Sustainability and economics in wheatbelt farming: achieving an integrated balance

Summary
Advice to growers on sustainability issues has often neglected economic considerations. This project addressed that deficiency for several sustainability issues (soil salinisation, herbicide resistance and soil acidification). A second strand of research focused on the human dimension to sustainable agriculture. It included studies of grower adoption of sustainable practices, growers’ attitudes, and grower monitoring of sustainability indicators, such as ground water levels in piezometers. The project included a comprehensive and innovative communication and implementation strategy.

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The information contained in these older reports is now several years old, and may have been wholly or partially superseded or built upon in subsequent work funded by GRDC or others. Readers should be aware that more recent research may be more useful for their needs. Findings related to agricultural chemical use are also potentially out of date and are not to be taken as a recommendation for their use.

Conclusions
Among the many conclusions, the following are highlighted:

1. Salinity
   - The economic values of off-farm benefits from on-farm salinity management are generally much smaller than previously appreciated. Salinity is often best managed on a local scale, rather than a catchment scale, particularly in Western Australia (WA), but also in many areas of other states.
   - The role of policy mechanisms to directly influence on-ground salinity management (e.g. market based instruments, regulation, and subsidies) should primarily be limited to selected high priority locations, not the whole landscape.
   - The on-farm economic benefits from salinity prevention are low relative to the direct costs and benefits of perennials.
   - Protection of most agricultural land (and some dispersed public assets) from salinisation will primarily depend on the development of profitable perennial land use options. This requires research and development (R&D) as a key element.

2. Herbicide resistance
   - The value of delaying the onset of herbicide resistance by early adoption of integrated weed management (IWM) strategies is negative in many cases. However, once resistance has developed, IWM is essential.
   - Selection of IWM strategies is very complex and highly situation specific, and is greatly assisted by using a decision support tool such as Ryegrass Integrated Management (RIM).
   - Inclusion of an occasional pasture phase in the crop sequence to help manage resistance is more profitable than traditional shorter crop-pasture rotations on soils where cropping is dominant.

3. Adoption of sustainable land uses
   - Lack of awareness of salinity is probably not a major factor in explaining slow and low adoption of the recommended practices. Rather, the major factors relate to the economic costs and benefits of current treatment options, the difficulties of trialling the options, long time scales, externalities, and social issues.
   - Moral persuasion and peer pressure can be very useful in raising grower awareness, but should not be relied upon to achieve adoption of innovations that are not clearly beneficial to the individual grower.
   - In some cases, a key problem in achieving adoption is uncertainty about the technology caused by not demonstrating its value quickly and/or convincingly enough. This is especially true for slow, indirect effects, such as impacts on the water table.
   - In general, growers have high levels of knowledge about salinity and its treatment, although their perceptions appear to be overly optimistic on a number of aspects of the problem. As a group they are highly uncertain about the extent of, and rate of increase in saline land, and they highlight the complexity, modest effectiveness and relatively poor economic performance of available treatment options.

4. Sustainability indicators
In many cases, the value of continuing to monitor an indicator would fall over time as knowledge and understanding increase. For this reason, even successful programs to promote monitoring by growers may have a limited life expectancy. If monitoring an indicator is to be valuable to a grower, the indicator must be related to management options that make a difference in achieving the grower’s objectives. However, if the achievement of objectives is very sensitive to management choices, the optimal choice may be so obvious that there is little value in collecting further information about it. It is not possible to conclude that monitoring indicators is, in general, a beneficial practice.

**Recommendations**

Many recommendations (for various stakeholders) emerged, and were widely communicated. Many are directly implied by the conclusions presented above.

Below are a number of other recommendations of a 'big picture' nature. Some are specific to a particular issue, while others arise from a consideration of the project as a whole.

1. Do not have excessive expectations of programs such as Landcare and the National Heritage Trust (NHT) that rely on awareness raising and partial subsidies for on-ground works. What is really needed to deal with the biggest natural resource management (NRM) issues is new land use options supporting new industries that are profitable and deliver environmental benefits in a win-win fashion.

2. In designing R&D, be careful to maintain an appropriate balance between research to understand the problem and processes, and research to develop new technologies to manage the problem. There is a tendency in the NRM area to focus on the former to the detriment of the latter.

3. Similarly, maintain an appropriate balance between research and extension. In the NRM area, there is a tendency to focus on extension at the expense of research, in the mistaken belief that the solutions are already known. Often there is a more pressing need to focus on development of appropriate technologies. If this is not done first, the extension will be of very limited effectiveness.

4. Programs for monitoring of sustainability indicators need to focus on small numbers of indicators that are of direct relevance to reaffirm management decisions, rather than the type of long lists of indicators that appear in most discussions of the issue.

5. Economic aspects of resource degradation issues have been shown to be absolutely central to understanding the issues and their management. This particularly includes farm-level economics, which are often mistakenly belittled as somehow inferior to economic analyses at the catchment scale. In reality, the two are complementary.

6. Options for making use of salinised resources are very important, particularly in environments where prevention or remediation of salinity is impossible. Returns on research, development and extension (RD&E) in this area are likely to be high.

7. Effective analysis of most sustainability certainly requires a multidisciplinary approach. Conclusions from work that does not take such an approach should be treated with considerable caution.

A wide range of additional recommendations are contained in the written papers of the project.

**Outcomes**

**Expected Outcome (benefits)**

**Economic Outcomes**

The project has had and will continue to have a range of benefits, particularly economic and environmental but also potentially in the long run, social benefits.

One prominent benefit will be more effective use of public funds spent on salinity. To the extent that the project's findings are acted on, it will result in a substantial reduction in wasteful and ineffective spending that has been typical of salinity policies up to now. There is good reason to expect that the effectiveness of the project in this area will be high, as evidenced by the following quotes from policy makers and policy advisers.

"Your research provided the sound economic and social principles that underpin the State's Salinity Investment Framework, that has recently been endorsed by Cabinet. ... Your articulate and powerful presentations to the State Salinity Council were instrumental in achieving the necessary shift in policy thinking that will enable more strategic, cost-effective investment."
Paul Vogel, A/Director, Environmental Policy Unit, Dept Premier and Cabinet, WA.

“Your wise counsel while participating in innovative policy development committees and inquiries for Government and community action will have a long-term impact on salinity management and Natural Resource Management in Western Australia.” Garry English, WA Farmers Federation.

“You provided the committee with a big-picture view of the issues which was challenging but at the same time easily understood. ... Your input will be a significant contribution to the Committee’s parliamentary report.” Pam Allen, Chairman, NSW Legislative Committee on Salinity.

“The work was influential at the highest levels of policy as well as with natural resource managers in the field. Overall, the SEA Project was one of the most successful that I have ever known.” Dr Don McFarlane, Director, Resource Management, Water and Rivers Commission, WA.

“New South Wales Treasury has found the work published under this project, by yourself and others, extremely valuable in developing our thinking on natural resource management issues. The SEA Project has injected much needed objectivity, practicality and realism into the discussion. The project has been particularly successful in conveying the available scientific, economic and social information on these issues together with associated policy implications in a manner that is readily accessible to decision makers.” Kevin Cosgriff, Executive Director, Resource Allocation, New South Wales Treasury.

“I think that the project has made a significant contribution to environmental policy in the last 3-4 years. This statement applies at the national level.” Alistair Watson, Freelance Economist, Melbourne.

“I have no doubt that your group, through the SEA Project, has influenced not only industry attitudes towards sustainability, but also national policy agendas, particularly in respect to dryland salinity.” Richard Price, National Manager, National Dryland Salinity Program.

A second category of benefits will result from the influence on the attention paid to technology development as a better policy approach than Landcare and NHT. The Cooperative Research Centre (CRC) for Plant Based Management of Dryland Salinity provides an example of potential benefits in this category. Estimated net benefits from the CRC over 50 years included the equivalent of $34million per year from protection of farm land from salinisation and $46million per year from productive use of saline land.

In addition, a detailed economic analysis of a bid to extend the CRC via a ‘supplementary bid’ to include animal issues estimated the following additional benefits (over the whole 50 years, not per year):

A discount rate of 8% (in real terms) over a time frame of 50 years is assumed. Results are as follows:

Grazing of perennial pastures in recharge areas, $229 million; grazing of saltland pastures, $53 million; both (assumed additive), $282 million.

The present values of benefits of salinity prevention attributable to this supplementary bid are as follows: protect additional 2% of agricultural land, $22 million; accelerate that protection by two years, $30 million; both (not additive), $55 million.

It is not claimed that all these benefits are attributable to this project. However, it is claimed that (a) results of the project played a significant role in galvanising support for the CRC bid, and in making the case for the CRC in the application, and (b) the policy environment has been significantly influenced in Australia, making it much more likely that efforts such as these will be supported in the long run.

A third category of benefits is direct financial benefits to growers through uptake of tools and recommendations from the project. Most prominent in this regard is the RIM spreadsheet, which has been particularly beneficial to WA growers. There have been 243 copies of the software sold, and 15 workshops held with growers and agronomists. The number of workshops will soon increase markedly with the inclusion of RIM in TOPCROP workshops.

Indicative of the potential benefits from using RIM, it was found that economic returns can be markedly influenced by the type of IWM strategy growers use. As one example from many, Marta Monjardino in her PhD project (which extended ryegrass RIM to include wild radish as an additional weed) found that when costs and benefits of weed control were considered within the overall evaluation of crop and pasture sequences, these specified rotations in the eastern wheatbelt of WA would
provide the following economic returns (annuity) over a 20 year period: PPWW, $84/ha; BPWW, $76/ha; BPPWW, $73/ha; BPPPPPWW, $76/ha; BLWW, $117/ha; BLWW, barley cut for hay, $108/ha; BLWW, green-manured lupins, $106/ha; BLWW+ PPP, $113; BLWW+ PPP, barley cut for hay, $103/ha; BLWW+ PPP, green-manured lupins, $105/ha.*

*P = pasture, W = wheat, B = barley, L = lupins.

It is stressed that these results apply to a particular scenario, and would change for a scenario with, for example, a different herbicide resistance status. This highlights the value of RIM for tailoring treatments to a particular farm situation.

**Environmental Outcomes**

Environmental benefits will arise from the project in a number of ways:

(a) The project has influenced the policy agenda and created a greater awareness that effective protection of assets from salinity requires such a high level of land use change that any funds used to support such change need to be tightly focused and prioritised onto top priority assets. This will result in more effective protection of these assets.

(b) The role in facilitating and advocating for technology development (e.g. the CRC) will see environmental benefits as a result of the wide uptake by growers of new commercial perennial land uses over large areas.

The types of benefits will include:

- Protection of biodiversity.
- Reduction in stream salinity.
- Reduction in flood risk due to lowering of water tables.
- Protection of infrastructure assets such as roads.

The role in generating these benefits is somewhat indirect, so estimating their magnitudes is difficult in the extreme. However, it can be stated with confidence that the project will have significant ongoing benefits in these areas.

**Social Outcomes**

One key benefit, which might be considered to be social is the support that the project has given to a number of students. In particular, the following research students have been supervised by members of the project:

(a) PhD

Kington, Elizabeth. 1996-2001. Why is Dryland Salinity Still a Problem in W.A. Agriculture?


Winter, Tennille. 2002-. Economic Policy Instruments for Dryland Salinity

(b) Master of Science


(c) Master of Science in Natural Resource Management

Don Cooper, 1998-1999. Economics of Oil Mallee Industries in Western Australia.

Glenn, Nicole, 1997-. Economics of Lime Application to Manage Soil Acidity.

(d) Undergraduate student projects

As well as providing supervision, the project has provided these students with a vital and stimulating work environment as part of a top class team. They have been strongly supported to make presentations of their work at conferences, and their work has been extensively featured within SEA News.

The recommendations of the project should also lead to long term social benefits, particularly as a result of development of new industries to address salinity. The WA Government’s Salinity Taskforce, which made extensive use of the project’s analyses, reported to government in 2001 as follows:

“New industries based on perennials will generate social benefits to rural regions, resulting from greater wealth and employment. This includes the potential to introduce new industries such as bio-energy, bio-fuels for transport, aquaculture and wood products, as well as maintaining existing industries such as wool and meat production with the introduction of perennial pastures.

“In all likelihood, the salinity-related benefits from new industries based on perennials will be small relative to the total of other benefits of such industries, which will include profitability, diversification, regional development and broader environmental benefits. Nevertheless, salinity provides an imperative to pursue this approach, since large-scale salinity prevention on farmland is probably not achievable by any other means. Salinity provides the primary impetus to Western Australia to review its agricultural land use.”

Thirdly, social benefits will arise from an enlightened policy approach, by reducing the tendency to support messages that encourage landholders to take up expensive new land use options that have not been properly evaluated, and may not be in the interests of the individual growers, or the broader community. Such an outcome is disheartening for growers, short sighted from a government perspective since it burns up good will, and ethically highly questionable. This issue was broached in one of the most commented on papers: Pannell, D.J. (2000). Ethics in dryland salinity management and policy, SEA Working Paper 2000/04, Agricultural and Resource Economics, University of Western Australia, (in SEA News issue #7).

Achievements/Benefits
Overview of Project Achievements

Project aims were:

1. Generate information of value to growers, research organisations and policy makers regarding the appropriate role and usage of sustainability indicators on and off-farm, economic values of sustainability-related research and, impacts of government policies on agricultural sustainability.
2. Develop simple decision aids for growers on sustainability-related management problems.
3. Enhance knowledge and understanding of the interaction between sustainability and economics among growers, extension staff, scientists, science funders and policy makers.

Contracted outputs

1. Applied knowledge on issues related to sustainability and economics in agriculture. One aspect is R&D aimed at identification and promotion of farming practices that are both economic and sustainable, focusing particularly on dryland salinity, herbicide resistance and soil acidification. The second aspect, building on the foundation of the above practical problems, is work of a more general nature. Relevant aspects of government policy were addressed, research methods and models were developed and rationalised, problems were prioritised, complex conceptual issues were clarified, and grower attitudes and behaviour were studied, including grower adoption of sustainable farming practices, and grower monitoring of sustainability indicators.

2. Decision support tools on herbicide resistance and water use and a strong communication strategy to deliver results of the project, including a web-based newsletter, were produced three times per year.

Outcomes and benefits: Benefits include improved profitability and sustainability of farms grappling with the sustainability problems studied. This occurred directly (e.g. through improved decision making from use of the RIM decision support tool for herbicide resistance) and indirectly (e.g. through influence on extension agents, other researchers and policy makers). The project has generated community wide benefits through improved environmental quality and improved cost-effectiveness of public funding, particularly for salinity.
Highlights

(a) Web site: Project outcomes have been distributed widely via the web-based newsletter, SEA News. Thirteen issues were distributed throughout the duration of the project. In total 58 relevant articles were published along with five additional articles relating to policy, six identifying ideas and lessons on sustainability from overseas and four focused on research and methodology (see Attachment). More than 1,100 subscribers have received each issue of SEA News, and there have been tens of thousands of hits on articles in the SEA News web site each year (estimated average of more than 50,000 hits per year). Unsolicited emails reveal great satisfaction with SEA News by readers.

“SEA News is arguably the best source of economic information relating to natural resource management in Australia.” Mike Young, CSIRO Land and Water.

"Have just read SEA News #5 and really impressed by the links between eco and socio-eco.” Peter Stephen, U of Melbourne.

“Thanks for the latest version of SEA News (Issue #10). It’s always full of stimulating articles.” Graeme Olsen.

“I think your articles and approach are very useful.” Daniel Connell, Media Liaison, Murray-Darling Basin Commission.

“Just read your paper 2000/04 (Ethics and Salinity) and was, again, impressed. Congratulations.” Neil MacLeod, CSIRO.

“Keep up the stimulating work please!” Phil Price.

“Thanks for another excellent newsletter. It is a valuable resource for me because of its relevance to that strange brew of agronomy, sociology and economics that is the real world (of agricultural sustainability).” Brett Robinson, CSIRO.

“Thanks Dave. As usual, a most interesting document.” Peter McKerrow, National Farm Forestry Facilitator.

“Thanks for continuing this fine publication.” Dan Carter, Agriculture Western Australia.

“I find this newsletter particularly useful.” Bernie Wonder, Deputy Secretary, AFFA.

“The Grains Corporation should be very appreciative to have their name attached to a project which is producing the type of work you have produced in the newsletter.” Jim Lewis, Futureprofit (PMP in Queensland).

(b) Workshops conducted with extension staff in regional centres on salinity, risk and farm management. Workshops with growers on herbicide resistance using the RIM model.

As evidence of the value of these workshops, results from a survey of growers (49 respondents) who attended recent workshops in the Esperance region (about half of the workshop involved a hands-on session with RIM) were presented.

How would you rate the value of attending the workshop? Scale (1: no value at all to 7: extremely valuable) - Average 6 out of 7.

How would you rate the relevance of the workshop to your farm management? Same scale - Average 6 out of 7.

Has the workshop changed any of your perceptions of any aspect of herbicide resistance management? 76% said yes

Do you think that you may change your crop-weed management as a result of attending the workshop? 63% said yes.

(c) RIM: The RIM decision support tool for integrated management of herbicide resistance was launched publicly in October 1999. It received wide media coverage and was the basis for a number of workshops involving growers, resellers and scientists. Up until August 2002, 243 copies of the software had been sold. RIM allows users to explore any feasible combination of chemical and non-chemical weed control methods, for a user-specified sequence of crops and pastures over a period of up to 20 years. Users are able to explore questions such as: How much income could I lose once resistance develops? Which combination of strategies provides the best overall management system for me once resistance is present? Is it worth trying to delay the onset of resistance by using herbicides less frequently? Is a particular treatment (e.g. green manuring) a profitable practice?

Subsequent to its initial release, RIM has been extended and enhanced in response to requests from growers, scientists and...
extension specialists, with key input from the WA Herbicide Resistance Initiative (WAHRI). The latest version is being included as a key part of a TOPCROP workshop on herbicide resistance to be delivered to grower groups across WA.

Another key improvement to RIM is the inclusion of a perennial pasture option, and of recharge indicators, to allow the model to be used to evaluate strategies for the joint management of herbicide resistance and recharge related degradation processes, particularly salinity.

Anonymous surveys of growers and advisers have revealed a high degree of satisfaction with RIM:

“Generally, I hold the program in very high regard - very well done.”

“The number of times I mention the program [to grower clients] would be in the hundreds.”

“It is a very good tool. All agronomists should use it to make growers aware of this problem.”

“Have found it a valuable management tool. Easy enough to use, and the results coming out of it are realistic enough to give it credibility.”

(d) Detailed analyses of issues in management of herbicide resistance:

- Review of IWM methods and impacts.
- Economic comparisons of alternative IWM systems.
- Economics of early adoption of IWM versus waiting for resistance first.
- Economics of pasture phases for resistance management.
- Economics of green manuring and haying as components of IWM.
- Research on impacts of grower workshops (including RIM model) on grower adoption of IWM methods.

All of these studies were completed in collaboration with scientists and students of the WAHRI.

“Collaboration between yourself and us at WAHRI has been very productive. As a result of your leadership in the development of bio-economic models there is now the ryegrass RIM, wild radish RIM and two species RIM models. I am convinced that this would not have been achieved without the fruitful collaboration between Pannell and WAHRI!” Stephen Powles Professor and Director, WAHRI.

(e) Salinity: Many activities related to dryland salinity have been completed:

- A detailed review explaining low grower adoption of salinity prevention technologies.
- A study of grower monitoring of piezometers, exploring why growers do or do not monitor.
- An important review of farm-to-farm impacts of salinity management with the important finding that farm to farm impacts are much less important than often believed.
- Analysis of policy needs and policy failings for dryland salinity.
- Studies of the economics of perennial plants for salinity prevention, particularly lucerne and oil mallees.
- Economic policy instruments for salinity management.
- Statistical methods to analyse groundwater trends and effects of land use change on recharge.

“Thanks for writing the paper ‘Salinity Policy: A Tale of Fallacies, Misconceptions and Hidden Assumptions’. As a revegetation worker of many years I think it is spot on and I hope that it can be promoted and used to influence policy. Keep up the good work.” Greg Dalton, SA.

(f) Extensive input into policy debate and policy development for salinity. Considerable effort was put into influencing policy directions in WA and nationally. The success in this arena is very exciting and widely appreciated, as is evident from letters sent by key people involved in salinity policy. A number of quotes from these letters are included in the outcomes section.

(g) Sustainability indicators. Studies of the economic value of monitoring sustainability indicators, the factors influencing the value of different indicators, actual grower monitoring of groundwater depth as an example indicator for salinity, and growers’ attitudes to that monitoring and their assessment of its value and limits.

This work has been very influential. For example, a workshop with interested scientists was organised in Queensland (QLD) specifically to study one of the papers in detail (Pannell D.J. and Glenn N.A. (2000). A Framework for Economic Evaluation and

(h) Adoption of sustainable practices. Reviews of adoption in relation to sustainable practices generally, and adoption of particular practices for management of salinity and herbicide resistance. Grower surveys of adoption of and attitudes to those practices.

The response to this work was also very strong. In response to demand, a separate web page devoted to the work was developed.

Other research

“The research on salinity (by the SEA project) has set the agenda for economic and biophysical research on this issue in Australia.” Gary Stoneham, Chief Economist, Department of Natural Resources and Environment, Victoria.

Many of the R&D opportunities that have been identified in the project have already been picked up in a variety of ways. The key one is the existence of the CRC for Plant-Based Management of Dryland Salinity. This CRC has picked up on the pressing need identified in this project to develop profitable perennial land uses to effectively deal with salinity on the required scale. The CRC is addressing a wide range of biological, physical, economic and social issues relevant to salinity. In preparing the proposal for its funding, likely benefits from the CRC’s planned R&D were estimated. Estimated net benefits over 50 years included the equivalent of $34 million per year from protection of farm land from salinisation and $46 million per year from productive use of saline land.

Beyond this, many projects influenced by the SEA project are planned or underway, including studies of actual or potential new perennial options at the farm level, catchment-level studies of economic impacts from revegetation, policy design and evaluation, market prospects for new products from perennials and social issues related to salinity. Further work on the potential synergies between salinity management and herbicide resistance management will be undertaken in a PhD funded jointly by the Salinity CRC and the Weeds CRC. The SEA project has also strongly influenced the thinking of bio-physical scientists in the plant breeding and farming systems programs of the CRC and of CRC management.

The need identified for high quality information on the farm-level economics of salinity treatments over the widest possible area was recognised by GRDC and funding provided to Ross Kingwell (Department of Agriculture WA) and Andrew Bathgate (New South Wales Agriculture) for a national project, which is proceeding well.

The high value of the RIM model as a research and extension tool has been recognised by the WAHRI. It is being used by postgraduate students and scientists to study a range of issues in integrated weed management. It is also being used as a key part of grower workshops, including TOPCROP workshops. Ongoing support for these activities with RIM is recommended.

A number of other R&D opportunities that have not yet been pursued exist. They include:

- A study of the factors that influence uptake of policy innovations by policy makers.
- Investigation of innovative extension methods that help make groundwater impacts and other underground processes more visible to growers.
- Further development and extension of the statistical method developed to analyse groundwater trends from bore data. It has considerable potential as a practical tool for grower groups. It is much cheaper and more direct than other methods to measure recharge.
- Improved methods to efficiently prioritise public investments for environmental protection at a regional or state scale.
- Collection of information to progress such prioritisation decisions.

Intellectual property summary

Most of the IP of the project is placed in the public domain by the process of publication. The RIM model is protected by copyright and distributed by WAHRI.

Additional information

Attachment
Detailed list of communication activities and outputs of the project.