the accurate assessment of pasture composition and FOO (food on offer) >100 Mallee livestock producers able to assess pasture dry matter quantity, quality and the grazing potential.	Pasture photo guide Vic.DPI. Tim Prance pasture utilisation workshops
Proved that the aboveground grazing and cropping system does impact the below ground microbial biodiversity and carbon turnover. Grazing and specifically overgrazing impacts negatively on soil biota, diversity and activity.	Vadakattu (2008)
Demonstrated that legume dominant annual pasture ground cover can decline below an accepted 50% following senescence irrespective of stocking rate. Highlighted the importance of stock containment as a necessary practice in the early summer, prior to stubbles becoming available	(Latta 2008b;Latta, In press)
Strategy 6 Implement communication, extension and participation activities to meet target of 500 producer participants in Grain & Graze activities with at least 180 adopting recommended Grain & Graze practices.	
Four field walks were conducted in 2005 (1 Vic, 1 NSW, 2 SA) to demonstrate a range of management changes that could provide farmers with the ability to sustain/ increase stocking rates with cereal forages, cell grazing and perennial pastures specific to Mallee conditions.	95 farmers participated
Workshop on Alternative Fodder crops - Dryland Lucerne conducted in 2005.	28 farmers participated
Grazing study presentation on Grain & Graze research at 2005 Mallee Research Station Open Day (Walpeup)	120 farmers participated.
MSF - Waikerie and Kerribee Core Site Field Days in 2005	230 farmers participated.
Feed lotting Study tour in 2005	300 farmers participated
2005 NSW extension program targeting farmer group meetings (3 groups X three meetings/yr)	130 farmers participated.
Non-specified Grain & Graze events including Steering committee meeting in conjunction with MSF R,D & E planning forum	40 farmers participated.
Conducted Mike Krause “Plan 2 Profit” training course in 2006.	50 farmers participated.
Information Day conducted in 2006 with Tim Prance, (Pasture Specialist) provided hands-on practical information on matching pasture availability for animal needs.	80 farmers participated
2006 Monitor farm updates Field Walk	65 farmers participated
Information Day on Sustainable Grazing and Drought Management conducted in 2006.	75 farmers participated

2006 NSW extension program targeting farmer group meetings (3 groups X three meetings/yr)	130 farmers participated.
2006 Feed lotting Study tour	50 farmers participated.
San Jolly (Nutrition expert) sheep nutrition Workshops and training information across three states to address the economics of drought feeding associated with land protection with the use of containment feedlots	125 farmers participated
Major regional field days at Waikerie SA and Walpeup Vic. in 2006 on integrated livestock cropping principles on monitor farms	250 (est.) in attendance
Promoting grazing cereals 2007 Annual MSF Waikerie Field day	110 farmers participated
Grain & Graze Field day (Werrimull) in 2007	30 farmers participated
National project Grain & Graze Forums – Passions, Issues and Challenges with mixed farming in the Mallee	30 farmers; 16 advisors
Presentations on the science based Grain & Graze research projects at Mallee Research Station 2007 annual field day	200 in attendance.
Roadshow presented in SA and Victoria in 2008 on the role and potential of grazing cereals.	Participation numbers not recorded.
Mallee Sustainable farming R, D & E bi-annual forum on What's the Future of the Family Farm? facilitated by Nigel McGuckian.	150 farmers and industry personnel in attendance.

The Mallee Grain and Graze program was successful in identifying and demonstrating opportunities and techniques to lift mixed farm productivity. The monitor farms program together with other research and development projects, developed and demonstrated techniques to modify feed production to better match the nutritional requirements of stock, while evaluation activities have demonstrated the level of participation and adoption of these practices by farmers.

A number of evaluation studies and activities provide evidence of improved awareness, knowledge, skills acquisition and on farm change as a result of the overall program.

In evaluation studies conducted at both national and regional level (McRoberts J 2008 and event evaluation sheets), there is strong evidence that the awareness factor of Mallee Grain & Graze exceeded the projected targets.

Total participation by Mallee farmers in Grain and Graze activities was around 2,300. While many farmers would have participated in more than one event the target participation rate of 500 would have clearly been exceeded. This is supported by information obtained from evaluation sheets completed by 58 participants at field days and farm walks from June to October 2007 where 45% of respondents had attended more than one Grain & Graze event. Extrapolating this proportion over all events would give a participation number of around 1,260 farmers.

Reports compiled by Viv Read and Associates clearly shows that the Mallee region had an impact factor of 58% (1555 of 5186 farmers were aware of Grain & Graze). This value is in line with the targets documented in the National Change on Farm strategy. Furthermore, 902 farmers participated (30%), a value in line with the Grain & Graze national goals as

anticipated by the National Change on Farm strategy which was to be reached after four years.

While it is not possible to provide specific on farm adoption rates of specific recommended practices, a number of evaluation activities conducted as part of the program provide evidence of rates of on farm change as a result of participation in the Grain and Graze program that clearly exceed the target number of 180.

Results from field day evaluations held in South Australia involving 21 farmers directly involved in SA Grain & Graze activities in 2007 showed that:

- There was a wide range of activities that farmers actively participated in.
- 71% had changed their farm planning or practices as a result of the Grain & Graze program, activities or information.
- 86% thought the Grain & Graze program, information and activities had given them confidence or confirmed that on farm decision/s they have made were the right ones
- 81% intended to change their farm planning or practices in the next 5 years as a result of the Grain & Graze program, activities or information.
- 100% said they would like to see the Grain & Graze project or similar project continue in the future.

Similarly, evaluation sheets completed by a further 58 participants at field days and farm walks from June to October 2007 showed that

- 62% had changed their farm planning or practices as a result of the Grain & Graze program, activities or information.
- 79% thought the Grain & Graze program, information and activities had given them confidence or confirmed that on farm decision/s they have made were the right ones
- 76% intended to change their farm planning or practices in the next 5 years as a result of the Grain & Graze program, activities or information.
- 98% said they would like to see the Grain & Graze project or similar project continue in the future.

Results obtained from the MSF Waikerie Field Day Grain & Graze session where 23 farmers were surveyed, showed 58% said that the Grain & Graze program, information and activities (such as the session attended) had helped them change their farm practices and planning for the future.

Further a brief questionnaire was distributed during the MSF Farmers Forum held in February 2008. Not surprisingly, 90% of respondents had heard of Grain & Graze prior to the Forum and 70% of these had attended workshops or field days. Of these, 100% rated the usefulness and quality of Grain & Graze activities they had attended as either average or high (60% high: 40% average). No respondents rated activities as low quality or low usefulness. Around 70% of respondents indicated that their involvement had improved business profitability and 60% indicated that Grain & Graze had influenced how they ran their farming enterprise.

Researchers for a national Grain & Graze Evaluation telephone survey sampled Mallee farmers (10) who had close involvement in the program i.e. hosted monitor farms or were existing steering Mallee Grain & Graze committee members (Read & Petersen 2008). The survey focused on three currently recommended practices being promoted through Grain & Graze Mallee and regional agency programs:

- Containment areas for sheep
- Sowing pastures and forage crops
- Grazing cereals

Farmers were asked about their level of adoption of any of these and the role of Grain & Graze in influencing their decisions to adopt.

The results show that 80% of respondents are either using, thinking about or trialling each of the three currently recommended practices, with around 50% currently using them on their own farms. Notably, 50% of all respondents indicated that the Grain & Graze program had helped them make decisions that enabled them to make a practice change and around 40% of farmers have changed other practices on their farms in some way as a result of their involvement.

Additional RMCG interviews with farmers who had participated in Grain & Graze activities, ranging from only minor involvement to wide ranging involvement confirmed that G&G had had substantial influence on those farmers who had been closest to it. (McRobert J, 2008). The extent of practice change as a result of the Grain & Graze program beyond this highly involved group and across the broader Mallee farming population is undetermined.

The Mallee Grain & Graze program also contributed to gains made towards catchment target levels.

Windscreen surveys undertaken by DWLBC have shown significant increases in soil cover in the Mallee, much of which is attributable to the rise in No-till cropping (up to 40%). Sown cereals for pasture can easily be no-tilled, while farmers generally work the ground coming out of volunteer pastures.

Leys *et al* (2008) reported attainment of progress towards meeting erosion levels less 50% of the 1999 benchmark and the interrelationship with Grain & Graze activities. Roadside and paddock surveys and the DustWatch program showed a reduction in erosion recorded as a resulted of continuous cropping and reduced tilth activities. Similar outcomes have been attained in Victoria (Wakefield, pers. comm.).

In the Victorian Mallee, over the past three years, there has been approximately 1500 hectares of lucerne planted through the CMA incentive program, in which the response has been variable due to the environmental constraints. Also, in the Manangatang district (Victorian Mallee) alone, saltbush plantings have increased significantly with approximately 3000 hectares planted. This is directly linked with the salinity recharge and discharge work.

Stock containment areas or drought lotting facilities (name dependant on State) has resulted in reduced soil erosion and paddock protection. In total a shift from 100 to greater than 250 farmers in the 3 states implemented containment areas on their properties.

In Victoria, the greatest strengths in the adoption of the Grain & Graze messages, was the support offered by Mallee CMA who provided financial incentives that made it possible to achieve change. In particular, these changes were the establishment of stock containment areas (drought feeding) and the plantings of either saltbush or lucerne. The research and demonstration and extension events conveyed the benefits of each of these production and environmental gains to the landholder in the region.

A farmer self-completion mail-out survey conducted during January 2008 reported tremendously positive feedback on the SCA roll out across the Victorian Mallee, whereby 98% of respondents indicated that they were happy with the process i.e. DPI provided a prompt and timely service, were understanding of clients needs, were helpful and respectful and were knowledgeable and provided good advice. A total of 78 Mallee farmers participated in the program.

Over three-quarters (78%) of Mallee respondents (representing over 50% of participating farmers) indicated that the Stock Containment Areas they had built on their properties had already resulted in production benefits. Over half were able to describe broader social and

economic benefits arising from being involved in the program, most commonly citing cleaner air, less dust and soil erosion, and better quality outputs, income and profits from their livestock enterprises (Aurora Draft report 2008).

The RMCG evaluation concludes that the Mallee Grain & Graze program provided a further vehicle for promoting the benefits and providing information to farmers using and intending to use Stock Containment Areas as part of their livestock management strategy during consecutive dry seasons. (McRobert J, 2008)

Another important factor of this project was the ability to improve farm profitability. A target of 10% was envisaged, however this was only partially achieved as the Mallee project only yielded a profitability increase of 6% (Viv Read, 2008). This was due predominantly to climatic factors throughout the duration of the project.

A further important consideration in assessing the success of a program is to assess the benefit cost (B:C) ratio of the project. The Mallee project had benefit: cost ratio analysis of 4.22 : 1 (Viv Read, 2008). In other terms, for every dollar invested into the project, a $4.22 return was seen. This was the highest B:C ratio compared to all other participatory regions. This means that while other regions that were able to achieve a profitability goal greater than 10%, they also spent more money in trying to achieve this. The Mallee project demonstrated excellent financial management options to the farming community that were cost-effective (especially during times of hardship) and could explain the large participation rate in this project.

The Change on Farm strategy recommended a number of tactics to be implemented to ensure active participation and achievement of goals. The Mallee project utilised a number of these tactics and could be a reason why the participation and adoption levels were so positive. The various methods (tactics) take into consideration the different learning styles of the participant by presenting information in a range of formats. Although a common tactic was “communication”, other more popular tactics include “training”, “mentoring and exchange” and “technology development”. These tactics were generally achieved by encompassing research sites, demonstrations and presentations from local and invited industry experts.

Plate 4. Learning from San Jolly, invited sheep expert to inform farmers on sheep nutrition needs

Plate 5. Hands-on assessments of sheep managed in containment areas.

Plate 6. Feed lotting study tour; participants looking at grain feeders and saltbush

7. What have we learnt as participants in a highly complex project/program?

Mallee Sustainable Farming Inc, together with the government agencies and farmers involved in the Mallee tri-state region, have identified a number of opportunities and improvements while participating in the Grain & Graze project. This program offered the opportunity for the first time of dedicated research and development toward improved livestock management within the Mallee, together with a holistic approach to management in terms of environmental and social responsibilities. The program has allowed for a dynamically complex concept to be investigated in the Mallee.

The project was confident in being able to address the third aim of the project, as presented in the project proposal. This was due to the participatory approach the Mallee Grain & Graze had envisaged would lead to success with practice change. The opportunities for farmers to learn from farmers in the paddock using practical on-farm techniques was thought to result in increased adoption, however, this approach appeared not to be supported by the funding agencies. There was disparity between what constituted “true” outcomes via scientific rigor, and demonstration/ monitoring without statistical data analysis as often conducted in the Mallee project. However, at the conclusion of the project there is a strong belief from the Mallee participants that there was a balance between new knowledge and existing knowledge. This is supported by the evaluation presented in the previous section of this report which clearly demonstrates that the Mallee team met communication and capacity building targets successfully with a high return on investment.

As stated in the previous pages, the Mallee proposal concentrated on an extension program to disseminate proven production and environmental outcomes to a wider community. It engaged with over 1,260 farmers (well above target) to encourage sustainable farming practices. Furthermore, adoption of these “good farm techniques” was implemented by well over the target number of 180 farmers.

Farmer participation also needs acknowledgement, in particular from the monitor farms; the level of in-kind participation was clearly understated. The effectiveness of this project component was a key driver to information transfer and the evaluation of simple and easy to adopt farm system changes that could be made to Mallee farms was seen as a real breakthrough in knowledge. It was the results that were obtained here that allowed for such high community engagement and thus uptake of profitable and environmental improvements on farm even during a drought, hence the outstanding statistics.

The initial project development was successful in approach with broad consultation between government agencies and farmers throughout the Mallee region. The pre-proposal consultative review and the formation of the steering committee should have resulted in a more targeted program; it offered input from a wide audience and in particular from the government agencies. Each government group had individual key deliverables. However, one difficulty with the tri-state arrangement was that the ground rules or expectations between each state agency differed. Individual state political agendas were followed, as was to be expected. Strong project leadership was not available at the level required and performance outputs dictated by the government agencies resulted in political confusion and a muddled goal for the region. Project management could have been improved by the steering committee and a strong overall focus would have resulted in the individual goals of each state department addressing the overarching research question. Instead it became a little disjointed rather than providing a clear goal for the Mallee region. The lack of knowledge in dealing with RIRCs from the animal industries also emphasized this.

The single biggest challenge was the impact of the drought. This made meeting all project milestones and activities difficult. This problem however was encountered by many other regions and was not without its positive benefits in the Mallee. There developed an understanding of the minimum requirements needed for pastures as well as an appreciation that mixed farming can provide a diversification of income stream and therefore a financial cushion during bad years.

The SWOT analysis clearly identified areas for continuous improvement for research, development and extension investment in the Mallee. The RIRCs involved in the project also needed to be mindful of the uniqueness of the Mallee region when comparing to most other mixed farming regions in Australia These considerations range from the natural environment to climate, farm scale, educational demographic and financial status. The Grain & Graze concept offered real value to the Mallee and there are now expectations that research and extension in the future be conducted in similar fashion and continue to concentrate on the production, environmental and social aspects of farming.

The farming community within the Mallee have already identified “knowledge gaps” from within this current project which places them in an advantageous position for future investment for mixed farming research within the region. The approach by the Mallee project that is worth endorsing is one whereby the goal is identified, then the question and methodology formulated to achieve that goal. This was found more effective than asking the question first without a firm goal or outcome in mind.

Steps to success;

1. Researchable hypotheses/ questions specific to farming community.
2. Professional officers develop hypothesis (in conjunction with key landholders)
3. Hypothesis presented
4. Methodologies/ timeframes prepared (GANTT)
5. KASA / SWOT evaluation
6. Back to farming community for consultation
7. Re-write project proposal
8. Method, staffing requirements, in-kind contributions, timeframes, budgets, agreements
9. Implementation (R,D & E)

To summarise, there are opportunities to deliver further tri-state R, D and E projects as there is general good will between the current Grain & Graze participants. However, for this to be successful, the clearly identified roles of each party need to be established early and managed accordingly. There are many advantages of working in a tri-state role; for example, the number of experienced ground staff able to participate and the knowledge of specific farm activities which can be transferred across the region to increase the number of on-farm trials implemented across the large Mallee area. Close working relationships have been developed and these relationships are being maintained. The identification of the individual strengths from state agencies are proving invaluable and these identifications will allow for better co-ordination of future R, D and E activities. Grain & Graze was a highly effective project and provided a plethora of tools that ultimately led to successful farm system changes. These changes will be continuously recognised and undoubtedly further adoption in the Mallee will be implemented.

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