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WRITINGS IN AGRICULTURAL ECONOMICS

**A Collection of Published Papers Presented in
Application for the Degree of Doctor of Science at Massey University**

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Declaration

I declare that the material to be examined in this thesis has not been submitted by me to any other university for the award of any degree.

Statement of Authorship

This thesis comprises 24 papers published in refereed journals, and five chapters published in books. Three of those chapters are taken from books of which I am the sole author. I am sole author of nine of the 24 journal papers, and senior author of all but four of the remaining 15 papers and of the remaining book chapters.

For papers and book chapters of which I was senior author, I was responsible for initiating and planning the research, conducting much if not all of the quantitative analyses, and for much of the writing. Of the four papers in which I was not senior author I was responsible for economic analysis in paper 1.2, for initiating, planning, and writing up for papers 3.7 and 3.12, and for a contribution to data and writing up of paper 3.10.

Acknowledgements

The published research submitted in this thesis spans my research career at Massey University since the early 1970s. There are many colleagues whose guidance, knowledge and support have been of great benefit and encouragement to me.

Perhaps the first to be acknowledged should be my co-authors whom I have had the privilege and pleasure of working alongside during my career. Their contributions are recognised by authorship or by acknowledgements in the various papers. I am especially grateful to the late Dr Don McKenzie for encouraging my application of economics to experimental research in horticultural science, to my numerous colleagues in Southeast Asia for stimulating my interest in that region's agriculture (see papers 3.1 and 3.3), to Professor Tom Hertel (Purdue University) for continual encouragement and guidance in applied general equilibrium modelling in agriculture, to Dr Anna Strutt (Waikato University) for our continuing collaboration in applied general equilibrium research, and to Dr Hengyun Ma (Zhengzhou Agricultural University) and Ms Xiaohui Zhang (Ministry of Agriculture, Beijing) for fuelling my interest in China's agricultural economy.

The progress and eventual quality of a research career is influenced in many ways by one's former teachers, and especially those whom one worked closely with during postgraduate studies. In my case, I acknowledge the profound influences of Professor Will Candler (during my masters research) and the late Professor John Dillon and Emeritus Professor Warren Musgrave during a very enjoyable doctorate study period at the University of New England, Australia. Colleagues at Massey University have over the years helped mold the direction and outcomes of my research career. The late Dr Eric Ojala first sparked my interest in trade policy and in the agriculture of the Asia-Pacific region, which was to play such a dominant role in my research career from that time. Emeritus Professor Robert Townsley was a valued guiding mentor, and our many long discussions allowed me to benefit hugely from his professionalism and intellect, especially in the field of production economics and mathematical programming, and in the application of that material to horticultural farm management. But many other colleagues also helped in various ways in my research endeavours, including Emeritus Professor Alan Frampton and Mr Alan Ward. I also wish to acknowledge the valuable assistance given over the years from the many administrative staff with whom I have worked.

Finally, but far from least, I sincerely acknowledge the support of my wife, Yvonne, that has been offered in countless ways over the years.

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Introduction

The thesis includes 26 papers and two books.¹ The latter are represented by one chapter selected from the first book and two from the second. The selected publications are presented in four chapters, each representing a particular stage of my research career.

The first chapter includes selected research outputs in the area of Horticultural Economics. I joined Massey University in 1971 to develop and teach courses in horticultural management and horticultural economics. These courses did not exist at that time, and were viewed as important additions to the university's programmes in horticulture. The majority of this research was published in the 1970s. My first textbook (*Crop Management Economics* published by Crosby Lockwood Staples in the UK in 1977) reflected my approach to teaching 'farm management' to horticultural students, and I used that text in my classes. From its 14 chapters, I include one in this thesis, on the use of production functions in horticultural management analysis. This, and also much of the remainder of the book, was significant since at the time of publication little if any literature was available anywhere on the specific applications of production economics to horticultural production.

Another emphasis during this period was developing linkages with horticultural scientists within the then Department of Agriculture and the Department of Scientific and Industrial Research, to encourage the use of economic analyses in the design and interpretation of horticultural production experimentation. The McKenzie and Rae (1978) publication is an example of this work and demonstrates the economic superiority of semi-dwarf apple production, that has become the dominant system in use in New Zealand.

During my teaching of horticultural management, I (with a colleague) developed a computerised management game to illustrate various aspects of crop management, enterprise selection, budgeting and decision-making under risk, and Rae and Oppenheim (1983) summarise this work – the first application I know of that used computerised gaming in the teaching of horticultural management.

¹ Rae, A.N. 1977. *Crop Management Economics*, London: Crosby Lockwood Staples.

Rae, A.N. 1994. *Agricultural Management Economics: Activity Analysis and Decision Making*, United Kingdom: CAB International.

My research into horticultural economics extended beyond management to markets, trade and policy. These fields are represented in this chapter with publications that include one of the earliest models of horticultural supply response (Rae and Carmen 1975) which was also novel in that it incorporated the adoption process of a new technology (semi-dwarf apple production systems), the first published paper on the market behaviour and supply diversion strategies of a horticultural producer marketing board (Rae 1978), a policy paper on New Zealand's guaranteed pricing scheme for apples (Rae 1976) that examined pricing efficiency and the issue of price versus income stabilisation, and a horticultural trade policy paper (Rae 1988) that addressed voluntary export restraints and the UK import apple market, again the earliest in its field.

The second chapter is devoted to my second book, *Agricultural Management Economics: Activity Analysis and Decision-making*, published by CAB International in the UK in 1994. During my time as a teacher of horticultural management, and from my study of published work in farm management generally, I became increasingly dissatisfied with the way in which production economics theory was utilised in farm management teaching. Typically, textbooks would have some introductory chapters on principles from production economics theory, followed with farm management analysis but without establishing strong and meaningful linkages between theory and application. I consider the approach I took in this book to be significant since all of its included techniques of applied management analysis were firmly rooted in the theoretical underpinning of the earlier chapters. I was substantially influenced by the earlier work of Longworth and Menz² and built my approach on what appeared to be the largely forgotten contribution of Georgescu-Roegen³ on activity analysis. This thesis includes two chapters from this book. The first introduces the concept of activity analysis, and the idea of activities as flows of inputs producing flows of outputs. Such 'production activities' are the basic building blocks of all the decision models developed in later chapters. The third chapter of this book introduces economic analysis within the context of activity analysis, using a spreadsheet framework for activity analysis – an early published example of how to use computerised spreadsheets in farm management analysis.

² Longworth, J.W. and Menz, K.M. 1980. Activity analysis: Bridging the gap between production economics theory and practical farm management procedures. *Review of Marketing and Agricultural Economics* 48: 7-20.

³ Georgescu-Roegen, W. 1972. Process analysis and the neoclassical theory of production. *American Journal of Agricultural Economics* 54: 279-294.

The third thesis chapter contains a selection of my published research on Asian agri-food markets, policies and trade. My interest in the study of Asia intensified in the 1980s after my appointment (in 1985) as International Coordinator of the Livestock and Feedgrains Study Programme of the Pacific Economic Cooperation Conference (PECC), followed in 1988 with a 5-year term as International Coordinator of the PECC Task Force on Agricultural Policy, Trade and Development. These positions involved me in the organisation of Pacific Rim research networks to address identified issues, and the organisation of annual conferences to explore that work within the tripartite (government, business and academic) structure of the PECC. Rae et al. (1992), Rae (1992) and Rae and Kasryno (1993) drew on that involvement and an Asian Development Bank study that I coordinated on livestock and feedstuffs policies, incentives and comparative advantages in Southeast Asia, perhaps the first investigation into this topic. These papers are of significance since they quantified for the first time the impacts that a country's policies regarding feedgrains and other livestock feedstuffs can have on the incentives facing Asian livestock producers – cases were revealed where assistance to feedgrain producers provide disincentives to the production of livestock products.

Research into changing patterns of food consumption in Asian countries led to four included papers - Rae (1997) examines the trend toward livestock products in national diets and Rae (1998) is the first publication that quantifies the importance of urbanisation on the increased consumption of livestock products in Asia. It can be noted that these publications drew attention to burgeoning demand for livestock products in Asia prior to the popularisation of the “livestock revolution” by IFPRI researchers.⁴ Rae (1999) uses detailed household survey data from Indonesia to measure the importance of several socio-economic characteristics of households in explaining differences in household food consumption patterns and nutrition outcomes; household expenditure and the level of women's education are shown to be the most influential in this explanation. Ma, Rae, Huang and Rozelle (2004) look specifically at China, and measure the influence of income growth on the demand for milk and various meats among both urban and rural households using a regional dataset that was augmented to include away-from-home consumption. As rural and urban incomes continue to grow, consumption shares of milk, aquatic products and poultry are expected to rise while that of pork will decline.

⁴ Delgado, C., Rosegrant, M., Steinfeld, H., Ehui, S. and Courbois, C. 1999. *Livestock to 2020: The Next Food Revolution*. Food, Agriculture, and the Environment Discussion Paper 28, International Livestock Research Institute, Washington DC.

The global beef market is segmented, depending on whether or not foot-and-mouth disease (FMD) is endemic in the exporting country. The research reported in Rae et al. (1999) was motivated by the prospect of parts of Latin America being declared FMD-free and therefore able to access the North American beef market, and examines how this might impact on New Zealand's competitive position in that and other markets.

Rae and Hertel (2000) use a global economic trade model (GTAP) to explore how different growth paths in Asia-Pacific livestock productivity might influence competitive outcomes in regional and global food markets, including the issue of whether countries will import feedgrains or meat products. Productivity in livestock production has been proceeding quite rapidly in some Asia-Pacific countries, but less so in others, and will impact on evolving national comparative advantage. Livestock productivity convergence is examined and projections are made for incorporation into the trade model.

More recently, my research into Asian agri-food markets has gained a focus on China. Five papers from this program are included here, in addition to the livestock demand paper mentioned above. The emphasis in three of these papers is productivity growth in China's livestock sector. Nin-Pratt et al. (2004) extends the work of Rae and Hertel (2000) by using a more refined approach to productivity measurement and its decomposition into technical change and catching-up components, Rae et al. (2006) measures for the first time not only total factor productivity and its growth in China's livestock sector, but obtains separate estimates for the beef, dairy, pig and poultry sectors. Ma et al. (2007) extend that work to a segment of China's milk production industry that is relatively large-scale and of growing importance – suburban dairy production. Rae (2008) summarises much of his work (and that of others) on the impact of the 'livestock revolution' on China's mainly-smallholder agriculture and its trade in livestock products, this being initially presented as the Presidential Address to the Australian Agricultural and Resource Economics Society annual conference in 2008. Rae and Zhang (2009) note that China's livestock sector was booming during the 1990s to the extent that market corrections eventually led to the exit of large numbers of producers from this industry. They use household survey data to explore the relationship between livestock specialisation and household income and some predictors of household exit from livestock production, and an identified policy concern is the exit of larger-scale specialised producers of livestock.

The final chapter of the thesis addresses my research into agricultural trade policy, using the techniques of applied general equilibrium analysis. This broad program of research involved the further development and application of a general equilibrium model of the global economy named GTAP (the Global Trade Analysis Project of Purdue University, USA). My work has focused on agricultural trade policy and policy reform. Three of the papers (Rae 2002; Rae and Strutt 2004a and 2004b) address the ongoing Doha Development Agenda negotiations in the World Trade Organisation, and simulate possible outcomes of those negotiations (tariff, export subsidy and domestic assistance reforms). The unique contribution of Rae (2002) is that it draws attention to the declining importance of grasslands livestock systems (relative to intensive feeding systems) in global livestock production and trade. This paper examines barriers to trade in livestock products and shows these barriers to be generally much higher for products from livestock that can be raised on grasslands compared with industrial non-ruminant meat products. This has contributed to the declining importance of grasslands in livestock production and trade. Possible WTO trade reforms are simulated and shown to promise a boost to grassland livestock farming. Trade reforms inclusive of grasslands products can moderate the downward trend in grasslands' share of global production and trade. Rae and Strutt (2004a) quantify the possible benefits to the New Zealand economy from a successful outcome to the Doha negotiations. Increased foreign market access and the rapid phase-out of other countries agri-food export subsidies were found to be high priorities for New Zealand. Rae and Strutt (2004b) address the complex issue of domestic support to agriculture. A hypothesis is that the negotiation resources allocated to this component of the negotiations is out of proportion to the likely benefits. This paper shows that reductions in domestic support to agriculture indeed would be relatively ineffective in contributing to global agri-food market liberalisation.

Several developing countries seek to develop food processing industries as part of their economic development strategies – that is, adding value to their agricultural raw materials. But these efforts can be thwarted if potential export markets provide protection to their own food processing industries. But other issues, which are explored in Rae and Josling (2003), are the developing countries own tariff barriers to agri-food imports, and protection of their own industrial sectors. The paper measures effective protection rates of food processing in a number of developing countries, that would be lowered should these countries reduce their tariff barriers against agri-food and industrial imports. It is concluded that trade reforms in

developing countries are about as significant as those in high-income countries in contributing to growth in processed food exports from the developing world.

The final two papers of this chapter are part of an ongoing programme of research into trade reforms, agriculture and the environment. Rae and Strutt (2001) examines WTO Uruguay Round agricultural trade reforms and their impacts on gross nitrate emissions from livestock farming, in New Zealand and globally. Using a modified GTAP trade model it finds that trade reform actually has the potential to reduce global nitrate emissions as livestock production is relocated from intensive production regions to those that are less-intensive. But in the absence of improved environmental policies the aggregate environmental impacts of growth and structural economic change is likely to be of much greater consequence than reform of trade policies to those concerned about environmental damage. Rae and Strutt (2007) further develop this work by extending it to all farm production rather than just livestock, recognising national milk quotas in some regions, and price-induced substitution in crop production between fertiliser and land as well as between purchased livestock feedstuffs and land inputs in livestock production that can alter the intensity of crop and livestock production. The environmental indicators were also extended to the use of nitrogen balance measures and indicators of farm intensification. A modified GTAP model is used to simulate possible Doha trade reforms on regional nitrogen balances and changes in the intensity of agro-chemical use in OECD countries. Trade reforms led to an improved nitrogen balance at the aggregate OECD level. Regions with high nitrogen surpluses per hectare are shown to experience some improvement in this environmental indicator. Cropping becomes less chemical-intensive in some OECD countries, but more so in others.

In recognition of my “sustained contributions in advancing economy-wide analysis of agricultural and trade policies through innovative GTAP research application”, I was elected by Purdue University as a GTAP Research Fellow for 2003-2006, and again for 2007-2010.

In recognition of my contribution to agricultural economics in New Zealand, I was elected Honorary Life Member of the New Zealand Agricultural and Resource Economics Society in 2009.