

**Requirements for
land management practices information
in Queensland**

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Table of Contents

1. PROJECT OBJECTIVES	3
2. STAKEHOLDERS.....	3
3. DRIVERS FOR OBTAINING INFORMATION ABOUT LAND MANAGEMENT PRACTICES	3
3.1 INDUSTRY GROUPS.....	4
3.2 REGIONAL BODIES.....	5
3.3 QUEENSLAND GOVERNMENT	5
3.3.1 <i>Rural Leasehold Land strategy</i>	5
3.3.2 <i>State of the Environment reporting</i>	6
3.3.3 <i>Environmental Protection Act 1994</i>	6
3.3.4 <i>Reef Water Quality Protection Plan</i>	6
3.3.5 <i>Rural Water Use Efficiency</i>	7
3.3.6 <i>Land and water management plans</i>	7
3.3.7 <i>Science needs</i>	7
4. METHODS OF OBTAINING DATA ABOUT LAND MANAGEMENT PRACTICES	7
4.1 LANDHOLDER SURVEYS.....	9
4.1.1 <i>Telephone surveys</i>	9
4.1.2 <i>Surveys of individual farmers</i>	9
4.1.3 <i>Surveys of groups with common interests</i>	12
4.2 SEEKING OPINIONS FROM PEOPLE WITH APPROPRIATE EXPERIENCE	13
4.3 CROSS-LANDSCAPE TRANSECTS.....	14
4.3.1 <i>Rapid Mobile Data Collection</i>	14
4.3.2 <i>Condamine Alliance</i>	14
4.4 INTERPRETATION OF AERIAL PHOTOGRAPHY AND SATELLITE IMAGERY	14
4.4.1 <i>Ground cover monitoring</i>	15
5. PRIORITIES	16
6. CLASSIFYING LAND MANAGEMENT PRACTICES.....	18
7. ISSUES	19
8. REFERENCES	20
9. APPENDICES	21
APPENDIX 1: LIST OF INTERVIEWEES	21
APPENDIX 2: EXAMPLES OF TARGETS RELATED TO LAND MANAGEMENT PRACTICES SET BY TWO NRM REGIONS	22
APPENDIX 3: ENVIRONMENTAL SELF ASSESSMENT QUESTIONNAIRE (SAQ).....	23
APPENDIX 4: POSSIBLE APPROACHES FOR CLASSIFYING LAND MANAGEMENT PRACTICES	32
Appendix 4A: <i>Land management practices grouped based on intent</i>	32
Appendix 4B: <i>Land management practices appropriate to dealing with particular land degradation issues</i>	35
Appendix 4C: <i>Land management practices appropriate to particular land uses.</i>	36

1. Project objectives

To identify:

- the key requirements in Queensland for land management practices information with a particular focus on agricultural lands ; and
- the drivers for this information i.e. what is the information required for? Information will be sought on key land management practices that impact on sustainability, environmental and production issues. Such information could be required to address government, regional bodies and industry priorities. The information could be useful for various current and future policy, science and monitoring initiatives.
- The links between related activities and opportunities for cooperation in the collection and analysis of land use and management practice information.

2. Stakeholders

A wide range of agencies and industry bodies have an interest in obtaining information about land management practices. They include:

- Rural industry groups
- Regional NRM bodies
- State government agencies
- Local authorities
- Community groups

Interviews were conducted with a cross-section of representatives of the above groups as detailed in Appendix 1.

3. Drivers for obtaining information about land management practices

Cropping and grazing occur on 88% of Queensland's land. Management practices in this very large proportion of the state have significant impacts on the condition of land, water and biodiversity and the profitability and sustainability of agriculture.

Information on these management practices and changes over time is of importance for monitoring and reporting natural resource condition and trend and modelling landscape processes to understand the impacts of land use and management on degradation issues such as salinity, deep drainage and water quality decline.

Monitoring, in particular, is currently a very topical issue amongst community members with an interest in natural resource management community. One approach is to monitor a selection from a wide range of indicators. However, such monitoring can be costly and time consuming. Landholders need to determine how many sites they will monitor e.g. one location, several locations in a paddock, or many samples from the whole of a property? The frequency of monitoring is another issue e.g. twice yearly, annually, every 2, 3 or 5 years, or just when specific events occur. The data also needs to be well managed otherwise there is little point in collecting it. A lot of monitoring is beyond the scope of landholders e.g. measuring runoff and loss of soil and nutrients

from a paddock requires sophisticated monitoring equipment that requires regular servicing.

A much simpler (and cheaper) alternative is to concentrate on monitoring land management practices rather than to monitor specific indicators e.g. sampling water quality at the end of large catchments is often considered to be an essential indicator for determining the health of a catchment. While this measurement provides useful information about the sediment, nutrient and pesticide ‘exports’ to our, seas, oceans, and inland lakes, it provides little information about the condition of our catchments e.g. a storm causing a serious soil erosion event in a part of a catchment may not produce any runoff that finds its way to the mouth of the catchment. Sediment lost from eroding paddocks is likely to be deposited somewhere in the catchment long before it reaches the mouth of a major river.

The following sections outline the drivers for land management practices information by various interest groups as identified during the interviews for this project.

3.1 Industry groups

The manner in which our land is managed and how our food is produced is coming under increasing scrutiny by the media and the community. People need assurance that their food is produced in an environmentally friendly manner and that it is safe for consumption. Landholders, and the producer groups that represent them, are also keen to ensure that their land will remain productive, that they have a positive public image and that their products will be sought after in the market place.

Considerable progress has been made by landholders in improving land management practices, but this is generally not well accepted by the community. Good farming is sound business, get the economics right and you look after the environment. The adoption of best management practices is a ‘win-win’ solution for profitable and sustainable farming through better farm practices.

Landholders have concerns about the imposition of what often is referred to as ‘draconian’ legislation. Their hope is that by demonstrating that they have adopted sustainable land management practices, the need for additional legislation can be averted.

Governments fund a range of projects that encourage the adoption of sustainable land management practices. Given the limited availability of such funds, there is a need to target government resources to encourage the adoption of management practices where the public benefits are perceived to be large relative to the magnitude of the investment made.

Incentives can be offered to landholders to encourage them to adopt various land management practices. Such incentives include the provision of grants and special funding distributed via regional bodies. The use of Market Based Incentives could ensure that consumers pay higher prices for products that had been produced using desirable land management practices.

Organisations such as the Meat and Livestock Authority who are funded with levies from meat producers plus support from the Australian Government see the adoption of land management practices as an indicator of how successful they have been in achieving their objectives. They need to report to both the community and the government on how well graziers are managing the environment.

3.2 Regional Bodies

To achieve healthy regional arrangements in Queensland, a network of regional NRM bodies have been established. These bodies are funded under the National Action Plan for Salinity and Water Quality (NAPSWQ) and the National Heritage Trust (NHT) extension programs. The Queensland NRM bodies coordinate the views of regional communities and are responsible for preparing regional NRM plans. These plans must incorporate existing natural resource plans (e.g. water, vegetation, coastal) and fill planning and management gaps. The plans must contain targets for managing the condition of natural resources.

The implementation of regional NRM plans is assisted by funding from a variety of sources. Regional Natural Resource Management Bodies need to know about the adoption of land management practices to assist with their planning, to determine priorities and to find out how successful they are in achieving their objectives and meeting their targets.

Obtaining information about the location of different land management practices may provide the opportunity to focus attention on specific problem areas e.g. land with serious erosion problems which have significant off-site effects in relation to water quality.

Appendix 2 provides examples of targets for the adoption of land management practices set by the Far North Queensland (FNQ) and Mackay Whitsunday NRM Regions.

3.3 Queensland government

Information about land management practices will be a key ingredient of a number of programs. Examples include:

3.3.1 Rural Leasehold Land strategy

This proposed strategy is a framework for managing and using state rural leasehold land sustainably by protecting its environmental, social and economic values. It gives precedence to managing state rural leasehold land in a way that recognises economic pressures, environmental imperatives, the declining condition of the natural resource and the threat of increasing climatic variability.

The approach of the strategy is long-term and linked to natural resource management outcomes. It builds on the provisions of the *Land Act 1994* and, while it does not rely on any substantial changes to existing legislation, it does provide a major shift from the current prescriptive approach to land administration, to a performance-based and outcomes-focused approach.

Many landholders already use property-level planning because it is good practice and profitable to do so. The leasehold strategy takes a similar systematic approach to property management. A land management agreement—which includes the resource and land attribute information integral to property planning systems—is proposed to be a minimum requirement for all new long-term grazing and agricultural leases. It will describe the natural resource attributes of the land, identify inherent environmental and cultural values, establish their condition, and identify all significant natural resource management issues. It also will set out the agreed natural resource management outcomes and the associated performance indicators. In short, the land management agreements exemplify the ‘outcomes-based’ philosophy espoused in the strategy.

Under the strategy it is proposed that the Department of Natural Resources, Mines and Water will initiate a review of all land management agreements, including an assessment of land condition, at 10-yearly intervals to ensure that they remain current and appropriate for the leased land. Establishing suitable monitoring strategies and indicators will be imperative in support of this process.

3.3.2 State of the Environment reporting

A component of this reporting is to provide a ‘report card’ on a range of land degradation issues to help determine if a particular problem is increasing or decreasing. It is impractical to take sufficient measurements to determine an overall picture of the status of a particular issue, especially in a state as large as Queensland e.g. the measurement of soil loss in a single paddock can only be successfully achieved by the establishment of sophisticated measuring equipment, and since significant erosion events may occur over widely spaced intervals of 10 years or more, then any measurements would need to occur over a long period of time. A practical alternative to direct measurement of soil loss is to monitor the practices that landholders have adopted that minimise soil loss e.g. the retention of at least 30 to 40% ground cover on the soil surface and the construction of contour banks in upland cropping areas.

3.3.3 Environmental Protection Act 1994

The *Environmental Protection Act 1994* obligates everyone to care for the environment and to avoid causing environmental harm. To provide guidance to landholders in achieving this, there are codes of practice relating to various primary industries such as dairying, sugar cane and fruit and vegetable production. Environmentally relevant activities (ERAs) such as cattle feedlots, piggeries and poultry farms require the preparation of an environment management plan to guide the operation of the activity. Monitoring of certain indicators may be required to show that no adverse environmental impacts are occurring. However the adoption of appropriate management practices is generally considered to be the simplest indication that the enterprise is being managed in an acceptable manner and this obviates the need for a comprehensive system to monitor a range of indicators.

3.3.4 Reef Water Quality Protection Plan

The purpose of the Reef Water Quality Protection plan is to develop actions, mechanisms and partnerships to halt and reverse the decline in the quality of water entering the Barrier Reef World Heritage Area. The plan's focus is to improve the health

of the reef ecosystems by addressing the diffuse sources of land-based pollutants (including sediments and nutrients) from catchments that are adjacent to the Great Barrier Reef. The plan will build on existing government, industry and community policies and programs.

Specific land management practices relevant to this plan would include those aimed at providing adequate levels of ground cover in both cropping and grazing lands, fertiliser management, and management of riparian zones.

3.3.5 Rural Water Use Efficiency

Industry and government are working together to improve the use and management of available irrigation water, thereby making Queensland's rural industries more competitive, profitable and environmentally sustainable. To help farmers achieve best practice in managing irrigation water on their properties, the Rural Water Use Efficiency Initiative has developed adoption programs. The following rural industry organisations manage these programs:

- Canegrowers (sugarcane)
- Cotton Australia (cotton)
- Queensland Dairyfarmers Organisation (dairy and lucerne)
- Growcom (horticulture).

The focus of Stage 1 of the Initiative was to improve the efficiency of on-farm water use and farm productivity. Stage 2 (2004–06) includes a focus on the off-farm environmental impacts of irrigation.

3.3.6 Land and water management plans

Land and water management plans (LWMPs) describe how land and water resources will be managed by irrigators so that there are no adverse impacts on natural resources and represent a commitment by landholders to the wise use of land and water resources without causing undesirable impacts on or off farm. The plan should contain information on farming practices that will be used to maximise sustainable production and maintain a stable land resource. It is proposed that audits will be carried out to determine if irrigators have adopted the LWMPs proposed in the plan.

3.3.7 Science needs

Information about land management practices provides valuable data for use in researching a range of land degradation and water quality issues. Those issues include catchment modelling, sediment modelling, salinity risk assessment, deep drainage, crop and pasture growth models, fertility management and stream and riverine processes.

4. Methods of obtaining data about land management practices

In collecting information about land management practices, it should be recognised that there are numerous 'farming systems' in use. The list below provides some examples:

- Farm management systems (FMS)
- Environmental management systems (EMS)

- Agricultural land management systems (ALMS)
- Organic farming
- Natural farming
- Precision farming
- Natural sequence farming (NSF)
- Controlled traffic farming systems (CTF)
- Ecological farming
- Permaculture
- Low input agriculture
- Sustainable agriculture
- Regenerative agriculture
- Holistic management
- Integrated pest management (IPM)
- Zero tillage (ZT)
- Conservation cropping
- Grazing land management (GLM)
- Cell grazing
- Rotational grazing.

Getting information about land management practices is much more difficult than mapping land use! The more intensive the land use, then the more information is likely to be documented e.g. there would be considerably more land management practices applicable to irrigated cotton than there would be for extensive cattle grazing.

Options for collecting information about land management practices include:

- landholder surveys
- industry surveys e.g. fertiliser sales
- seeking opinions from people with appropriate expertise
- cross-landscape transects
- interpretation of aerial photography or satellite imagery
- audits.

The information may be spatial (e.g. mapping an area in which a certain practice is used) or aspatial (e.g. determining the proportion of landholders who may have adopted a particular practice). Land management practices may apply to an area of land such as a paddock or to a linear strip of land such as for the following:

- riparian areas
- windbreaks
- wildlife corridors
- waterways
- drainage systems
- roads and tracks

Some landholders are becoming involved in precision agriculture which can include the use of high resolution satellite imagery, Geographic Positioning Systems (GPS_ and Geographic Information Systems GIS. This enables them to easily produce yield maps and to keep an accurate record of their land management practices in a GIS based system. This enables them to easily access data about crop inputs (irrigation, nutrients

and pesticides) over a period of years. This high-tech approach is a significant change to the hard copy diary system that many landholders currently use. Such a system requires significant time to analyse and is prone to error depending on the diligence of the landholder in recording the information.

4.1 Landholder surveys

4.1.1 Telephone surveys

An example of a telephone survey is that carried out by the Meat and Livestock Authority (MLA) every two years. The questions chosen for each survey depends on their current priorities. The identification of the adoption of and attitude towards certain land management practices is a key ingredient of the survey. The data is for internal use, but relevant data is shared with other agencies.

The survey is carried out by contractors. In 2005, there were 300 graziers surveyed out of a total of 18 000 in the Northern zone (mostly in Queensland but graziers in the Northern Territory and the Kimberleys were also surveyed). A problem associated with the use of any survey based on a questionnaire is that some questions get misinterpreted e.g. in the MLA survey, some respondents quoted bull joining rates of 80% (the figure is generally <10%). The staff employed by the contractors would not be expected to question such idiosyncrasies.

4.1.2 Surveys of individual farmers

4.1.2.1 Australian Bureau of Statistics surveys

Australian Bureau of Statistics (ABS) surveys have included questions to landholders about land management practices. However surveys conducted across a broad cross-section of landholders provide limited opportunity to ask detailed questions about land management practices related to specific rural industries.

In 2005, a pilot survey about land management practices in two shires of the Fitzroy basin was conducted by ABS (Australian Bureau of Statistics 2006). This survey provided an opportunity to use more targeted questions than could be used in a national survey but the questions asked were still fairly generic e.g. the question below about control of weeds and pests would provide limited useful information and it would be difficult to monitor any significant changes if these questions were repeated at a later date.

Example question from 2005 ABS Survey in Fitzroy and Livingston Shire: *Actions to resolve weed and introduced pest problems during the 12 months ending 30 June 2004*

1. No actions
2. Use of herbicides (add the number of undiluted litres)
3. Use of pesticides (add the number of undiluted litres)
4. Slashing, cutting, pulling or mowing
5. Crop and pasture management
6. Grazing management
7. Use of biological control agents e.g. Insects

8. Burning
9. Baiting, trapping or shooting
10. Fencing and or netting
11. Preventing the spread of weeds to neighbouring properties (eg vehicle or machinery washing, creating buffer zones, weed declaration areas etc
12. Other – please specify

Landholders would be less likely to divulge information about their land management practices to an ABS survey than they would to a workshop based exercise that they had volunteered to attend. Another issue is that people may not always answer such questions correctly. They don't want to contradict what they may have said in previous surveys, or they may provide a response that they consider would provide a most favourable outcome for them. As an example it has been said that graziers may state four different carrying capacities for their property:

- when they are selling their property
- what you tell Department of Natural Resources, Mines and Water relating to pastoral leases and unimproved value of land
- one for the bank manager
- the real one.

In the future there may be opportunities for ABS surveys to obtain more detailed information about land management practices by targeting landholders in specific industries and/or within a specified area.

4.1.2.2 Cane industry

Compass

The COMPASS (Combining profitability and sustainability in sugar) program was developed by BSES in conjunction with grower organisations within the cane industry. It aims to assist canegrowers in identifying areas where they might improve their land management practices to achieve sustainability and minimise off-site impacts. As part of the program, workshops cover a wide range of farming activities including:

- fertiliser use
- soil health
- irrigation
- drainage
- business management
- pest management
- management of riparian vegetation

The COMPASS program includes a workbook where canegrowers can assess their progress in the adoption of best management practices. An on-line version is also available which automatically generates a report for the farmer and allows for the collation of data.

Canegrowers Public Environment Report 2005

The Canegrowers organisation, with funding from the Federal Department of Environment and Heritage, has commissioned an audit of land management practices in the cane industry (Wrigley 2005). The report is available on The Canegrowers web site at

<http://www.canegrowers.com.au/FileLib/Public%20Environment%20Report%202005.pdf>

The report was carried out by an independent consultant. Five percent of all farmers across all districts and all property sizes were surveyed. It focuses on benchmarking the adoption of industry best management practices by cane growers across a wide range of farming activities. Examples of results include:

- 75% of farmers have adopted green cane trash blanketing, which reduces soil loss from farms to that equal to or less than soil loss from National Parks or native pastures
- 68% of farmers undertake minimum tillage, which improves soil condition, retains organic carbon, reduces the need for fertiliser inputs and increases the water retention capability of these soils
- 71% of farmers use subsurface placement of fertilisers which reduces the potential for the volatilisation and run-off losses and 82% of farmers obtain professional advice on fertiliser rates
- there has been 20% reduction in fertiliser use by growers from 1996 to 2003
- 87% of growers maintain native vegetation buffers along riparian zones
- 74% of growers have chemical accreditation and 89% of growers mix, fill and rinse chemicals and their containers in appropriate areas
- 77% of growers recycle chemical containers
- 25% of growers have completed a COMPASS course

Canegrower Productivity Boards

Local cane growing productivity boards e.g. Mossman agricultural services, Tully cane productivity services, Mackay area productivity services, Burdekin productivity services and seven other productivity boards along the Queensland coast also collate the adoption of industry best management practice at a local and regional level.

BSES surveys

BSES extension officers are also collecting data from individual canegrowers in a structured process that involves a comprehensive survey. Targets are set to interview a certain number of growers in specified areas. This process is generating a large corporate repository of information on land management practices from which they can get information on an area such as a mill region or a catchment.

4.1.2.3 Cotton industry

Cotton Australia representatives work through recommended BMPs, mostly on a one on one basis and give growers feedback on their performance. Growers develop an action plan to remedy shortcomings. A proportion of growers (who have volunteered) get audited by Cotton Australia. Cotton Australia has employed a facilitator on the Darling Downs to encourage uptake of the process. Farrell and Johnson (2005) provide a detailed account of practices used for pest management in the cotton industry.

4.1.2.4 Horticultural industries

An audit of the practices adopted by 98 banana farmers has been carried out by GrowCom. It involved a one-on-one survey using a questionnaire. A draft report has been prepared. Similar audits are proposed for the pineapple and macadamia industries.

4.1.3 Surveys of groups with common interests

4.1.3.1 Cane industry 'shed meetings'

An example of such a technique is the use of 'shed meetings' in the cane industry. Data about land management practices have been obtained from interviews with up to 40 farmers in a group. An example of data obtained from shed meetings held in far north Queensland is provided in Table 1.

Table 1 Data obtained from cane industry 'shed meetings'

Practice	Current adoption rate %	Target adoption rate by 2010 %
Grassed headlands	75	100
Stable drains	60	100
Trash blanketing	100	100
Minimum tillage	60	90
Legume rotations	30	85
Fertiliser changes	50	90

Source: McDonald and Roberts 2006

4.1.3.2 Queensland Murray Darling Committee subcatchment groups

The Queensland Murray Darling Committee has 56 subcatchment groups. Facilitators work with the groups in discussing a range of land use and management issues. Groups discuss their current actions, preferred situations, and develop action plans to get to the preferred situation e.g. changing 1000 ha of cultivation from conventional cultivation to zero tillage.

4.1.3.3 Sustainable land management through partnerships and spatial information technology project

This project is funded by the National Landcare Program and is conducted through the North East Downs Landcare group in conjunction with Condamine Alliance and SEQ Catchments.

Information about land management practices is obtained as part of a property management planning process. Groups of landholders are each provided with a property map and workshops are held to discuss issues such as:

- Land resource information
- Land use and limitations of soil types
- Self assessment questionnaire
- Identification of the priorities based on the self assessment
- Risk assessment
- Targets and action plans

As part of the process, participants respond to a total of 100 questions (Refer to Attachment 2). The information collected is confidential and overall results are collated to obtain an overall subcatchment picture.

The groups prioritise the range of issues to be addressed from a sub-catchment perspective. A sub-catchment action plan is then developed incorporating all individual plans and proposed expenditure. Although individual scores are collated with

information from other group members to go into the sub-catchment plan, the individual scores and information is confidential and remain the property of individual landholders.

4.1.3.4 Department of Primary Industries, Local Consensus Data (LCD) project

This data was collected in the early 1990s as part of a Department of Primary Industries Project in Central Queensland and was sponsored by the Meat Research Corporation. The data was collected from meetings held with socially compatible groups of local graziers and focussed on the concept of best management practices. The project is summarised in *The Sustainable Beef Production System Project* (Clarke 1996).

Separate reports have been published for each group. The following is an extract of the topics covered in the report from the Kunwarara area in Central Queensland:

- description of local land types
- enterprises
 - breeding
 - fattening - on better land
- cattle management
 - breeds and breeding
 - bull to cow ratios
 - cows - recommended culling age
 - heifer management
 - mating
 - reproduction rates
 - weaning
 - marketing
 - herd health
 - causes of death
 - vaccinations
 - internal parasites
 - external parasites
 - supplements
- grazing land management
 - stocking rates and pasture management
 - dry season management
 - tree and woody weed management
 - fire management
 - fences and water
 - pests – e.g. lantana, rubber vine, devils fig, dingoes, pigs
 - pasture improvement
- property sizes
- research and development needs

4.2 Seeking opinions from people with appropriate experience

This technique involves the use of experienced people to assess the adoption of LMPs. They can estimate the percentage of farmers adopting a practice in a particular industry and in a particular area.

An example of such an approach is that used by the regional body, Condamine Alliance. A questionnaire has been developed and used for interviews with key industry and research personnel working in the catchment. Information was acquired on the main current recommended practices (CRPs) for each industry and their level of adoption in each industry group in various areas of the Condamine Catchment. The report, *Current Recommended Practice Report – PAP4* (Lambert and Webb 2005), outlines details of CRPs and the estimated percentage adoption of each practice.

4.3 Cross-landscape transects

Cross-landscape transects (or windscreen surveys) can be conducted by appropriately skilled people to provide information about LMPs by following a specified route in a vehicle. Two examples of such surveys are provided:

4.3.1 Rapid Mobile Data Collection

This project is coordinated by the Queensland Department of Natural Resources, Mines and Water. The data collected provides an independent condition assessment as well as calibration and validation data for remote sensing and modelling projects including the Aussie Grass project. Extensive data collections are obtained by travelling thousands of kilometres throughout grazing lands in Australia. While the data collected generally monitors land condition and that of the grazing resource, with appropriate analysis of these and other data, inferences may be able to be made about the LMPs that led to the observed condition.

4.3.2 Condamine Alliance

Two ‘windscreen’ surveys are conducted per year in October and April (beginning and end of the growing season). Each survey takes about three weeks. Observations are made on most roads in the catchment and also from elevated areas estimating the percentage adoption rate of certain practices. Photographs are taken of representative pastures in different condition and identified on maps. The survey has only covered grazing lands to date but will be expanded to include cropping.

4.4 Interpretation of aerial photography and satellite imagery

Aerial photography and high to medium resolution satellite imagery can be used to determine a number of land management practices such as the following:

- the use of contour banks and strip cropping
- paddock sizes
- grazing rotation systems
- use of wildlife corridors
- fencing of riparian vegetation
- irrigation (e.g. differentiate between centre pivot and travelling irrigation systems)
- controlled traffic farming

In the future, satellite imagery could be used to obtain information on issues such as the following:

- riparian vegetation monitoring

- mapping selected cropping management practices e.g. contour banks and windbreaks

In Queensland, high resolution satellite imagery (Spot 5 mostly) has been or is being purchased for extensive areas including the Queensland Murray Darling Basin, the Fitzroy, Burdekin, Mary and Burnett River catchments as well as South East Queensland Catchments. The main driver for this imagery purchase is property planning with the majority of funding provided by regional bodies or Geosciences Australia in most cases. However, there is also considerable potential to assess and monitor selected land management practices through automated image interpretation procedures.

There is also some work being done by the Department of Natural Resources, Mines and Water to determine if land management practices can be monitored using MODIS satellite imagery. This satellite has been capturing new imagery every one to two days since April 2000. It may be possible to use this imagery to obtain information about matters such as the following:

- frequency of tillage
- stubble levels
- weed growth
- herbicide usage (by detecting change in colour of a paddock)
- cropping frequency; and
- crop rotation systems e.g. planting of a legume crop following cotton.

4.4.1 Ground cover monitoring

To assist with the challenge of monitoring ground cover in extensive grazing lands, the Department of Natural Resources, Mines and Water is developing a ground cover monitoring tool. The tool uses imagery from the Landsat series of satellites to monitor trends in ground cover in cleared areas from 1988 to the present time. Ground cover is derived from Landsat imagery using an empirical relationship based on measured field sites across areas of western and northern Queensland.

Outputs from the project are currently being evaluated by working in partnership with graziers, regional natural resource management groups and other state government departments/agencies.

The tool can be used to determine areas with the highest grazing pressure enabling managers to more evenly spread grazing pressures across the property or to reduce overall stock numbers. It can be used to assess past and future management decisions and can assess the impact of existing property infrastructure such as fence lines and watering points. Comparisons can also be made with the cover levels on neighbouring properties and other properties throughout the district. Land resources that are most productive and those that are most susceptible to land degradation become readily apparent.

The tool is currently available for evaluation purposes to a limited number of graziers for areas in which data is available. Images can be provided showing cover levels for a property for selected years. An image can also be provided that shows the mean cover levels for selected years as well as the trend in cover levels, which indicates if cover levels are increasing or decreasing. The images are usually provided as hard copy

printouts but they can also be viewed on a computer using software that can be downloaded for no charge.

5. Priorities

An aim of this project was to find out information requirements for land management practices especially in relation to agriculture. This is an important topic considering that such practices have a very significant impact on issues related to sustainability, the environment and the livelihoods of rural people and that 88% of Queensland is used for agriculture (both cropping and grazing).

Prioritising the needs for information about land management practices is not a straightforward exercise because of the many competing interests e.g. are we more interested in practices that have an environmental or a production focus? Environmental interests are important but our economic livelihood and very survival is also pinned to the production of food and fibre products. The matter is further complicated by the potentially immense number of practices that could be considered for each rural enterprise.

The importance of a particular land management practice depends on the local environment. Land will vary in its vulnerability to a particular land degradation problem depending on a range of factors e.g. vulnerability to soil acidification depends on factors like soil type, climate, crop type and type and amount of fertilisers applied. The practice of lime application is only necessary in soils vulnerable to soil acidification which represents <1% of Queensland. Nevertheless this is an important area since it includes significant areas of land used for the production of sugar cane, horticulture and irrigated pastures.

For some issues it may be better to focus on land that is at risk of a particular problem rather than land already affected by the problem. This strategy can be appropriate to problems such as salinity.

Table 2 lists a range of practices used in the sugar cane industry and the outcomes that they impact upon. A strategy adopted in the Douglas Shire of Far North Queensland, following the gathering of data on land management practices relevant to sugar cane production was to prioritise the best management practices (BMP's) that will most likely make a difference in relation to effects on soil, water and biodiversity. Most BMP's had >70% adoption, but some were much lower than this. A reasonable question is that if such practices were so good, then why weren't more farmers adopting them? A likely reason was that these practices had more of a public than private benefit. A strategic approach is to tackle the BMPs that people were most likely to adopt and then to work out strategies for the adoption of the less popular BMPs in the longer term.

Table 2 Individual Practice Impacts on Specific Environmental Outcomes

Practice	Outcome Affected								
	Soil			Water			Biodiversity		
	Chemical.	Physical	Biological	Sediments	Nutrients	Toxicity	Water	Food	Predators
1. Soil analysis	✓	✓	✓		✓				
2. Leaf analysis	✓								
3. Less soluble fertilizers	✓				✓				
4. Rate & season of fertilizing	✓				✓				
5. Lime/gypsum application	✓	✓	✓						
6. Mill mud application	✓	✓	✓		✓				
7. Legume rotation	✓	✓	✓	✓	✓				
8. Acid sulphate treatment				✓		✓			
9. Trash blanketing	✓	✓	✓				✓	✓	
10. Trash planting		✓		✓	✓	✓			
11. Vegetated drains		✓		✓			✓	✓	
12. Grassed headlands		✓		✓					
13. Stable waterways		✓		✓			✓	✓	
14. Minimum tillage	✓	✓	✓	✓	✓				
15. Compaction reduction		✓	✓						
16. Selection of pesticides	✓					✓			
17. Minimising of pesticide rates	✓					✓			
18. Predator control (pigs, rats)									✓

Source: McDonald and Roberts 2006.

Attempts may be made to quantify the benefits of adopting specific land management practices using the concept of 'environmental metrics' (D Freebairn, personal communication). This could involve the following considerations:

- What are the Current Recommended Practices (CRP's) to improve water quality?

- What impact do these CRP's have in improving water quality (e.g. conservation tillage reduces sediment loss from a paddock by 80%)?
- What does each practice cost?
- What are the benefits – private, public?
- What is their relative impact \$/reduction in sediment
- What area are they relevant to?
- How easy to adopt?
- Are they fair?

A priority rating index can be determined for each practice based on the formula (cost of reduction/unit of the pollutant) X (area) X (adoptability) X (nuisance index + investment ranking).

From the interviews conducted there was a very strong emphasis on the need for information about practices that impact upon water quality with ground cover seen as the major indicator driving this issue. Bare ground is a liability because of its vulnerability to soil erosion and weed invasion and the impact that it has on water quality in downstream areas. It is evidence of undesirable land management practices that have allowed the land to reach such a state. The ground cover monitoring tool referred to in section 4.4.1 provides an opportunity to readily obtain data about ground cover in cleared areas on a regular basis over the vast areas of grazing land in inland Queensland. Such observations give vital clues as to how the land has been managed. Land with poor cover levels is very likely to have been subjected to excessive stocking pressure.

Besides ground cover, other priority issues that were frequently mentioned during interviews were as follows:

- Pesticide management
- Weed and pest animal management
- Nutrient management
- Soil health
- Water use efficiency.

6. Classifying land management practices

Some consideration has been given to possible approaches for classifying land management practices. Examples are provided in the Appendix 4. The following options were considered:

- LMPs grouped based on intent (Appendix 4A)
- LMPs appropriate to dealing with particular land degradation issues. Examples are provided for controlling soil erosion by water (Appendix 4B).
- LMPs appropriate to particular land uses. Examples are provided for dryland cropping, irrigated cropping and extensive grazing (Appendix 4C).

7. Issues

Some issues raised during the interviews included the following:

- Documented land management practices can be too generic for some issues and inappropriate for some landscapes and situations.
- A potential issue in working with groups of landholders is that such groups are often attended by the more progressive farmers and so the sample can be biased. In the following years you may survey the ‘stragglers’ which could indicate that adoption rates are declining when, in fact, the overall adoption rate may be increasing.
- Farmers may not be willing to divulge information to the government. People can be suspicious about the government’s motives for seeking information about land management practices especially when it is being sought by agencies with regulatory roles and where such agencies are not held in high regard by the rural community. The availability of high resolution satellite imagery has created ‘spy in the sky’ scenarios.
- Landholders are likely to be more cooperative in divulging information where they can see a potentially positive benefit e.g. providing information that may be essential for alleviating any future biosecurity threats.
- Landholders may be ‘over surveyed’ or suffering from ‘survey fatigue’ – too many requests for people to do surveys may result in similar responses that urban people have towards unsolicited phone calls. Some surveys can take a fair amount of time to complete and if done properly may require landholders to do such things as calculating areas of their property that relate to a particular land management practice or calculating how much herbicide they used on their property in a year – landholders are not likely to have all of this information at their finger tips.
- Where people receive grants, there are often confidentiality clauses, which prevent agencies such as Regional Bodies passing on specific details about a property. In the cane industry, farmer surveys have been carried out to assist with policy formulation. Wording has been included in the survey that growers are told how the information will be used and farmers indicate agreement by signature. This arrangement could preclude the provision of such information to a wider audience.
- There are some concerns about the use of terms like ‘best management practice’. People with this view believe that such practices are continually evolving and that the use of the term infers that when ‘best management practices’ have been achieved there is no further room for improvement. As an alternative, some are using the term “best management principles” e.g. soil loss will be kept to minimal levels without prescribing exactly how this should be achieved. Farmers don’t want to be told exactly what to do; they don’t want to be burdened with prescriptive legislation and regulations.
- Some questions get misinterpreted e.g. what do terms like strategic grazing and conservation cropping mean?

- An issue is how to manage the vast amount of information that could be collected about land management practices and the availability of long-term funding in order to expedite this. To obtain meaningful results monitoring needs to be carried out over an extended period in order to determine trends in the adoption of practices.

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9. Appendices

Appendix 1: List of interviewees

In preparing this report interviews were conducted with the following:

Industry bodies

- Sugar cane industry
 - Canegrowers – Tim Wrigley
 - BSES – Ross Gilmore
- Horticulture
 - GrowCom – Margie Millgate
- Beef
 - Meat and Livestock Authority – Wayne Hall and Rod Dyer

Regional Bodies

- Far North Queensland NRM - Alan Dale, John Reghazani, Bob Stewart, Diana O'Donnell (DPIF, extension project officer)
- Fitzroy Basin Association – Gavin Peck, Kristian Smith, Andrew Baldwin
- Condamine Alliance – Lucy Larkin, George Lambert
- Queensland Murray Darling Commission – Rick Kowitz
- South East Queensland Catchments - Bruce Lord, David Manning, Peter Pearce

State agencies

- Department of Natural Resources Mines and Water (NRMW)
 - Paul Lawrence (Reef Water Quality Protection Plan)
 - Dave Schmiede (Land and Water Management Plans and Rural Water Use Efficiency)
 - Ross Bigwood (project considering partnerships to achieve resource condition monitoring)
- Department of Primary Industries and Fisheries (DPIF)
 - Graham Harris (cotton industry)
 - John Grimes (Principal Catchment Ecologist, Rockhampton)
 - Lew Markey (Senior Extension Officer, Longreach)
- Environmental Protection Agency
 - Lynne Turner (State of the Environment reporting)
 - Teresa Eyre (Biodiversity issues)
 - John Bennett

Local Authorities

- Douglas Shire – Brian Roberts

Landcare groups

- North East Downs Landcare – Peter Crawford

Appendix 2: Examples of targets related to land management practices set by two NRM regions

Far North Queensland NRM Region

1. 85% of farmers in all catchments areas apply Nitrogen fertilisers as per the recommendations (incl. accounting for filter mud).
2. 50% of farmers use soil tests in every crop cycle as a method of assessing cane nutrient requirements
3. 80% of farmers apply Nitrogen fertiliser either underground or as close to the stool as possible and applied when there is the least risk of loss
4. 80% of fallow area uses either a spray out fallow or a legume/break crop (including direct drill) with green cane trash blanketing (i.e. not cultivated)
5. 30 % of farmers prepare ground for plant crops using strategic or zonal tillage and controlled traffic zones
6. 45% of farmers retain inter-row trash through minimum tillage planting of replant crops
7. 60% of farmers use a range of chemicals for weed control that enables a reduction in the use of Diuron and Atrazine
8. 60 % of farmers maintain a vegetated (including native trees) riparian zone to intercept nutrients at depth and from overland flows
9. 45% of farmers retain a trash component at all times in the crop cycle
10. 55% of farmers have a system of farming where the normal practice is not to burn the trash

Mackay Whitsunday NRM Region

1. Qualitative targets for reducing soil and nutrient loss from intensive agriculture set by 2005 (scale to be determined).
2. Farmers use an industry agreed set of management practices that reduce soil and nutrient loss and land degradation by 2008 (practices and adoption rates to be defined by 2005).
3. Improved industry extension programs developed for intensive agriculture to improve land and water management practices and support achievement of adoption targets by 2008.
4. Set interim quantitative water quality targets by 2005 in all catchments for reduced sediment and nutrient discharges achieved as a result of defined and agreed adoption rates for BMPs per industry for 2014.)
5. Reduce sediment, nutrient and chemical pollutant loads from 2005 ongoing.

Appendix 3: Environmental Self Assessment Questionnaire (SAQ)

This questionnaire is used in the *Sustainable land management through partnerships and spatial information technology project* funded by NLP and conducted through the North East Downs Landcare group in conjunction with Condamine Alliance and SEQ Catchments.

Rating Scores : 1 – no knowledge or understanding of this practice; 2 – you recognise this practice but have no plans to implement it at this stage; 3 – you have plans to implement this practice but have not done so as yet; 4 – you have commenced to implement this practice; 5 – you have fully implemented this practice; NA – this practice not applicable to your property or business				
MANAGEMENT AREA	ELEMENT OR ASPECT OF MANAGEMENT	RECOMMENDED MANAGEMENT PRACTICE	RATING	ACTION? (Tick Y/N)
1. Business and family	Family harmony	I am committed to a balanced lifestyle with designated times for families, annual holidays and social events		
2. Business and family	Profitability	I have a well documented business plan which includes a written property vision or mission statement, and a succession strategy		
3. Business and family	Profitability	I prepare and follow a financial budget each year		
4. Business and family	Profitability	I regularly analyse my financial position in regards to profitability, assets and liabilities, debt to income ratio and return on assets		
5. Business and family	Profitability	I am a member of a production group that is involved in benchmarking and maximising profitability		
6. Business and family	Profitability	I am always on the lookout to improve my business and management skills including attending training and skills workshops and field days		
7. Chemical storage, handling and application	Chemical application	Chemical containers are triple rinsed and rinsate is added to the sprayer tank for immediate use or disposal on paddocks where that particular chemical is used		
8. Chemical storage, handling and application	Chemical application	All immediate neighbours are notified of my intention to spray and the type of chemical that is to be used		
9. Chemical storage, handling and application	Chemical application	Best spray management practice is used at all times for chemical application, including monitoring of weather conditions, adhering to recommended application rates etc		
10. Chemical storage, handling and application	Chemical handling	Chemicals are secured during transport, are isolated from driver and passengers, and are not transported with animal or human foodstuffs		

Rating Scores : 1 – no knowledge or understanding of this practice; 2 – you recognise this practice but have no plans to implement it at this stage; 3 – you have plans to implement this practice but have not done so as yet; 4 – you have commenced to implement this practice; 5 – you have fully implemented this practice; NA – this practice not applicable to your property or business				
MANAGEMENT AREA	ELEMENT OR ASPECT OF MANAGEMENT	RECOMMENDED MANAGEMENT PRACTICE	RATING	ACTION? (Tick Y/N)
11. Chemical storage, handling and application	Chemical storage	I have a designated chemical storage shed that is fenced off or locked, has a bunded floor and is well ventilated and placed well away from dams or streams		
12. Chemical storage, handling and application	Chemical storage	Warning signs are placed on the outside of the chemical shed, and safety and emergency measures such as protective safety clothing, respirators and wash and shower facilities are in place		
13. Chemical storage, handling and application	Chemical storage	A record is kept of all chemicals purchased, including date of purchase, place of purchase, batch numbers and expiry dates		
14. Chemical storage, handling and application	Compliance with legislation	I do not have any banned pesticides stored on my property		
15. Climate and weather	Risk management	I use climate forecasts, rainfall records and climate decision support systems in planning management strategies in advance		
16. Climate and weather	Risk management	I plan my grazing management and stocking rates on a conservative basis in order to better manage a season turning dry		
17. Climate and weather	Risk management	I have a documented drought management plan with a range of strategies, including “trigger” indicators for herd/flock reduction		
18. Climate and weather	Risk management	I have sufficient water storage or water supply for stock and domestic use to withstand a 1 in 100 year drought		
19. Cropping	Water use	I maximise the use of rainfall in my cropping program by using tools such as water use efficiency (WUE) of crops		
20. Cropping	Crop rotation	I have a clearly defined crop rotation strategy that considers a range of factors including profit, disease, weeds, nitrogen, stubble cover, moisture storage, risk management and soil biological health		
21. Cropping	Pest Management	I use an integrated pest management strategy to minimise the use of pesticides in my crops		
22. Cropping	Salinity	I use opportunity cropping whenever applicable to reduce leakage to the groundwater system and to assist in maintaining groundcover		

Rating Scores : 1 – no knowledge or understanding of this practice; 2 – you recognise this practice but have no plans to implement it at this stage; 3 – you have plans to implement this practice but have not done so as yet; 4 – you have commenced to implement this practice; 5 – you have fully implemented this practice; NA – this practice not applicable to your property or business				
MANAGEMENT AREA	ELEMENT OR ASPECT OF MANAGEMENT	RECOMMENDED MANAGEMENT PRACTICE	RATING	ACTION? (Tick Y/N)
23. Cropping	Soil fertility	If a pasture ley phase is not appropriate to my cropping program, I endeavour to incorporate grain legumes on a regular basis in my crop rotation strategy in order to maintain soil fertility levels		
24. Cropping	Soil management	I manage crop residues to maintain maximum groundcover, and I aim to have at least 30% groundcover remaining at planting time		
25. Cropping	Soil management	I have implemented a strip cropping system in my cropping areas on flat or floodplain country wherever it is suitable or practical, and is a recommended practice for this area		
26. Cropping	Soil management	All cropping country with a slope of over 1% is contour banked, and tillage and planting operations are managed accordingly		
27. Cropping	Tillage	I plant crops using a minimum number of tillage operations and I am using a zero till operation wherever it is practical		
28. Energy use	Emissions	I regularly service all farm equipment and vehicles, and during the service procedures checks are made to ensure that fuel efficiency is maximised		
29. Energy use	Energy efficiency	I actively minimise the energy requirements for lighting, heating and cooling in the home and farm buildings		
30. Energy use	Energy efficiency	I always consider energy consumption whenever purchasing new equipment and household appliances		
31. Energy use	Fossil fuel use	I regularly monitor fuel consumption in my cropping, grazing, transport and domestic activities with the objective of reducing fossil fuel consumption		
32. Energy use	Fossil fuel use	Where possible, farming operations are conducted to enable more than one operation in one pass to reduce fuel consumption (eg chemical and fertiliser application at planting)		
33. Energy use	Fossil fuel use	I have plans to replace equipment powered by fossil fuels with renewable or cleaner energy sources whenever practical (eg wind or solar)		
34. Energy use	Fossil fuel use	I reduce losses of fuel through evaporation by positioning fuel tanks in shaded areas		

Rating Scores : 1 – no knowledge or understanding of this practice; 2 – you recognise this practice but have no plans to implement it at this stage; 3 – you have plans to implement this practice but have not done so as yet; 4 – you have commenced to implement this practice; 5 – you have fully implemented this practice; NA – this practice not applicable to your property or business				
MANAGEMENT AREA	ELEMENT OR ASPECT OF MANAGEMENT	RECOMMENDED MANAGEMENT PRACTICE	RATING	ACTION? (Tick Y/N)
35. Grazing	Grazing management	I manage my pasture country to maintain at least 70% ground cover on flat and low slopes and I aim for 100% groundcover on steep areas, with suitable pasture species		
36. Grazing	Grazing management	I have a grazing strategy that is based on a controlled short term grazing system rather than a continuous uncontrolled grazing regime		
37. Grazing	Grazing management	The overall stocking rate for my property is based on current best practice recommendations according to land type, pasture availability (supply) and pasture quality		
38. Grazing	Off-site impacts	I keep comprehensive records for my entire herd/flock to enable tracing of chemical applications, parasite treatments and other activities that could be an issue at point of sale		
39. Grazing	Parasite control	I rotate parasite control chemical groups on a planned basis to reduce the risk of resistance		
40. Grazing	Parasite control	I am actively pursuing management practices that will reduce chemical usage in my grazing operation		
41. Grazing	Pasture quality	My sown pastures always consist of perennial species and I always include a legume in the pasture mix		
42. Grazing	Pasture quality	I regularly conduct monitoring activities to assess the condition of my pastures, including groundcover percentage and the mix of desirable palatable species		
43. Greenhouse and air quality	Emissions	I only burn grassland according to a strategy which takes into account fire hazard reduction, protection of sensitive flora and fauna, weed control, and improvement in grazing species quality		
44. Greenhouse and air quality	Emissions	I never burn crop residues unless absolutely necessary to enable planting machinery to work through at planting time		
45. Greenhouse and air quality	Emissions	I have considered revegetation or agro-forestry for creation of carbon sinks where practical		
46. Greenhouse and air quality	Off-site impacts	I follow Industry Codes of Practice and guidelines to ensure that intensive livestock operations are located to reduce offensive odours to neighbours and the community		

Rating Scores : 1 – no knowledge or understanding of this practice; 2 – you recognise this practice but have no plans to implement it at this stage; 3 – you have plans to implement this practice but have not done so as yet; 4 – you have commenced to implement this practice; 5 – you have fully implemented this practice; NA – this practice not applicable to your property or business				
MANAGEMENT AREA	ELEMENT OR ASPECT OF MANAGEMENT	RECOMMENDED MANAGEMENT PRACTICE	RATING	ACTION? (Tick Y/N)
47. Greenhouse and air quality	Pasture quality	I am aware that dietary quality can have a major effect on the quantity of methane emitted by livestock and I consider feed quality as part of my grazing strategy		
48. Human resources	Workforce efficiency	I give clear verbal and/or written instructions to employees and family members for each task or duty		
49. Human resources	Workplace harmony	I provide all employees information on my business mission, goals and policies at the time of employment		
50. Human resources	Compliance with legislation	I fully meet my legal obligations as an employer including compliance with the Occupational Health and Safety legislation relevant to my state, and keep up to date with any changes in the legislation		
51. Human resources	Compliance with legislation	All family members and employees (casual and permanent) are trained or informed as to always consider potential impacts to the environment resulting from their duties and activities on the property		
52. Human resources	Compliance with legislation	The legal responsibilities and implications associated with the property business are understood by all family members		
53. Human resources	Compliance with legislation	I have conducted a risk assessment to identify all areas of potential hazard for my family members and employees, and I have emergency plans in place for incidents relating to identified hazards		
54. Human resources	Human safety	First aid kits are located in all property vehicles and areas where rapid treatment may be needed		
55. Human resources	Human safety	All family members and employees have had basic First Aid training, and this training is kept up to date		
56. Human resources	Workforce efficiency	I have a written job description to provide to all long-term employees		
57. Human resources	Workforce efficiency	I conduct a training needs assessment for all employees to ensure that employees are appropriately skilled for all tasks and duties they are asked to perform, and actively encourage permanent employees to undertake off-farm training		

Rating Scores : 1 – no knowledge or understanding of this practice; 2 – you recognise this practice but have no plans to implement it at this stage; 3 – you have plans to implement this practice but have not done so as yet; 4 – you have commenced to implement this practice; 5 – you have fully implemented this practice; NA – this practice not applicable to your property or business				
MANAGEMENT AREA	ELEMENT OR ASPECT OF MANAGEMENT	RECOMMENDED MANAGEMENT PRACTICE	RATING	ACTION? (Tick Y/N)
58. Land capability and property planning	Appropriate land use	I am familiar with the Land Capability Classification guidelines for the land classes on my property and carry out my landuse activities according to these guidelines		
59. Land capability and property planning	Appropriate land use	I have identified the different soil types on my property (depth of surface and subsoil, structure, fertility, pH, organic matter) to assist in applying the appropriate landuse to each soil type		
60. Land capability and property planning	Grazing management	I have established a stock watering point layout that encourages even grazing and minimises stock traffic		
61. Land capability and property planning	Integrated catchment management	My farm plan takes into consideration off-site impacts and local and regional catchment priorities		
62. Land capability and property planning	Off-site impacts	I recognise Council zoning and adjoining landuses and adjust management or landuse accordingly		
63. Land capability and property planning	Property infrastructure	All property infrastructure such as roads and tracks, yards, and fences have been assessed as to their location in relation to potential environmental impacts e.g. erosion from tracks on steep slopes, interference with overland flow		
64. Soil management and dryland salinity	Integrated catchment management	I am aware of the salinity hazard or potential for salinity in my catchment or sub-catchment from known data sources		
65. Soil management and dryland salinity	Salinity	I have conducted a property landscape assessment to identify sites of potential salinity hazard and risk		
66. Soil management and dryland salinity	Salinity	I have established piezometers in known or potential salinity hazard areas to enable regular monitoring of ground water levels and quality, and I regularly monitor water levels and EC levels		
67. Soil management and dryland salinity	Soil fertility	I conduct soil tests on my cropping country regularly (at least every two to three years) to determine fertility levels		
68. Soil management and dryland salinity	Soil fertility	I conduct soil tests on my grazing country periodically to determine soil fertility levels		
69. Soil management and dryland salinity	Soil fertility	I use deep nitrogen soil testing in cropping country to assess and monitor deep soil nitrogen levels and take this information into consideration when applying nitrogen fertiliser		

Rating Scores : 1 – no knowledge or understanding of this practice; 2 – you recognise this practice but have no plans to implement it at this stage; 3 – you have plans to implement this practice but have not done so as yet; 4 – you have commenced to implement this practice; 5 – you have fully implemented this practice; NA – this practice not applicable to your property or business				
MANAGEMENT AREA	ELEMENT OR ASPECT OF MANAGEMENT	RECOMMENDED MANAGEMENT PRACTICE	RATING	ACTION? (Tick Y/N)
70. Soil management and dryland salinity	Soil fertility	I use nutrient budgeting methods to assess crop or pasture nutrient requirements before applying fertiliser		
71. Soil management and dryland salinity	Soil structure	I assess cropping soils for the development of hardpans and soil structure decline		
72. Soil management and dryland salinity	Tillage	I do not cultivate under dry and windy conditions unless absolutely necessary		
73. Vegetation and biodiversity	Biodiversity conservation	I have a biodiversity management plan in place which is consistent with the objectives and targets identified in my local Landcare or Catchment Management plan and/or other regional plans		
74. Vegetation and biodiversity	Biodiversity conservation	The biodiversity values and habitat condition of all native vegetation on my property have been assessed, including the identification of rare and threatened species that may utilise areas of my property		
75. Vegetation and biodiversity	Biodiversity conservation	I recognise that native grasses and plants can comprise a valuable ecosystem, and I have measures in place to conserve quality areas of open grassland if this was Part of the original landscape		
76. Vegetation and biodiversity	Biodiversity conservation	Vegetation remnants and watercourses are only grazed to reduce biomass for fire control and to assist with weed control without degrading ground or shrub layer vegetation or creating tracks		
77. Vegetation and biodiversity	Biodiversity conservation	Dead trees and fallen branches on land and in watercourses are left to provide habitat and aid stream functioning		
78. Vegetation and biodiversity	Biodiversity conservation	My revegetation activities attempt to recreate vegetation similar to that which occurs naturally in the local environment, using local tree, shrub and ground-cover species		
79. Vegetation and biodiversity	Biodiversity conservation	Watercourses, vegetated corridors and other valuable habitat features within or next to cropping country are protected by uncropped buffer strips		
80. Vegetation and biodiversity	Riparian management	Vegetation is maintained along watercourses and around wetlands in widths according to local/state vegetation management guidelines		

Rating Scores : 1 – no knowledge or understanding of this practice; 2 – you recognise this practice but have no plans to implement it at this stage; 3 – you have plans to implement this practice but have not done so as yet; 4 – you have commenced to implement this practice; 5 – you have fully implemented this practice; NA – this practice not applicable to your property or business				
MANAGEMENT AREA	ELEMENT OR ASPECT OF MANAGEMENT	RECOMMENDED MANAGEMENT PRACTICE	RATING	ACTION? (Tick Y/N)
81. Vegetation and biodiversity	Riparian management	Vegetation remnants, riparian zones, wetlands, farm dams and watercourses are fenced off to control stock access and to facilitate controlled grazing, and alternative watering points are provided in strategic locations		
82. Waste disposal	Recycling	I have a recycling program in place for all recyclable materials used on the property, including household recyclables, tyres and batteries		
83. Waste disposal	Waste management	I do not dump landfill waste on my property, and do not treat gullies or erosion areas as landfill sites		
84. Waste disposal	Waste management	I take all waste oil to a used oil collector or to the local authority collection dump if available		
85. Waste disposal	Waste management	All animal carcasses are disposed of in an appropriate manner to prevent access to pest animals and to avoid pollution of ground water		
86. Waste disposal	Waste management	I maintain my septic system in accordance with local and state legislative requirements		
87. Waste disposal	Waste management	Intensive livestock effluent is treated and disposed of in accordance with legislative requirements		
88. Water use	Irrigation water use	Irrigation supply and drainage water is regularly monitored for salinity, sodicity, turbidity, nutrients and chemicals at appropriate intervals		
89. Water use	Irrigation water use	I take care to prevent irrigation drainage water from entering natural waterbodies, wetlands or waterways and a tail water recycling scheme is in place where appropriate		
90. Water use	Irrigation water use	I minimise water wastage by monitoring soil moisture and accurately scheduling irrigation applications		
91. Water use	Irrigation water use	I monitor my water use on the basis of units of production and financial return per megalitre and I have a process in place to continually improve my irrigation efficiency		
92. Water use	Stock water use	I have a program to check and maintain stock water supplies and delivery systems for leaks to ensure maximum water use efficiency		
93. Weeds and pest animals	Compliance with legislation	I carry out weed and pest animal control programs in accordance with the requirements of relevant state and local weed and pest animal legislation		

Rating Scores : 1 – no knowledge or understanding of this practice; 2 – you recognise this practice but have no plans to implement it at this stage; 3 – you have plans to implement this practice but have not done so as yet; 4 – you have commenced to implement this practice; 5 – you have fully implemented this practice; NA – this practice not applicable to your property or business				
MANAGEMENT AREA	ELEMENT OR ASPECT OF MANAGEMENT	RECOMMENDED MANAGEMENT PRACTICE	RATING	ACTION? (Tick Y/N)
94. Weeds and pest animals	Integrated pest management	I work with my neighbours, the local sub-catchment or landcare group, and local authorities to control weeds and pest animals on a coordinated basis where possible		
95. Weeds and pest animals	Integrated pest management	I am aware of the range of weed control methods available (physical removal, fire, chemical and biological) and use a mix of these methods in order to achieve a more effective control		
96. Weeds and pest animals	Weed management	I do not buy in any fodder or grain without a signed declaration certifying the product is weed free		
97. Weeds and pest animals	Weed management	I observe a stock withholding period in a specified area on my property whenever buying in livestock and feeding bought in fodder		
98. Weeds and pest animals	Weed management	I have a protocol in place to reduce the chance of visiting vehicles spreading weeds onto the property		
99. Weeds and pest animals	Weed management	I have a specified area for cleaning down machinery to ensure weeds are not spread to other areas on the property		
100. Weeds and pest animals	Weed management	I am aware of the potential for pest animals to spread weeds, so I monitor pest animal numbers with this in mind – I don't just look for damage to fences or crops to assess pest animal numbers		

Appendix 4: Possible approaches for classifying land management practices

Appendix 4A: Land management practices grouped based on intent

These are all ‘doing’ words where you would monitor what a landholder actually does rather than considering their reason for carrying out such a practice.

Land management practice classes

1st level - describes broad nature/intent of practice

1. Infrastructure actions/practices
2. Production system actions
3. Environmental services actions
4. Monitoring performance actions

1. Infrastructure actions (things you get when you buy the property)

2nd level – describes nature of infrastructure in more detail

- 1.1 Fences
- 1.2 Drainage practices
 - a. Laser levelling
 - b. Raised beds
 - c. Drains <0.5 metres deep
 - d. Drains 0.5 to 1 metre deep
 - e. Drains > 1 metre deep
- 1.3 Bridges/crossings
- 1.4 Pipes
- 1.5 Yards
- 1.6 Buildings
- 1.7 Roads/tracks
- 1.8 Dams/detention basins
- 1.9 Quarries
- 1.10 Silage pits
- 1.11 Contour banks and grassed waterways
- 1.12 Permanent beds/controlled traffic
- 1.13 Strip cropping (doesn't really fit under infrastructure)
- 1.14 Stock watering facilities

3rd level - describes density (per km²) or length (km per km²) of infrastructure action

- 1.1.1 <1/km²
- 1.1.2 2-5/km²
- 1.1.3 5-10/km²
- 1.1.4 10-25/km²
- 1.1.5 >25/km²

4th level – describes frequency of replacement/major upgrading (if applicable)

- 1.1.1.1 <5 years

- 1.1.1.2 5-10 years
- 1.1.1.3 10-25 years
- 1.1.1.4 >25 years

2. Production system actions

2nd level – describes action in broad detail

- 2.1 Fertilising (inorganic)
- 2.2 Tilling
 - a. Conventional tillage
 - i. 3-5 passes per year
 - 1. chisel ploughing
 - 2. disc ploughing
 - 3. rotary hoeing
 - 4. hand-hoeing
 - ii. >5 passes
 - b. Minimum tillage
 - c. Zero tillage
 - d. Inter row tillage
- 2.3 Clearing
- 2.4 Liming (includes dolomite)
- 2.5 Burning
 - a. Burning crop stubble, post harvest
 - b. Burning crop stubble, pre planting
 - c. All paddocks every year
 - d. Strategic burning
- 2.6 Irrigating
 - a. Flood / furrow
 - i. schemes to recycle tail water
 - b. Fixed sprinkler overhead
 - c. Fixed sprinkler low throw
 - d. Fixed sprinkler micro jet
- 2.7 Rotating
- 2.8 Stocking/destocking
 - a. Stocking rates (Adult Equiv per hectare)
 - b. Grazing strategy?
- 2.9 Harvesting crops
- 2.10 Spraying/fumigating
 - a. Herbicide (rate of decay/ persistence?)
 - i. Nature of application
 - b. Insecticide
 - i. Nature of application
 - c. Fungicide
 - i. Nature of application
- 2.11 Manuring/organic amendment
- 2.12 Applying gypsum
- 2.13 Stone picking
- 2.14 Applying clay amendment
- 2.15 Harvesting wood

3rd level – describes intensity of actions

- 2.1.1 no fertiliser added
- 2.1.2 fertiliser added every 5-10 years
- 2.1.3 fertiliser added every 2-5 years
- 2.1.4 fertiliser added every year - <25 kg/ha/year
- 2.1.5 fertiliser added every year - 25-50 kg/ha/year
- 2.1.6 fertiliser added every year – 50-100 kg/ha/year
- 2.1.7 fertiliser added every year – 100-250 kg/ha/year
- 2.1.8 fertiliser added every year – 250-500 kg/ha/year
- 2.1.9 fertiliser added every year – >500 kg/ha/year

4th level – describes the nature of application

- Prior to planting
- At planting
- Post planting
- Foliar application
- Fertigation
- Aerial application

3. Environmental services actions

2nd level - describes action in broad detail

- 3.1 Revegetate land with native plants
- 3.2 Stabilise gullies
- 3.3 Stabilise streams
- 3.4 Declare conservation status to land
- 3.5 Destock land
- 3.6 Destroy exotic weeds and pests in conservation lands
- 3.7 Establishment of filter strips

3rd level – describes intensity of actions

- 3.1.1 Isolated trees and shrubs planted
- 3.1.2 Trees/shrubs planted along fences and laneways
- 3.1.3 Trees/shrubs planted in areas 1-5 ha in size
- 3.1.4 Trees/shrubs planted in areas 10-25ha in size
- 3.1.5 Trees/shrubs planted in areas 25-100ha in size
- 3.1.6 Trees/shrubs planted in areas >100ha in size

4. Monitoring performance actions

- 4.1. Tree cover
- 4.2. Ground cover
- 4.3. Biodiversity
- 4.4. Soil health
- 4.5. Rainfall
- 4.6. Water quality
- 4.7. Water flow
- 4.8. Weeds
- 4.9. Pests

Appendix 4B: Land management practices appropriate to dealing with particular land degradation issues.

LMPs could be listed for land degradation issues such as the following:

- soil fertility decline
- soil erosion by water
- degraded riparian areas
- soil erosion by wind
- salinity
- soil acidification
- soil structure decline (compaction)
- weeds and pests
- soil sodicity
- mass movement
- pasture condition

The following is a list of LMPs appropriate to the control of soil erosion by water

- choosing land in accordance with its capability
- maintaining adequate levels of surface cover
 - cropping
 - avoid burning
 - minimum/zero till
 - opportunity cropping
 - use of crops that provide high levels of cover
 - grazing
 - strategic stocking strategies
 - use of watering points and paddock sizes to spread grazing pressure
- managing runoff
 - cropping
 - construction and maintenance of contour banks and waterways in upland areas
 - use of strip cropping on flood plains subject to erosive flooding
 - appropriate location, construction and maintenance of infrastructure such as roads and fences
 - pastures
 - water ponding for rehabilitation of scalded land

Appendix 4C: Land management practices appropriate to particular land uses.

1. Selection of land management practices appropriate to dryland cropping

- Using land in accordance with its capability
- Fertility management
 - Use of fertilisers
 - inorganic
 - specific types
 - organic
 - specific types
 - Method of determining fertiliser rates
 - no formal method
 - soil and plant analysis
 - use of test strips
 - Managing soil acidification
 - Use of lime
- Maintaining soil organic matter levels
 - Reducing tillage
 - Growing high yielding crops
 - Pasture leys
- Erosion control
 - Maintenance of at least 30 % cover
 - No burning
 - Reduced tillage
 - Zero tillage
 - Use of crops that provide good cover levels e.g.
 - Good cover – wheat, barley and sorghum
 - Poor cover – sunflower, cotton and chickpeas
 - Opportunity cropping - double cropping to take advantage of near full soil moisture profiles soon after harvesting a crop
 - Runoff management
 - Construction and maintenance of contour banks and waterways in upland areas
 - Strip cropping on floodplains subject to erosive flooding
- Weed management
 - Application of appropriate treatments
 - Tillage
 - Hand removal (hoeing)
 - Herbicides
 - Broadacre
 - managing to avoid herbicide resistance
 - Spot spraying
 - Biological control
 - Rotating crops to minimise vulnerability
- Disease management
 - Using resistant crop varieties

- rotating crops to minimise vulnerability
 - application of appropriate treatments
- Fertility maintenance
 - Using optimum levels of fertiliser
- Minimising soil compaction
 - Controlled traffic farming
- Reducing the risk of salinity
 - Opportunity cropping to use excess moisture
 - Healthy crops to extract as much soil moisture as possible and reduce deep drainage
- Drainage
 - subsurface
 - surface
- Management of adjacent native vegetation
- Grain storage

2. Selection of land management practices appropriate to extensive grazing

- Stocking strategies
 - set stocking rates
 - rotational stocking
 - timed controlled grazing (cell grazing)
 - seasonal or long term weather forecasting
- Use of supplementary feeding
- Fencing strategies
 - size of paddocks
 - fencing according to land types
- Pasture management
 - fertilising (rarely practiced in Queensland dryland pastures)
- Watering points
 - additional watering points can spread grazing pressure more evenly over a paddock (or provide an opportunity to overgraze the whole paddock!)
 - access of cattle to riparian areas
- Weeds control
 - use of herbicides
 - broadacre or spot
 - mechanical control
 - biological control
 - woody weed management
 - attitudes towards species which some consider to be weeds while others consider to be productive pastures e.g. buffell grass, leucaena
- Pest management
- Riparian management
- Vegetation management issues e.g.
 - mulga land management
 - gidyea encroachment into the Mitchell grass lands
 - tree thickening
- Use of exotic pasture species (improved pastures)
- Fire management

- e.g. burn during August (the ekka!)
- Production related issues
- Enterprises
 - Breeding and / or fattening
- Management
 - breeds
 - breeding programs
 - management issues related to
 - mating (bull to cow ratios)
 - heifers
 - weaning
 - culling
 - herd health
 - vaccinations
 - internal and external parasite management
 - use of supplements

3. Selection of land management practices appropriate to irrigated cropping

- Methods of application
 - flood / furrow
 - fixed sprinkler overhead
 - fixed sprinkler low throw
 - fixed sprinkler micro jet
 - schemes to recycle tail water
- Monitoring
 - use of a method that determines how much water to apply and when e.g.
 - new technology enables the continuous monitoring of soil moisture using probes, water can be switched on or off automatically
 - ensure furrows are delivering the water to the right place at the right time and there is no ponding
 - check water pressures to ensure the system is being used efficiently
 - monitoring supply channels to ensure there is no leakage
 - monitoring deep drainage
 - issues associated with chemicals, nutrients and water
 - use scheduling to avoid excess application of water
 - know your soil type - deep sandy soils versus clay soils
- Chemical application
 - pesticides and fertilisers - similar situation as for water - when and how much to apply and what product?
- Storm runoff
 - groundcover - how they manage runoff events
 - avoid bare ground in the wet season
 - tail water systems to accommodate storm run off
 - buffer areas to filter runoff
- Water harvesting (collecting over land flows and pumping into ring tanks)
 - managing the storage (use it or save it?)
- Drainage
 - subsurface
 - surface

- Chemical storage, handling and application
 - storage security and location
 - store location
 - drum disposal
 - distance of mixing /loading area from streams, dams and wetlands
 - spill control facilities
 - communication with neighbours and spray contractors