

Economic Assessment of Agricultural Pollution Management Options in Sugar Cane  
Production in Queensland: A Case Study Involving a Dugong Protection Area

Thesis submitted by

Ben JACOBSEN

BEC (Hons) JCU

March 2004

for the degree of Master of Economics  
in the School of Business  
James Cook University

## STATEMENT OF ACCESS

I, the undersigned, the author of this thesis, understand that James Cook University will make this thesis available for use within the University Library and, via the Australian Digital Theses network, for use elsewhere.

I understand that, as an unpublished work, a thesis has significant protection under the Copyright Act and I do not wish to place any further restriction on access to this thesis.

---

Signature

---

Date

## Abstract

Sugar cane production inevitably creates off-site environmental impacts. This thesis addresses the joint production of an agricultural good and environmental externalities and investigates options to manage transboundary effects. Sugar production activities upstream of a marine protected area may alter the natural setting and impose costs on individuals and society that are not offset by commensurate increases in benefits. Expanding the Burdekin River Irrigation Area in North Queensland to supply the Molongle Block would bring areas adjacent to Upstart Bay Dugong Protection Area under cane production with the potential to create net social costs. Irrigated cane production might introduce dry season flows and pollution carried by water, affecting the ecological value of dugong (*Dugong dugon*) habitat. The thesis examines why environmental damage might occur in the coastal region and explores some of the mechanisms that might be used to better minimise problems. The original contribution is an economic analysis of Dugong Protection Areas, identifying appropriate mechanisms for intervention.

A case study of potential cane production adjacent to Upstart Bay is used to explore agricultural pollution mitigation policy options. Constructed wetlands are one option, employing biological processes to mitigate agricultural pollutants. The problem of handling variable loading rates to avoid intertemporal ineffectiveness would lead to high cost mitigation. Controlling the timing of pollutant loadings via retention ponds may be a more cost effective alternative. Retarding dry season flows and first flush events for release in subsequent high flow events is expected to provide reductions in environmental impacts. Subregional retention ponds allow for effective coordination of the timing of wastewater releases and may also have economies of scale advantages.

Integrating agricultural production and ecological criteria in economic analysis of policy options revealed shortcomings in available datasets. Gaps in knowledge constrain a full evaluation of mitigation policy, but reflect a situation commonly encountered in natural resource management. Some existing planning tools could be used as a basis for pollution mitigation. The *Coastal Protection and Management Act 1995* might be used to strengthen the environmental aspects of land and water management plans required by the *Queensland Water Act 2000*. Property level drainage outflow points may allow for effective monitoring of water quality. The strategic location of drainage outflow

points in a new irrigation development could address measurement problems hindering effective responses.

Instruments which might be worthwhile interventions include traditional regulatory approaches and market based instruments. Instruments such as tradeable permits linked to a regional mitigation infrastructure have the potential to further reduce the pollution risk at the lowest social cost. The first challenge in establishing a marketable permit system that creates an incentive to reduce pollution is the setting of limits for the aggregate quantity of pollution permissible.

In considering the potential implications of the case study for the sugar growing industry as a whole, more parameters become relevant for policy analysis. A whole of catchment approach similar to the Productivity Commission investigation of policy options for water quality and the Great Barrier Reef lagoon (2003) provides a framework to address complex land use issues affecting the land-marine interface. It is argued that policy options that inherently create incentives to reveal private information aligning private interests with desired environmental outcomes and allow for site variability must feature as part of the abatement policy mix. Finding ways to lever community capacity to implement policy options and ensure desired environmental outcomes through adopting some targeted regulatory options remains the challenge for agricultural pollution mitigation policy.

## Table of Contents

	Page
Statement of Access	ii
Abstract	iii
Table of Contents	v
Acknowledgements	vii
Statement of Sources	viii
Electronic Copy	ix
Chapter 1 Economics and the Environment	
1.1 Introduction	1
1.2 New Development	2
1.3 Environmental Impacts	3
1.4 Externalities and Protected Areas	4
1.5 Managing Externalities: Agricultural Pollution Mitigation Policy	5
1.6 Outline of Thesis	5
Chapter 2 Economics of Marine Protected Area Management: Why Mitigate Transboundary Effects	
2.1 Introduction	9
2.2 The Environment: a Public Good or a Common Pool Resource	9
2.2.1 Valuing Environmental Goods and Services: Ascribing Importance	12
2.3 Externalities	14
2.3.1 Agricultural Production Externalities	17
2.4 Protected Area Management	19
2.4.1 Marine Protected Area Management	20
2.5 Conclusion	21
Chapter 3 Land Development for Cane Production in a Coastal Environment: A Case Study	
3.1 Introduction	23
3.2 Dugong Protection Areas: Marine Protected Areas for Dugong Habitat Conservation	23
3.2.1 Dugong and Seagrass: An Introduction	23
3.2.2 Protecting Dugong Habitat	25
3.3 Selecting A Case Study of New Agricultural Development	27
3.4 Key Features of Molongle Block and Upstart Bay Dugong Protection Area	27
3.5 Conclusion	32
Chapter 4 Agricultural Pollution, Pollution Pathways and Potential Impacts	
4.1 Introduction	33
4.2 Pollutants of Interest	33
4.3 The Seagrass Community in Upstart Bay	35
4.4 Potential Agricultural Development Adjacent to Upstart Bay	37
4.5 Irrigated Agricultural Pollution Mitigation Alternatives	37
4.5.1 Constructed Wetlands	41
4.5.2 Retention Ponds	43
4.6 Irrigated Agricultural Pollution Mitigation Scale	43
4.6.1 On-farm Water Storages	43

4.6.2 Regional Treatment Facilities	44
4.7 Conclusion	45
Chapter 5 Policy Perspectives	
5.1 Introduction	46
5.1.1 Data Limitations	47
5.2 Economic Framework	47
5.2.1 Property Rights	51
5.2.2 Information Asymmetry	51
5.3 Assessing Mitigation Policy Options	52
5.3.1 Direct Regulation	53
5.3.2 Incentives and Subsidies	54
5.3.3 Information and Extension	56
5.3.4 Endorsed Voluntary Self Regulation	57
5.3.5 Education and Incentives	53
5.3.6 Market Based Instruments	58
5.3.6.1 Competitive Tendering	59
5.3.6.2 Tradeable Permits	60
5.3.6.3 Wetland Banking	64
5.3.7 Summary of Policy Options	65
5.4 Conclusion	66
Chapter 6 Water Quality and the Great Barrier Reef	
6.1 Introduction	67
6.2 Water Quality in the Great Barrier Reef Lagoon	68
6.3 Policy Options	70
6.3.1 Nutrient Sensitive Zones	70
6.3.2 Auctions	71
6.3.3 Compulsory Industry Implemented Best Management Practices	72
6.4 Implementing Abatement Options	72
6.5 Features of Policy Implementation	74
6.6 Political Processes	76
6.7 Conclusion	76
Chapter 7 Summary and Conclusions	
7.1 The Context of This Study	78
7.1.1 An Overview of the Study	78
7.2 Future Research Directions	81
7.3 Conclusions	82
References	86

### Acknowledgements

Firstly I would like to thank the Cooperative Research Centre for Sustainable Sugar Production (CRC Sugar) for providing a scholarship to conduct this research in 2000. The objective of the Masters project was to provide an economic assessment of agricultural pollution management options in sugar cane production in Queensland involving Dugong Protection Areas as a case study. My personal circumstances have constrained the timely production of this research, and although the CRC Sugar no longer exists, I will endeavour to extend my findings to sugar industry representatives.

Secondly to Thilak Mallawaarachchi, formerly a Senior Natural Resource Scientist at CRC Sugar, who, in so many ways, provides leadership in making economic investigations germane. I wish to thank him for the personal integrity that takes and his commitment to continuing professional development, I find it inspirational.

Thanks also to Associate Professor Owen Stanley, who has provided practical support and encouragement when I needed it most.

## STATEMENT OF SOURCES

## DECLARATION

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

The following publications and communications have been derived from this work:

Jacobsen, B., 2002, “An Economic Analysis of Agricultural Pollution Mitigation Policy: Towards Protecting the Near Shore Marine Environment in New Development”, National Student Essay Award Winner, Environment Institute Australia Annual Conference, Brisbane, 31 July – 2 August.

Jacobsen, B. and Mallawaarachchi, T., 2002, “Issues in the Implementation of Pollution Mitigation: A Case Study of Potential Expansion of the Sugar Industry in North Queensland”, paper presented at 46<sup>th</sup> Annual Conference of the Australian Agricultural and Resource Economics Society, Canberra, ACT, 13-15 February.

Jacobsen, B., 2001, “Issues in the Implementation of Nonpoint Source Pollution Mitigation: A Case Study of Potential Expansion of the Sugar Industry in North Queensland”, poster paper presented at Sustaining our Aquatic Environments – Implementing Solutions, Townsville, November 20 – 23.

Jacobsen, B., Lukacs, G. and Mallawaarachchi, T., 2001, “The Economics of Constructed Wetlands for Pollution Mitigation: A Case Study in the Burdekin River Irrigation Area”, paper presented to Fourth International Conference on Geochemistry in the Tropics, Townsville, May 7-11.

Jacobsen, B. and Mallawaarachchi, T., 2001, “Policy Issues in Protected Area Management: An Examination of Dugong Protection Areas”, paper presented at 45<sup>th</sup> Annual Conference of the Australian Agricultural and Resource Economics Society, Adelaide, South Australia, 23 - 25 January.

---

Signature

---

Date



## Electronic Copy

I, the undersigned, the author of this work, declare that the electronic copy of this thesis provided to the James Cook University Library is an accurate copy of the print thesis submitted, within the limits of the technology available.

---

Signature

---

Date