Australian Agribusiness Forum

Sydney - November 13th 2002

Session A - Proceedings

Sponsored by;
Agriculture Fisheries and Forestry - Australia
Ridley Corporation
The Rural Industries Research and Development Corporation
The Grains Research and Development Corporation
Westpac

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Abstracts

The experience of New Zealand agricultural co-operatives in accessing global markets

Romuald Rudzki, Massey University New Zealand

The paper examines the operations of Fonterra (dairy industry), and Zespri (kiwifruit) in foreign trade. Case studies are provided and key elements critically examined with conclusions drawn. A comprehensive literature review is included.

The internationalisation of agricultural co-operatives – A source of conflict?

Ignacio Donoso, Massey University New Zealand

The paper examines through a summary of a comprehensive literature review the internationalisation of agricultural co-operatives globally. The review covers recent research on the areas of agricultural co-operatives, business internationalisation theory, and internationalisation of co-operatives, therefore representing a comparison of the similarities and differences between the general business literature -mostly based on the internationalisation of investor-oriented firms (IOF)- and the agricultural co-operatives specialised literature in the topic of internationalisation. Starting with a review of the traditional definition of co-operatives and their unique characteristics, the paper covers areas like: the emergence of new co-operative models, reasons for internationalisation as well as the barriers to it, forms of internationalisation adopted by co-operatives, and potential conflicts that can arise. The paper introduces two New Zealand organisations, Fonterra Co-operative Group –a dairy pure co-operative-, and Zespri Group – a kiwifruit hybrid co-operative- and examines through publicly available information their situation with respect to internationalisation.

Impacts of swine FMD outbreak in Taiwan on import demand for Australian beef

Hui-Shung (Christie) Chang, School of Economics, University of New England

In March 1997, a FMD epidemic broke out in Taiwan and within four months 40 percent of pig population was wiped out. The demand for pork fell substantially following the outbreak due to food safety concerns. Because pork consumption accounted for almost one third of total meat consumption in Taiwan, averaging 40 kg per person per year, for more than a decade, a significant reduction in pork demand could be expected to lead to an increase in consumption of other meats, including beef. Further, because more than 90 percent of beef consumed in Taiwan is imported, mainly from Australia, New Zealand and the United States, a possible move towards beef seems to present an marketing opportunity for all beef suppliers to Taiwan, including Australia.

The objective of this study is to determine the impact of the FMD outbreak, as well as other demand shifters, on the demand for Australian beef in the Taiwan market. The findings will be useful in the development of marketing strategies by the Australian beef industry to improve market position. To achieve the research objective, demands for beef imports from Australia, the United States and New Zealand were estimated econometrically based on monthly data from January 1990 to December 2001. The major finding was that the FMD outbreak had little impact on the demand for Australian beef export to Taiwan; New Zealand and the United States fared only slightly better.

Animal Product Consumption Trends in China

Dr Zhang-Yue Zhou - Asian Agribusiness Research Centre, University of Sydney Orange

Since 1978, China's livestock sector has grown rapidly. Total meat output (including pork, beef, mutton and poultry) reached 61 million tonnes in 2000, 5 times the output in 1978. Outputs of milk and eggs reached 9.2 million tonnes and 22.4 million tonnes in 2000, about 7 and 9 times the corresponding output in 1978.

Cost of production on New Zealand dairy farms; the impact of feed conversion efficiency and milk price.

Nicola Shadbolt, College of Science, Massey University

Traditionally, New Zealand dairy production has been based on high pasture utilization at high stocking rates, which resulted in low animal performance. Recently, a group of farmers in New Zealand gradually changed their production policy to a high production per hectare system achieved through high animal performance. These farmers concluded that this objective could be obtained by decreasing stocking rates and utilizing supplements strategically, while still maintaining efficient pasture utilization. In a pastoral system the highest proportion of cost of production is that related to growing grass. If more grass is better utilised through improved management practices, the cost per kg of milksolids is reduced. Research on these farms identified a range of feed conversion efficiencies indicating varying feed utilization of the combined pasture and supplement diet. Comparative analysis between these case study farms and the more traditional systems identified differences in average cost of production and other key performance indicators. With a 30% drop in price for 2003, the paper analyses the impact of this on each system.

Efficiency Measurement of Australian Dairy Farms: National and Regional Performance

Mary Graham, School of Economics, Deakin University

The dairy industry is a major growth industry both in terms of value of output and as a major value adding and export industry. A nationwide survey of dairy farmers in 2000 conducted for the Dairy Research and Development Corporation, provides the data base to which the linear programming technique, Data Envelope Analysis (DEA) is used to explore the distribution of productive efficiency in the industry across Australia and also within individual dairy regions. The efficiency scores attained will vary depending on the size of the sample and the inputs selected in estimating the production frontier. In addition, regions vary in size and scale of operation and this raises the question as to what is the appropriate scale. This can vary from one region to another. The paper explains the linear programme and estimates the productive efficiency of dairy farms for all Australia and for individual regions. Regions are also examined in terms of scale of operations to see if there is justification in the move towards bigger dairy production units than currently exist, given their factor mix.

Dairy farmer decision aid for investment in fodder conservation equipment.

Lloyd Davies, Economist, NSW Agriculture, Tocal.

Dairy farming margins are generally small and the pressures to adopt new technologies to reduce costs are increasing. Purchased feed costs is the major variable cost in dairying and currently averages 15 cents per litre or around 60% of variable costs and 40% of total operating costs. Converting surplus spring pasture production or specialist fodder crops into silage or hay for feeding out in times of pasture shortage is a key strategy considered by farmers to reduce fodder costs. However, a new fodder conservation strategy usually involves considerable machinery investment and other changes on the farm. A spreadsheet model has been developed to help farmers evaluate whether the projected benefits are greater than all of the additional costs, including the overhead costs. The model allows the user to enter all relevant work rate and cost information and evaluates the proposed system using a partial budgeting approach.

Climate and Weather Services for Agriculture

Ian Muirhead, Bureau of Meteorology

"The north wind is best for sowing seed, the south for grafting"

For many centuries weather folklore such as this has been used to aid decision making in agriculture. The trouble with weather proverbs is not so much that they're all wrong, but that they're not all right for all times in all places (Spencer, 1954). Improvements in science and technology have both improved the accuracy with which weather fundamental to farming can be forecast, and opened up a range of new products to improve efficiency and reliability within the agricultural sector – from crop planning to the marketing of produce. This paper discusses a number of products and services available from the Australian Bureau of Meteorology which have application in agriculture, and discusses the direction of potential advances in the next few years. Historical climate data, Forecasts and observations, Seasonal outlooks, Special services for agriculture, Weather risk prediction, Interaction with the agricultural community. The paper will conclude with a brief presentation of selected case studies to illustrate some current applications of weather and climate information in agriculture. The talk will end with a short discussion on the latest developments in the El Nino cycle.

StockPlan - A drought decision tool for graziers

Lloyd Davies, Economist NSW Agriculture, Tocal

StockPlan is a suite of computer decision support tools that enable cattle and sheep producers explore management options in the early stages of drought and during drought. The main aim of these decision tools is to assist producers make management decisions, which minimise the environmental and financial impacts of drought. Management options are explored through three StockPlan tools: *Drought Pack*, *Im Pack* and *FSA Pack*; and helpful advice through seven StockPlan links: Introduction, Decision-making Process, Drought and Over Grazing Issues, Animal Health and Welfare, Climate, Bob's Story and "Where to get help". An optional hot key is also available to connect users to the NSW Agriculture Drought Web site. *Drought Pack* provides a 'user-friendly' snapshot of the financial consequences of management and feeding strategies for sheep and cattle enterprises through a projected period of limited pasture. *FSA* looks at the likely financial consequences of feeding, selling and agisting a specific class of stock. *Im Pack* is a herd or flock model that can plan and track stock numbers up to 10 years in advance. It calculates breeding numbers, the numbers available for sale their impact on the cash flow.

Who can help the Australian sugar industry?

George Antony, CSIRO Sustainable Ecosystems, Tropical Landscapes Program

The Australian sugar industry's latest crisis is more than another temporary price downturn: the Brazilians are riding roughshod in the export markets, environmentalists are circling at home, and governments are much cooler about offering cash assistance than they used to be. Who can help the industry, then ? We argue that only the industry can help itself, through major restructuring, and there are promising options for doing so. In better times, preference for pervasive industry regulation caused potential gains to be missed. Now it may lead to bankruptcy if it prevents the adoption of new ways. Up until the mid-1990s, the Australian sugar industry was the international leader in technology and costs, making most of such component-oriented improvements as new varieties and harvesting technology that did not require systemic changes. However, these are no longer sufficient to maintain international competitiveness, as they do not address costly inefficiencies in the supply chain. Advances in whole-of-system analysis and a build-up of region-wide industry data have created new analytical capabilities to support better supply-chain integration, with the promise of quick returns. Applying a broader perspective, horizontal integration with other activities in the region has the long-term promise of creating more flexible diversified farming and processing systems. These could achieve higher value adding, improve the economic efficiency and resilience of sugarcane-based production systems and, contrary to received wisdom, enable win-win outcomes from pro-active environmental management.

The experience of New Zealand agricultural co-operatives in accessing global markets

Dr Romuald E. J. Rudzki and Karla Davidson,
Massey University
New Zealand

1. Introduction

It is essential to understand the importance of history in shaping agriculture within New Zealand. Sinclair (2000) describes the development of the country which began with the first migration to the islands between 1100 and 1400 AD by Polynesians seafarers who called the islands Aotearoa (Land of the Long White Cloud). Early evidence of agrarian communities can be seen in the kainga (villages) with their neighbouring kumara plantations. Westernisation of the islands occurred following their sighting in 1642 by Dutchman Abel Tasman who named them Nieuw Zeeland after the Dutch province of Zeeland. His attempts to land were rebuffed by Maori warriors who killed a number of his crew. The subsequent exploration and mapping of the coastline by the English Captain James Cook in 1769, 1772 and 1776 and his contact with Maori led to his claiming the islands for the British Crown. The Dutch East India Company in their search for the great southern continent had funded Cook, which had been predicted. With the establishment of Australia as a penal colony, New Zealand was attractive firstly to sealers and then to whalers, who introduced the worst aspects of pakeha (white man) influences to the Maori population including firearms, prostitution and alcoholism. Armed with the new muskets, Maori tribes engaged in inter-tribal warfare with devastating effects leading to a declining Maori population.

The attractiveness of the lush and fertile New Zealand contrasted to the hot and arid landscape of Australia with waves of land speculators, farmers and sundry other groups moving to colonise the islands. Of these, the most significant was Edward Gibbon Wakefield, a social theorist who wanted to use New Zealand as the testing ground for his theory of “scientific colonisation” by preserving English class structures of the village by transferring a cross-section of society but without the “dregs” at the bottom. He hoped thereby to recreate the rural idyll, which would ensure continued land ownership by the gentry and continued labouring by the working class who would be unable to purchase land due to its high cost relative to the income produced.

It is estimated (Harper et al, 1998) that “Between 1839 and 1847, the New Zealand Company dispatched nearly 19,000 settlers and established them in “planned settlements” in Wellington, Wanganui, Nelson and New Plymouth. This was the core of pakeha immigration, with the only substantial non-Wakefield settlement being Auckland.” (P.765).

Orange (1992) provides a detailed account of the signing of the Treaty of Waitangi in 1840. This defining moment in New Zealand history saw the Maori chiefs surrendering sovereignty to the British Crown in exchange for citizenship, privileges, and duties enjoyed by British subjects as well as land and fishing rights in perpetuity. Maori were only allowed to sell land to the Crown who would then sell it on to the purchasers at substantial profit. The Wars that followed (Bellich 1988) have been variously described as the ‘Maori Wars’, ‘New Zealand Wars’ or ‘te riri pakeha’ (‘white man’s anger’) and spanned the period between 1860 and 1881 when peace was finally declared. These were probably the darkest years in New Zealand’s history as the Treaty terms were disregarded in favour of economic exploitation seen in the deforestation of the country and the growth of the agricultural sector particularly in sheep farming (both meat and wool) and the dairy industry (for produce and hides).

Treaty Claims as to land ownership and the correct interpretation of the Treaty are still issues current today and define the landscape in terms of land ownership, fishing and hunting rights, forestry and the extensive agricultural and horticultural developments that have occurred with the introduction of dairy cattle by immigrant farmers and (in 1851) viniculture by French Ctholic Marist missionaries.

The first use of refrigerated shipping in 1882 allowed extensive sales of New Zealand products and especially lamb, to Great Britain that continued for close on a century until the 1970s. This agricultural base to the economy served New Zealand well, particularly in its favoured agreements to supply the United Kingdom with lamb and butter. These Agreements held until Britain’s accession to the European Community in 1973, when New Zealand had to find new markets for its products.

Grant (1996) describes the period of wholesale implementation of free market principles in the 1980’s. This was unusual for a Labour government anywhere in the world and was popularly called ‘Rogernomics’ after its chief driving force, the Finance Minister Roger Douglas. Withdrawal of subsidies meant that New Zealand agricultural products became competitive on the global market with aggressive expansion of exports.

The signing in 1983 of the Closer Economic Relations Trade Agreement between New Zealand and Australia allowed free and unrestricted trade.

In 1984 New Zealand adopted a ‘no-nuclear’ policy, which led to US withdrawal from the ANZUS defence pack aimed at preventing the spread of Communism in the period of the Korean war (1950-1953) onwards.

The GATT Uruguay Round Agriculture Agreement of 1994 with its requirement for reduction of subsidies to agricultural production and exports meant that New Zealand was well-placed to take advantage of free trade in the globalized agricultural industry as described by Le Heron (1993) and agricultural co-operatives (Cobia, 1989).

On the 1st March 1998, a new combined Ministry of Agriculture and Forestry (MAF) was formed out of the Ministry of Agriculture and the Ministry of Forestry with a remit to: *“help the government create an environment allowing the food, fibre and timber industries make the best contribution to sustainable economic growth and environmental quality, while managing risks to human, animal and plant health and safety, and to resources.”*

In 1999 the MAF Regulatory Authority was separated into the Biosecurity Authority and the Food Assurance Authority. The decision of October 1st 2002 to allow the use of human genes in cattle does not bode well for New Zealand’s organics industry with an estimated value of NZ$80 million as well as for the ‘Clean and Green Godzone’ image, which is of such value for the tourist industry. The traditional industries are now being supplemented with new additions aimed at New Zealand’s most important markets in the USA, Japan, Australia, the United Kingdom, China and South Korea, in such areas as forestry, horticulture, fishing, manufacturing, wine production and tourism.

2. The New Zealand Agricultural, Forestry and Horticultural sectors

MAF (2002) provides a useful summary of statistics relating to the sectors within New Zealand for the year ending March 2002. Agriculture is defined as meat and meat products, dairy products, wool, and other pastoral based products excluding horticulture, which includes vegetables, fruit and nuts together with preparations thereof. Employment within agriculture was 115,040, with a further 32,660 in horticulture and 24,315 in forestry of a total population of around 3.8 million and of a total working population of 1,727,268. Total exports for the three areas were valued at $20.6 billion and accounted for 66% of New Zealand’s total exports. The top export destinations are shown below in Table 1.

Within the various sectors, the Producer Boards are responsible for various functions as described by MAF (2000). The Boards are ENZA (apple grower), Fonterra (dairy), New Zealand Federated Farmers, New Zealand Game Industry Board, New Zealand Hop Marketers, New Zealand Meat Producers Board, New Zealand Wool Group, Pork Industry Board, Poultry Association of New Zealand, Wools of New Zealand, and Zespri International Limited. Enderwick and Akoorie (1996) provide detailed case studies of many of the key producer boards responsible for the development of agricultural exports within New Zealand, including the New Zealand Dairy Board, New Zealand Venison, New Zealand Kiwifruit Marketing Board, Woolrest International, Tenon Developments, and the Forestry Corporation of New Zealand.

Table 1: Top Export Destinations in terms of sales (NZ$m) for year ended December 2001 (provisional values in NZ$m free on board)

Country	Agriculture	Forestry	Horticulture	Total
USA	2615	491	141	3247
Japan	1248	767	380	2395
Australia	953	917	213	2083
UK	1046	3.4	137	1186.4
China	685	362	16	1063
South Korea	437	548	22	1007
Germany	659	0.7	31	690.7
Taiwan	420	99	61	580
Malaysia	472	48	43	563
Philippines	438	84	14	536
Mexico	511	0	2.2	513.2
Canada	505	3	1.8	509.8
Belgium	499	3.0	7.5	509.5
Indonesia	426	66	8	500
Hong Kong	322	62	42	426
EU	0	0	310	310
Singapore	139	28	29	196
Total	11375	3482.1	1458.5	16315.6

Source: MAF (2002)

3. New Zealand Agricultural Co-operatives

The first co-operatives were farmer trading co-operatives established in 1881 in Timaru and Christchurch with further co-operatives arising as the benefits of having lower cost supplies and regular purchases for produce became self-evident.

The present day New Zealand Co-operative Association (NZCA) is an umbrella organization, which was established for agricultural co-operatives but after changing its constitution, now allows non-agricultural membership. Currently it has 33 co-operatives as members.

Within the dairy industry the co-operatives include Fonterra (which is New Zealand's largest company) and other dairy co-operatives including Westland and Tatua. Tatua is a New Generation co-operative aiming to maximize added value to the commodity. The success of this approach can be seen in the way Tatua paid out $6.80 per kilogram of milk solids in the last financial year compared to Fonterra's $5.30.

In the meat industry the co-operatives include PPCS and Alliance, with both AVCO and Richmond having changed their co-operative status to a corporate one.

In the horticultural sector, Zespri is a hybrid co-operative with 12 supplier companies of which 5 are co-operatives. ENZA is the co-operative of apple-growers.

The wool sector has recently seen (October 2002) the formation of the largest wool co-operative known as the Primary Wool Co-operative Limited with a projected turnover of $50million in its first year. This was formed from the Dannevirke-based East Coast Wool Co-operative with 400 shareholders and the wool division of Christchurch-based Combined Rural Traders (CRT) with 9000 shareholders. This new co-operative becomes the second largest procurer of wool in New Zealand.

The two short case studies that follow - of Fonterra and Foodstuffs – represent in many ways the two extremes of globalisation, with Fonterra as New Zealand's largest company competing successfully on the global stage and Foodstuffs fighting to protect its domestic market share from foreign competitors.

4. Fonterra

The largest of the co-operatives is Fonterra with membership of over 13,000 farmers (Fonterra Annual Report. 2001). Fonterra is also New Zealand's largest company and foreign currency earner.

New Zealand has one of the world's most market-oriented agricultural policies. Since the radical reforms of the agricultural sector in 1984, the level of agricultural subsidy in New Zealand has been practically non-existent and New Zealand is now virtually a "free trade" country. This has resulted in New Zealand milk producers being among the least regulated in the world, able to produce without any constraints on milk production.

The global dairy industry, according to Promar International (2000), is both large and very dynamic. World consumption of dairy products is currently estimated at 539 million tonnes per annum and is forecast to grow at an annual rate of 1-2% to 2005.

Furthermore, the world dairy industry is a multi billion-dollar industry made up of several major players. Since the 1980s, recent trends in the global dairy industry have been deregulation, and increasing globalisation. In fact, globalisation has been the driving force for the large number of mergers and take-overs among dairy companies recently (Rabobank, 2001).

Fonterra - founded in 2001 - is a New Zealand owned and based co-operative company, with earnings of NZ$ 13.9 billion in dairy sales in the year to 30 June 2002

(Fonterra Annual Report, 2002). Fonterra has group operations in around 120 countries, and was ranked fourth in Rabobank's 2002 list of world top dairy companies.

The New Zealand dairy industry is export oriented with more than 95% of milk produced on New Zealand dairy farms being used for export. This contrasts with most other countries, where the majority of milk is consumed domestically. This reflects not only New Zealand's relatively small population of 3.9 million, but also the size of the country's dairy sector, with over 13,000 dairy farmers.

Fonterra has segmented its business into four broad product groups: cheese, cream and associated products, milk powders, and protein – which encompasses casein and whey. The company has also segmented global business into five regions, within which New Zealand is considered a separate, domestic region:

(1) ASIA - including both South and North Asia, China, Hong Kong, the Philippines, Malaysia, Indonesia, Japan, Korea, and India

(2) AIME – including Africa and the Middle East: Saudi Arabia, Pakistan, Iran, Iraq etc

(3) AMERICAS – including both North and South America, Mexico, and the Caribbean

(4) AUSAPAC - Australia and the Pacific

(5) EUROPE - including Russia

The New Zealand dairy industry set its sights on export very early, and was in fact exporting cheese and butter from Canterbury to Australia in the 1840s. When refrigerated shipping was invented in 1882, exports of butter and cheese were expanded to Britain, South Africa and other distant markets (Xu, 1998, p. 22).

In the early exporting days, each dairy manufacturing company marketed its exports independently. Some bigger companies set up agencies overseas to sell their product, such as Amalgamated Dairies, which was set up in London by the New Zealand Co-operative Dairy Company.

In 1923 the Government established the Dairy Produce Export Board – which became known as the 'Dairy Board' – to act as the central export seller. The New Zealand Dairy Board (NZDB) was established in 1961 under the Dairy Board Marketing Act. This Act gave it monopoly rights over the purchasing and marketing of all export dairy products from New Zealand. A detailed account of the New Zealand Dairy Board is provided by Enderwick and Akoorie (1996).

Historically the United Kingdom was one of the Dairy Board's most significant export markets. Under a bulk marketing arrangement, the UK paid premium prices for more than 90% of New Zealand's dairy produce, in a bid to counter wartime food shortages during World War II (Webb, 1995). The UK bulk purchase agreement ended in 1954, however the New Zealand dairy industry remained very dependent on the UK market for the next few decades.

As discussed by Xu (1998), the threat of British entry to the European Community (EC) in 1973 prompted a move to find new markets for New Zealand's dairy export. Around this time the Dairy Board started to implement some strategies which have been drivers of their success ever since. They started to focus on new business development, and concentrated on strategies including joint ventures and a focus on branding. By the time Britain joined the EC in 1973 and the traditional access to that market was cut, the Dairy Board was well down the track with new markets for its products.

From its inception, the New Zealand Dairy Board was owned by hundreds of co-operative dairy companies, who were the supplier-shareholders. Over the years, the manufacturing companies that owned the Dairy Board merged to become more efficient. By the end of 2000 more than 95% of the industry had consolidated around two major manufacturing companies, New Zealand Dairy Group and Kiwi Co-operative Dairies.

The Fonterra merger required special Government legislation in order to overcome concerns of a domestic market monopoly, hence the passing of the 2001 Dairy Industry Restructuring Act.

Enderwick and Akoorie (1996) outline how the New Zealand Dairy Board (now incorporated into Fonterra) is principally a processor and marketer of milk in processed form, unlike their competitors who have other significant business activities. Some of Fonterra's well-known brands in New Zealand are Anchor, Chesdale, Fernleaf and Mainland. However Fonterra, as well as their competitors, face changes in demand for the products they produce, including butter consumption – which has declined in recent years due to consumers becoming more health conscious, but is now increasing in markets such as the United States, and Westernised food products containing dairy ingredients, which are being consumed more in Asian markets.

According to Fonterra Shareholders' Council Chairman John Wilson (2002), Fonterra's productivity edge, in feed conversion and also in manufacturing, is their most important advantage over the competition. However Wilson believes that New Zealand's competitive advantage in the dairy industry is ultimately based on just one thing – its people.

Wilson (2002) also said that the dairy market faced by Fonterra is one of the toughest and most competitive in the world and is highly restricted. He goes on to say:

"Of the world's total dairy market, only around six percent is truly open to [Fonterra]. In some cases, high tariffs mean that [Fonterra] start with a huge disadvantage over local competitors, or that [they] can't access the market at all. In other cases, tight quotas mean [Fonterra] have to be able to build a profitable business despite knowing it can only expand so far before [they] run out of access."

One of Fonterra's main bases of competitive advantage is that New Zealand dairy farmers are among the lowest cost milk producers in the world following the reforms of the 1980's and the withdrawal of subsidies. In addition, the farmers can supply milk relatively cheaply during the Northern Hemisphere winter. This is because New Zealand cows can be fed on grass all year round, with little need for stock food. This contrasts with most overseas competitors who have to feed their livestock with expensive stock food in winter, due to the harsh winter climate.

According to McBride (1986), co-operatives - such as Fonterra - are formed with the aim of providing services to the producers (members), which they as individuals, cannot provide by themselves as effectively, if at all. There are several benefits of being part of a co-operative, with the most obvious being economies of scale. Some of the other benefits are capital investment timing advantages, increased bargaining power, reduced uncertainty, and statutory support.

In contrast, the Federation of Danish Co-operatives (2000) believe that co-operatives, especially when compared with investor owned firms, are at a disadvantage when it comes to competing on an international scale due to their substantial capital requirements, slow-decision making, long term patience, and low risk-taking willingness. However, the evidence from New Zealand disproves this, such as Robb's (1999) work which shows that co-operatives consistently outperform investor-owned companies and which drew on the Lerman & Parliament comparative studies of US co-operatives and investor-owned firms.

Rabobank (2001) outlines one of the disadvantages for New Zealand-based Fonterra, which is that they have a small domestic market – based on a total population of 3.9 million people. New Zealand consumes around 5% of the milk produced in the country, leaving 95% for export (Webb, 1995). However, Rabobank (2002) notes that Fonterra controls 30-35% of world dairy trade, which indicates that the small domestic market has not been a disadvantage for the company in practice.

Another significant challenge faced by Fonterra in accessing global markets is raising capital. The company is well aware of this, and are currently looking at what capital structure will best meet their investment needs, keeping in mind that not all farmer shareholders have the same wish for investment.

In conclusion, Fonterra has been able to consolidate the positions of its forming co-operatives and has established itself as the world's fourth largest dairy company, with strategic alliance established with Nestlé in the US market.

Fonterra has been instrumental in the Global Dairy Alliance, which was inaugurated in Buenos Aires on the 4th October 2002. It brings together non-subsidised dairy producers from Argentina, Australia, Brazil, Chile, New Zealand and Uruguay, in order to further promote trade liberalisation within the global dairy industry and to reduce both subsidies by such countries as the US and European Union, and other protectionist measures such as tariffs.

5. Foodstuffs

Globalisation's two-edged sword is cutting deep into New Zealand's supermarket heartland with the arrival of Australian-owned Foodland. Rotherham (2002) summarizes Foodstuffs as follows:

The Foodstuffs organisation is New Zealand's fourth-largest business and the largest grocery distributor. It is run by owner/operators under three separate, regionally based cooperatives – Foodstuffs (Auckland), Foodstuffs (Wellington) and Foodstuffs (South Island). The three cooperatives jointly own Foodstuffs (NZ) Ltd, which acts as the federation body and owns the brands. Foodstuffs' brands [retail outlets] include: New World (125 stores), Pak 'N Save (34), Four Square (312), Write Price (8), and cash 'n carry operations: James Gilmour & Co. in Auckland. Toops Wholesalers in Wellington, Trents Wholesalers in the South Island. Private labels Pam's and Budget. (P.43)

Foodstuffs has been in conflict with Australian-owned and Perth-based Foodland Associated (FAL) which has bought the New Zealand Foodtown and Woolworths stores at a cost of NZ$690 million giving it a 45% share of New Zealand's NZ$9.2 billion annual supermarket sales, compared to Foodstuffs' 55% share.

Foodstuffs has challenged the decision of the Overseas Investment Commission (OIC) to allow the sale giving as grounds that it would reduce competition in the New Zealand market and lead both to a duopoly and to higher prices since Foodland had 55% of the market.

The keys to success for Foodland are to achieve economies of scale with its additional $1.6 billion in sales, by achieving better trading terms from suppliers as well maintaining prices on the shelves by resisting a price war with its rival. In addition, savings in the supply chain are also expected by getting suppliers to deliver direct to stores as opposed to a central distribution centre. Foodland is clearly seeking to make itself more attractive as a take-over target for foreign owned chains such as the UK's Tesco, Germany's Aldi, New Zealand's Warehouse, or the US-owned Wal-Mart, whose current strategy is to open one new store every business day somewhere in the world.

Foodstuffs will clearly have to fight in order to survive particularly if larger supermarket chains target Australia and New Zealand as their next markets of choice.

6. Accessing global markets

Any literature review on the internationalization of co-operatives (Donoso, 2002) will show that co-operatives are facing an unprecedented period of change not only in terms of mergers and acquisitions, but also in their ethos and strategic direction, with many examples of co-operatives changing their mutual status to become corporates.

It is clear from the experience of co-operatives in many sectors and in many countries, that the major problems are those common to co-operatives elsewhere, namely the widely held belief of their ability to raise capital for growth through the membership. However, the work of Ernst & Young reported by Edlin (1995) show that this is not the case. The Ernst & Young study found no evidence that structures or access to capital were restricting growth, rather it was the quality of management and strategic direction that made the difference.

This issue of valuation of agricultural co-operatives is illustrated in the way by which Standard & Poor's undertakes evaluations of credit risk based on the following factors: financial flexibility, operating efficiency, market position, regulatory environment, ownership, diversity, access to capital, financial ratio analysis, risk mitigation strategies and other investments. These should serve to concentrate the minds of co-operative members as to how they are judged externally in relation to other commercial entities.

In addition, internationalization is clearly having an effect on co-operative activity within the home market, with many foreign producers seeking access and market share.

7. Conclusion

Although a relatively new country, New Zealand has based its economy on the export of agricultural production such as the use of refrigerated shipping to transport meat to Europe from the 1880s onwards. The withdrawal of agricultural subsidies in the 1980s has ensured that New Zealand producers are able to compete successfully in global markets, with Fonterra (a dairy co-operative) ranked fourth in the global dairy industry and New Zealand's largest company trading in over 120 countries, despite its woes after its first year of operation as described by Baldwin (2002).

Within the New Zealand agricultural sector, New Zealand co-operatives are a major force, embodying many of the cultural value that were required for survival of the early pioneers to the islands. Although some co-operatives have demutualised and become corporate bodies, new ones have formed to successfully compete alongside co-operatives in other countries in global markets (Egerstrom et al. 1996).

The natural advantages enjoyed by New Zealand in terms of climate, suitable land and location (being able to produce during the Northern Hemisphere's winter), has meant that the sector has been able to develop in ways that have been complemented by social factors that have encouraged co-operative forms of organization.

New Zealand co-operatives are consolidating and merging in order to increase their ability to compete in targeted markets with niche products that are increasingly seeking to add value to commodities through processing and new product development.

Agricultural and other co-operatives are clearly here to stay in New Zealand and have repeatedly shown how they can outperform corporate models of ownership, being the preferred choice for primary producers.

Although only a small country at the edge of the world, New Zealand has shown its ability to lead agricultural practices and production in many ways, and continues to be at the forefront of innovation in both products, processes and co-operative structures globally as described by Parnell (1995).

For example, New Zealand's no-nuclear policy has been challenged this year (2002) by US insistence on linking any trade deal between the US and New Zealand with the relinquishing of New Zealand's sovereignty over its 'no-nuclear' policy. New Zealanders regard such insistence as bullying and blackmail by the dominant global power, in ways that disregard the contribution of New Zealand armed forces to various conflicts where they have fought alongside US forces from World Wars One and Two, through Korea and subsequently in peace-keeping around the globe. The American government seems to have an unnerving ability to alienate its allies in ways that common enemies have failed to achieve, over such issues, including its refusal to ratify the Kyoto Protocols and the International Criminal Court.

How New Zealand responds to such challenges and the lifting of the moratorium on GE organisms are likely to be the defining moments of its modern agricultural history and will forever change the face of the landscape in ways that cannot be conceived. It is to be hoped that such changes will be both sustainable and beneficial, protecting the uniqueness of New Zealand's flora and fauna, in ways that the Dodo would have appreciated.

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Technical Biography – Dr Romuald Rudzki

Name: Dr Romuald E J Rudzki

Degrees: BA (Hons) Soc Sc (1982), PhD (1998)

Current position: Lecturer in International Business

Address:

Department of Management

College of Business

Massey University

P O Box 11 222

Palmerston North

New Zealand

Tel. +64 6 350 5799 ext. 2788

Fax. +64 – 6 – 350 5661

E-mail: R.E.Rudzki@massey.ac.nz

Current research interests: the strategic management of internationalization, globalization and anti-globalization, New Zealand biotechnology, business education.

Technical Biography – Karla Davidson

Name: Karla Davidson

Degrees: BCA (2000), BBS (Hons) (2002)

Current position: Research student, Department of Management, Massey University

Address:

Department of Management

College of Business

Massey University

P O Box 11 222

Palmerston North

New Zealand

Tel. +64 6 350 5799 ext. 2788

Fax. +64 – 6 – 350 5661

Email: karladavidson@hotmail.com

Current research interests: strategic management, agri-business, Fonterra, global dairy industry

The internationalisation of agricultural co-operatives – A source of conflict?

Ignacio Donoso, Massey University New Zealand

Agricultural co-operatives

1.1 Background: definition, principles, characteristics and types

Principles play a central role in co-operatives and they define to a great extent the nature and role of co-operatives. Disagreement exists about what constitute the 'true co-operative principles', as they have evolved over time and co-operatives with them (Barton, 1989; ICA 1995).

Despite the differences, some general definitions can be found. For example: '*a co-operative is a user-owned and user-controlled business that distributes benefits on the basis of use*' (Barton, 1989, p.1). A very similar and generally accepted definition (and the one that will be used for this study) states that a co-operative is an agricultural producer organisation that is user-owned, user-controlled and user-benefited (Cook, 1997; USDA, 1997).

When analysing the reasons behind the formation of co-operatives one can also find differences, but in general terms co-operatives are formed with the objective of providing services to agricultural producers (the members), which they as individuals, cannot provide by themselves or at least not so effectively (McBride, 1986). As a general rule, '*co-operatives are considered means of correcting or mitigating market failures*' (Harte, 1997, p. 43). Although the primary purposes of co-operatives are economic-related benefits for its members, co-operatives may pursue some non-economic objectives as well.

Although the co-operative movement is extremely important all through the world with total sales of agricultural co-operatives estimated at US$ 450 billions (Centre de Gestion des Coopératives, 1995), they play an extremely important role in the developed world, especially in countries like the US, Canada, and the Netherlands among others (ICA, 1995).

In several aspects co-operatives are similar to other forms of businesses such as Investor Oriented Firms (IOF), they operate in the same business environment and under the same rules, electing a board of directors and hiring managers. Most importantly they share the same common objective of maximising long terms wealth of shareholders/members (Lynch, 1998). On the other hand co-operatives are unique in several aspects when compared to other forms of businesses.

There are three key differences that distinguish a co-operative from other forms of business. These are the user-owner principle, which means that the persons that own and finance the co-operative are those that use it; the user-control principle, which implies that the control of the co-operative is under those who use it either on a proportional or democratic basis; and the user-benefit principle, which implies that the benefits of the co-operative are distributed to its users on the basis of their use (Barton 1989, McBride 1986, Nilsson 1996). A critical difference is that while IOFs have the single objective of maximising value at firm level, co-operatives must maximise value both at co-operative/firm level and at member level (Lynch, 1998).

Another of the unique characteristics of the co-operative form, which is often overlooked, is the way relationships between the co-operative members, board of directors, and the managers, also called the 'management triangle' are handled. The involvement of the members in management decisions is a critical difference with other forms of businesses (McBride, 1986). While such differences make co-operatives a distinct form of business organisation, just as in any business, in order to compete successfully, they must be soundly financed, managed and run (Schroder, Wallace & Mavondo, 1993).

Co-operatives can be classified according to size (large, small), financial structure (stock and non-stock), organisational structure (centralised, federated, mixed), geographic area served (local, regional, national, transnational), function performed (marketing, supply, processing, bargaining and service), scope (vegetables, dairy, meat, etc) and the already mentioned classification according to the principles ruling them, among others classification systems. Therefore, several taxonomies of co-operatives have been elaborated (Cook, 1995; Van Dijk, 1996).

An extremely important group, and the ones covered in this study, are marketing co-operatives. Marketing co-operatives link members' production, product processing and food marketing at local, regional or international level, with the first two options being historically the chosen ones (Bager, 1997). Traditionally, marketing co-operatives have concentrated in selling their members' farm product either in raw or processed form, but lately marketing co-operatives are becoming more vertically integrated, increasing control all the way up to the retail level, even on an international level (Cobia, 1989).

1.2 Changes in the international scene and emergence of new co-operative models

Changes in the international scenario have been one of the major forces behind the restructuring of agricultural co-operatives worldwide. Among them competition has increased, consumers have become more demanding, technological changes in logistics and storage have been drastic, retailers have become more powerful and concentrated, and globalisation of economies has resulted in economies of scale in production, logistics and marketing (Verheijen & Heijbroek, 1994; Bijman, Hendrikse & Veerman, 2000).

As a consequence of deregulation and globalisation, competitiveness is increasing, impacting on co-operatives as it is on other types of business. But while some of the weaknesses of the traditional co-operative model are being exposed, on the other hand, co-operatives' major competitors, multinational food corporations are actively expanding their activities, making the food industry more concentrated (Schroder et al., 1993; O'Connor & Thompson, 2001; Wilson 1999). At the same time, governments are reducing their financial support, undermining some of the benefits of being in a co-operative (Harte, 1997; Wilson, 1999).

With the drastic explosion in international trade that the world has seen over the past 40 years, co-operatives have also become increasingly involved in exporting, agricultural markets have become global rather that local, with the opportunities, challenges and risks this implies. Risks are magnified in the export market by multiple factors such as currency exchange, transportation, trade and non-trade barriers, etc (Bijman et al., 2000).

It should be noted that differences among co-operatives in different continents and countries are considerable (Centre de Gestion des Cooperatives, 1995). The same happens among sectors such as dairy where co-operatives have an extremely high market share, compared with others where they have little or no power (Bager, 1997). However, despite the previous point we find that "*Integration in the milk sector, amalgamation of farmer owned meat businesses, joint ventures with co-operatives or in the private sector across national boundaries is commonplace through the food chain*" (Wilson, 1999). The issues facing co-operatives are universal, the choices and need for change are different only because of local laws, regulations, and local market anomalies (Cook, 1996).

Several authors such as Nilsson (1998), Wilson (1999) and O'Connor & Thompson (2001) have performed international descriptions of worldwide trends of agricultural co-operatives, focusing especially on structural changes; 'c*o-operatives around the world find themselves in a period of major, perhaps unprecedented changes'* (O'Connor & Thompson, 2001, p.1).

The world trend of mergers of co-operatives has been especially strong in some sectors, such as the dairy industry. Despite this shift to fewer and larger co-operatives Wilson (1999) found a counter swing by the formation of new groups such as machinery rings or farmer markets more recently. In general, the nature, structure and professionalism of co-operatives have been changing, with emphasis being placed on co-operation rather than the legal form of the business (Nilsson, 1998; Wilson, 1999).

As a consequence of the agricultural co-operatives intent of remaining competitive within the increasingly internationalised, deregulated and demanding markets previously described, and in order to overcome a numbers of limitations inherent to the traditional form of co-operative, several new co-operative models have been emerging over the last years (Cook, 1995; Nilsson, 1996; Stranskov, 1996), '*The structures and strategies of co-operatives … are all being questioned* - or should be - *as local and national food systems become integrated into a new, global food system*' (Cook, 1996, p. 143, emphasis added).

The main inherent limitations that these new models have been trying to overcome have been well studied and can be summarised as the common property problem, the portfolio problem, the horizon problem, the decision-making problem, and the control problem (Nilsson, 1996). Harte (1997) condensed them as the horizon problem, the portfolio problem, and the control problem. Using other words but following the same logic Cook (1995) identified the main co-operative limitations to ownership issues, control issues, and dilution of benefits issues.

According to Nilsson (1998) a new agricultural co-operative model is emerging with the primary processing being conduced within increasingly larger co-operatives with some operating even internationally, and with the trade between the co-operative and its members becoming more business-like. According to Nilsson, the traditional co-operative model with its many ideological attributes has a precarious future. In Nilsson's model the collection and first stages of processing remaining in the co-operative, with the subsequent processing being conducted by partly owned subsidiaries. This model fits with the current reality of Irish and U.K co-operatives.

In the United States, during the 1990's a group of new co-operative business structures, focused on value-added processing (as opposed to the traditional commodity marketing) have been formed, receiving the name of New Generation Co-operatives (NGC). NGCs have been studied in depth over the past years (Cook, 1995 and 1996; Nilsson, 1998), with local adaptations of the NGC model being implemented in

Australia (Plunkett & Kingwell, 2001), New Zealand (Frampton, 2002), and Canada (Ketilson, 1997) among other developed countries.

NGCs have been seen as a possible solution to overcome the traditional co-operative limitations without weakening the essential co-operative principles (Cook, 1995 & 1996). NGCs are typically (with exceptions) small, high-focused co-operatives. The core characteristic and main difference of the NGC is that capital is not treated as common property; instead members hold a number of shares proportional to their delivery rights, which in turn operate as a two way-contract between the co-operative and the member for a certain amount of product. Other interesting characteristics of NGC are: the use of equity tradable shares among shareholders/farmers, closed memberships, and the requirement of full contribution to equity capital when joining (O'Connor & Thompson, 2001).

Finally, Stranskov (1996) identified four co-operative models that were taking form. The first model consists of large farmer-controlled co-operatives, with outside institutional investors; the second model assumes internationalisation of the co-operative; in the third model co-operatives would concentrate in their traditional activities, leaving marketing to an outside strategic partner. Finally in the fourth model, co-operatives form strategic alliances with cross-border IOFs or co-operatives. Grosskopf (1996) described two models of European co-operatives taking shape. The first one is a truly international co-operative with members having ownership and membership rights across national boundaries. The second possible model, and more likely to happen according to the author, is an interregional entity, owned by regional co-operative members.

1.3 Future opportunities and challenges

"*Co-operatives are at a crossroads in their development. The future of co-operatives depends on the ability of their leaders to convince members to structure themselves in order to compete on multi-commodity, value added and global bases*" (Lang, 1995, p. 4).

A mix of positivism and negativism can be perceived when reviewing the specialised literature, in relation to the future of co-operatives. Some authors like Bager (1997) are extremely optimist about co-operatives' future. Cracknell (1996) on the other hand, although recognises that no intrinsic reason stops co-operatives being efficient and competitive, provided they have dynamic and imaginative management, warns that the movement must be rebuilt from the grass roots. Wilson (1999) agrees with the view, stating that drastic changes are necessary.

The existence of multiple possible partners, products, markets, and services options have located co-operatives at a point where significant new choices are again essential (Lang, 1995). Greater responsibility lies now over the co-operative's board of directors, in order to seize opportunities and understand that co-operative philosophy and principles are not inconsistent with the requirements of the dynamic competitive environment (Wilson, 1999; Verheijen & Heijbroek, 1994), "*Historically, co-operation has flourished in times of adversity*" (Wilson, 1999, p.100).

Consensus exists in the specialised literature, that co-operatives have to move closer to the consumer and reach further up the value chain where more profits can be found (Lang, 1995; Strandskov, 1997). Traditionally co-operatives have focused in obtaining economies of scale to reduce input prices or by collaboration to improve marketing effectiveness. Although these functions are still relevant, there are new rationales; the objective in business co-operation must be to make the value chain more efficient and profitable, by pooling assets, time and knowledge (Wilson, 1999).

An important issue is however, how close to the final consumer should (and realistically can) co-operatives get, because even though the potential rewards are attractive, co-operatives that decide to vertically integrate and market final consumer products are faced with challenges such as the developing of a customer-oriented organisation, the establishing of a recognised brand, constant development of new products, and others which may be difficult and expensive to achieve (Cobia, 1989).

In terms of product differentiation, it is increasingly likely that both domestic and international markets will call for differentiated consumer products rather than commodities. The more promising opportunities of the future for co-operatives may lie in development of new, customised products, which will increasingly be produced, processed, and marketed outside of traditional channels (Seipel & Heffernan, 1997).

Also, with the expansion of regional pacts (NAFTA, EU, Mercosur), co-operative members are beginning to understand the value of welcoming foreign producers of complementary products under the co-operative umbrella. Co-operatives will continue to expand beyond exporting into other offshore activities, which in turn will enhance the presence and visibility of co-operatives in markets around the world (USDA, 1997). Book (1992) argues that internationalisation should be present in all planning and strategy development by co-operatives. According to him the distribution of activities should increasingly be considered in the international context.

Internationalisation of agricultural co-operatives

The choice of internationalisation

The Federation of Danish co-operatives (2000) defined 'international co-operative' as any co-operative that has initiated one or more of the following forms of internationalisation: Export, Alliances, FDI and/or organization of transnational co-operatives. According to this definition several agricultural co-operatives in Europe, North America, Australia, and New Zealand have been international for a long time as they export a significant proportion of their production.

Whether to internationalise or not, should be one extremely important decision among several strategic decisions that agricultural co-operatives are currently evaluating in order to respond to the previously described pressures. Other strategic options may include: concentration paths (union, merger, acquisition, partnership, joint venture), diversification versus specialization, vertical versus horizontal integration, and cost leadership versus product differentiation (Mauget & Declerck, 1996).

Despite of the work of several researchers and co-operatives' leaders supporting internationalisation (Book, 1992; Salaberria, 1997), only a limited number of agricultural co-operatives have expanded production into foreign markets, although the number is growing (Bager, 1997). Mauget & Declerck (1996) found, when comparing structures, strategies and performance of agricultural co-operatives in the EC, that expansion into international markets remained weak at that time, except for certain co-operatives, due mainly to the high costs involved.

Buccola et al (2001) found that the most important factors that determine co-operatives choice of internationalisation form are the capital subscription methods, marketing objectives, foreign experience and propensity, and the nature of the products manufactured. Co-operatives have to decide now how they can internationalise sales and production on the basis of a division of activities in which the special preconditions of individual geographical areas are taken in consideration (Federation of Danish Co-operatives, 2000).

Reasons for internationalisation of agricultural co-operatives

The reasons behind the internationalisation of agricultural co-operatives are in general terms exactly the same as that of any form of business, such as continued growth, utilisation of economies of scale, strengthening of competitiveness, utilisation of know-how, access to export markets, direct presence in important markets, and ability to seek resources abroad (Federation of Danish Cooperatives, 2001). Buccola et al. (2001) shortened the list, considering that there are only three main possible reasons why co-operatives internationalise: increasing the firm's market share, enhancing average sale price, and reducing or diversifying risk.

Competitive pressures have arisen, primarily from multinational companies, which are making national boundaries increasingly irrelevant through the use of new technologies, combined with highly mobile investment capital, and global sourcing of raw materials and labour (Seipel & Heffernan, 1997). On the other hand, as it has already been stated, the particular goals and conditions of co-operatives mean that the motivations and starting points for internationalisation differ in certain areas from the IOFs ones (Federation of Danish Co-operatives, 2000). So for example, global sourcing can be a strong competitive reason for co-operatives to internationalise, but at the same time it can be a limiting factor (USDA, 1997).

The motivations and mechanisms for foreign sourcing strategies are various. So for example, sourcing of non-members raw products, which may seem contradictory at a first glance, can be related to lowering per-unit costs through greater use of plant capacity, or the fill of seasonal marketing windows for maintaining all year round availability, or for broadening the co-operatives product line (USDA, 1997). Finally co-operatives may expand their memberships to include foreign members; so foreign sourcing can be a previous step to the formation of transnational co-operatives (Federation of Danish Co-operatives, 2000).

The issue of economies of scale and reaching sufficient size is also one of the big forces behind agricultural co-operatives internationalisation. "*Sufficient size is essential for all strategic options… internationalisation or regionalisation is often a possibility and sometimes a necessity*" (Verheijen & Heijbroek, 1994, p. 174). An important point is that not only large food companies in general and co-operatives in particular, can become international. Size is not a necessity for internationalising (Bager, 1997), although it is sometimes a consequence.

There are inherent advantages in the co-operative form, which make co-operatives specially suited for internationalising that cannot be underestimated when considering international expansion (Cook, 1997; Salaberria, 1997; Federation of Danish Co-operatives, 2000). Grosskopf (1996) and Seipel & Heffernan (1997) see in the co-operative's organisational and ownership structure important strengths for internationalisation.

2.3 Problems and barriers of co-operatives internationalisation

Although the reasons behind internationalisation are the same for IOFs and co-operatives, the barriers and limitations to internationalisation for co-operatives are not exactly the same (Book, 1992; Schroder et al., 1993; Nilsson 1996).

Co-operatives' traditional preconditions towards considerable capital requirements, willingness to take risks, long-term patience and fast decision-making, put them in a different and disadvantaged situation for taking part in processes like internationalisation in comparison with other forms of business, specially against IOFs. Multinationals (a type of IOFs) experience in setting up business and carrying on production abroad, together with their ability to raise capital from the share market, ensures them rapid expansion (Federation of Danish Co-operatives, 2000).

According to Schroder et al. (1993) there are six barriers which agricultural co-operatives and in general, Producer Marketing Organisations (PMO), have to overcome in order to internationalise. These barriers are: 1) developing of a marketing orientation instead of producer orientation, 2) the location in the food chain, as they are at the beginning of the chain far from consumers and market signals, 3) the sourcing of raw materials dilemma, 4) relationships with governments (when government support exists), 5) strategic thinking barriers, and 6) the development of a long term financing strategy. From the six mentioned barriers, Schroder et al. (1993) stated that the first four, apply to all PMOs irrespectively of their size and stage of maturity, with the last two being important in the early stages of their lives.

Seipel & Heffernan (1997) identified as limitations to co-operative international involvement: the diverse interests of members, the aversion to higher risks associated with international investments, the horizon problem (aversion to long-term commitments with little short-term benefits), and the physical ties to domestic resource bases. In terms of international involvement with foreign co-operatives, they identified the problem of different connotations (some of them bad) of the co-operative concept in some countries. Co-operatives' risk aversion was also identified by Grosskopf (1996) and Buccola et al. (2001) as one of the biggest barriers for internationalisation.

An important limitation to co-operatives internationalisation lies in the fact that most co-operatives have ties to producers/members within a particular region, and they do not have the same freedom in shifting production and processing around the world that IOFs have (Seipel & Heffernan, 1997, Federation of Danish Cooperatives, 2000).

Cook (1997) states that co-operatives face the following constraints when internationalising: mission clarity, single origin nature, capital availability, and governance (lack of skilled outside directors). Even though most of the barriers identified by the mentioned researchers are similar, no agreement exists in the identification of the major barriers to the internationalisation of co-operatives, even though it could be said that some consensus exists identifying the 'financial' or 'capital problem' as a key one.

O'Connor & Thompson (2001) argued that financial limitations are not only a big internationalisation barrier, but they are the origin (entirely or partially) of a big part of the co-operative traditional weaknesses. According to Salaberria (1997), president of the Confederation of Co-operatives of the Basque country (Spain), the solution to the financial problem lies in a change of co-operatives' attitudes to capital, by thinking of realistic and economically stimulating means of capital contributions, either from their own members or from outside members.

The existence of considerable barriers does not imply at all that co-operatives cannot successfully internationalise. Schroder et al (1993) stated that co-operatives and producer marketing organisations can in fact overcome the internationalisation barriers and cited the New Zealand Dairy Board (NZDB), as a successful case. According to Huet (1996) a market-oriented focus (as opposed to production-oriented) and a shift from defensive to offensive strategies (Egerstrom, 1997) are mandatory if co-operatives are going to compete in international markets. Finally Seipel & Heffernan (1997) see in the constant creation of local and regional niches in the food system, the logical response to globalisation pressures that co-operatives should follow.

2.4 Internationalisation forms

The internationalisation terminology differs between the business literature and the co-operative specialised literature. So for example while in the business literature (Bartlett & Ghoshal, 2000; Hill 2001) the term 'transnational' is used to describe an organisation with its physical assets (subsidiaries) dispersed internationally, but interdependent as the most evolved form of international organisations. On the other hand, the co-operative literature defines a transnational co-operative as a co-operative with members in two or more countries (Federation of Danish Co-operatives, 2000), although it is also possible to find the term 'international co-operative' being used for the same meaning (Verheijen & Heijbroek, 1994).

Internationalisation of co-operatives is a world trend, with American co-operatives using foreign direct investments (FDI) forms, and Europeans co-operatives moving towards the transnational co-operative form (O'Connor & Thompson, 2001). Bager (1997) stated that three general models are adopted by co-operatives with strong international commitment: the conversion to limited company; the formation of limited subsidiary, and issue of shares to members/farmers and non-farmers. Even though this classification may fit the Irish scene – where Bager did the research – it is somehow limited for applying worldwide, but still useful for comparison purposes.

Co-operatives as well as IOFs, when internationalising use in some cases a portfolio of arrangements including trading companies, foreign distributors, brokers, licensing, and foreign direct investments, according to the product and market conditions. On the other hand, the factors influencing the election are considerably different from the IOFs ones, being strongly based on factors such as financial resources and structure, risk exposure and risk preferences, information resources and product types (USDA 1997, Buccola et al. 2001).

Overseas business arrangements can be ordered according to the degree of commitment the firm/co-operative makes in the international venture. Using this scheme, Buccola et al. (2001) ordered, from least to greatest commitment, overseas business arrangements used by co-operatives as: 1) domestic sales to an overseas trading company, 2) sales through a foreign distributor, 3) sales through a foreign broker, 4) direct sales to an overseas wholesaler or retailer, 5) overseas coventure (licensing), and 6) foreign direct investment.

Cook (1997) condensed into four basic options the forms of internationalisation for agricultural and food firms: importing, exporting, FDI, and commercial relationships – including JV, coventure, franchising, licensing, and strategic alliances. However, more detailed business internationalisation studies have identified as many as nine different stages of internationalisation (Bartlett & O'Connell, 1998).

2.5 Potential conflicts

The arisen of potential conflicts when internationalising have been identified by several researchers (In't Veld, 1996; Normark, 1996; Van Dijk, 1996; Salaberria, 1997). Internal conflicts may come from several sources, like members seeing their co-operatives undergoing rapid changes, and not understanding or appreciating these changes. Conflicts may be short or long-term conflicts. Van Dijk (1996) advises as a possible solution to avoid conflicts, that managers and farmers-directors bring in consultants to help formulate and evaluate business strategy.

Normark (1996) states that proposal of strategic changes are often evaluated from the viewpoint of effectiveness within the co-operative, without paying much attention to the member-perspective. Change's proposals that are successfully created in a way that balances both the user's interests with the business logic are important for the long run of the co-operative.

In't Veld (1996) stated that values should not be isolated from a co-operative business as they are the foundations of the co-operative form. So when co-operatives are growing in size and scope, theses values need to be re-examined, '*Member orientation – the true touchstone of the co-operative identity – has tended to become increasingly mixed with profit orientation'* (Bager, 1997, p. 12). The question may be, is that wrong? According to the USDA (1997) "*Co-operatives must balance the interests of members with the need to compete in a dynamic and competitive marketplace through globally focused strategies, which is in turn essential to the interest of members*".

Kyriakopoulos (2000) argues that many aspects of the market orientation restructuring of co-operatives, which has become necessary in order to compete in the current business environment remain dark, especially those associated with the integration of co-operative firms and members. Van Dijk (1996, p. 176) points in the same direction, "*Strategic policies such as scaling up, internationalisation, or vertical integration, must be judged against the aims of the co-operatives members…. That sounds simple, but it is hardly the case"*.

Case study research on internationalisation of agricultural co-operatives

Dobson (1992) analysed the New Zealand Dairy Board (NZDB) strategy and its manifested intention of becoming a multinational food company. Another case study where the NZDB was the main focus of attention is the study performed by Schroder et al. (1993), where they cite examples of globalisation strategies used by Producer Marketing Organizations (PMO), discuss the barriers that must be overcome, and with a case study, show how a PMO, the New Zealand Dairy Board (NZDB), can successfully overcome those barriers.

Mauget & Declerck (1996) studied EC agricultural co-operatives' behaviour and performance on the period 1990-1991. Related to internationalisation they described the remarkable expansion into foreign markets of Danish meat processor co-operatives and the acquisition of foreign companies to process products followed by Danish dairy cooperative MD Foods in the Middle East, and Irish dairy co-operatives in the U.K. and the U.S. (Avonmore, Waterford, Golden Ave, and Kerry). Especially interesting is the successful case of Dutch dairy co-operative Campina-Melkunie, in raising funds by issuing members participation certificates. As a failure case of internationalisation the experience of a French dairy Coop, ULN, was analysed.

The Basque Mondragon Co-operative Corporation (MCC) has been the centre of several studies that have tried to understand the reasons behind its successful growth without loosing its co-operative status, although some questioning regarding its loyalty to co-operative principles have also arisen (Hanna, Ridnour, & Meadow, 1992; Huet, 2001; Kohler, 2002). Internationalisation is the main growth strategy of the MCC with establishment of foreign subsidiaries, acquisitions, JV, and international alliances, consolidating a US$ 5 billions business.

Seipel & Heffernan (1997) studied three American co-operatives, Land O'Lakes, Harvest States Cooperative, and Farmland Industries, which according to them have responded to the globalisation challenge. Land O'Lakes international activities include feed manufacturing, technical assistance and training activities; Harvest States participates with a transnational grain corporation and is also a member of a consortium of U.S., Dutch, Swedish, French and German co-operatives; Farmland Industries purchased a transnational Swiss-based grain-trading firm, with offices in Switzerland, Germany, Argentina, France, and the U.S.

Ketilson (1997) in a study of the Canadian co-operative Saskatchewan Wheat Pool, which converted itself to a publicly-traded co-operative, reviews the democratic structures and process such as volunteer activities, survey of members, member education, and participation of members in decision making, which are considered necessary in order to remain true to its roots.

The Federation of Danish Co-operatives (2000), reviewed several European agricultural co-operatives in the process of internationalisation, focusing in the Transnational Co-operative form. The study covers eight case studies (Table 1), analysing barriers and obstacles, legislation issues, success factors and alternative organizational models for transnational co-operatives establishment. Worthy of being highlighted is the case of Dutch co-operative Aalsmer, the world largest auction hall for cut flowers and plants, which has 'full members' in Holland (96%), Germany (1%) and Belgium (3%), and 'special suppliers' in Israel, Kenya and Ecuador, besides receiving deliveries of 'normal suppliers' from large parts of the world. Also interesting because of its trully transnational structure is the case of Arla Foods.

Table 1: European examples of Transnational co-operatives (turnover data from 1998)

	Activity	Turnover	Members: number and composition
Milchunion Hocheifel	Dairy	573 mill DM	3,050 members (79% Germany, 13% Belgium, 8% Luxemburg)
COVAS	Sugar	80 mill NLG	3,000 members (97% Holland, 2% Germany, 1% Belgium)
Aalsmeer	Flower auction	2,959 mill NLG	3,500 members (96% Holland, 3% Belgium, 1% Germany)
AVEBE	Potato starch	1,603 mill NLG	5,600 members (68% Holland, 32% Germany)
Arla Foods	Dairy	36,000 mill DKK	17,600 members (54% Denmark, 46% Sweden)

Source: Federation of Danish Co-operatives (2000)

Model Development and Case Studies

3. The development of a model of Foreign Market Service Modes (FMSM) used by agricultural co-operatives in the process of internationalisation

While analysing the case studies that follow, it was found necessary to organize all the different Foreign Market Service Modes[1] (FMSM) used by the two studied agricultural co-operatives within a model.

The Federation of Danish Co-operatives (2000) defined 'international co-operative' as any co-operative that have initiated one or more of the following forms: export, alliances, direct investment and/or organisation of a transnational co-operative. The model, although useful, proved to be basic and limited for categorising certain FMSM. Pan & Tse (2000) developed a hierarchical model of entry market modes, which although

[1] Although the specialised literature tends to use the term foreign market entry mode, the term Foreign Market Service Mode (FMSM) was used, as this is considered to be more comprehensive.

very comprehensive and useful for differentiating FDI, JVs and wholly owned subsidiaries, is mainly focused to IOFs and therefore has limited application for agricultural co-operatives.

It is important to state that because of the exploratory nature of this case study (Yin, 1994) and because of the limited amount of existing research in the topic of internationalisation of co-operatives, the case studies description started using the mentioned existing models within the framework provided by the literature review, but as they proved their lack of fit, a new model was conceptualised (Figure 1). In this new model six main FMSM can be identified: exports, FDI, external sourcing, knowledge agreements, strategic alliances and formation of transnational co-operatives. Some of the main FMSM can in turn be subdivided into sub-modes like for example FDI into JVs and wholly owned subsidiary.

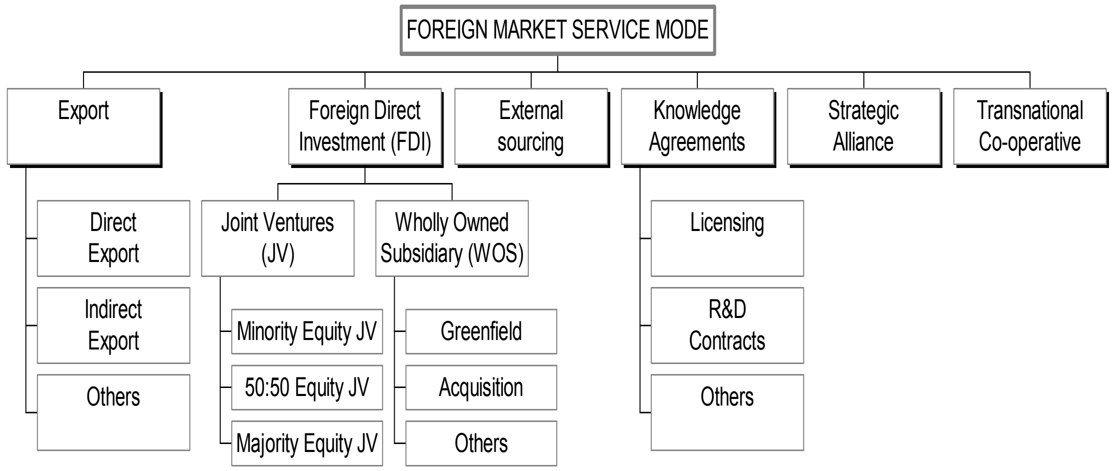

Figure 1: Model of Foreign Markets Service Modes used by agricultural co-operatives (Donoso, 2002)

Exporting, either directly or through intermediaries, is the most common way co-operatives enter international markets. For example, in 1995 over 90 US farmer co-operatives exported agricultural products individually valued at more than US$ 5.6 billion with around 70% of this consisting of commodities. In total co-operatives' exports accounted for about 12.3% of total US agricultural exports (USDA, 1997)

Foreign Direct Investment (FDI), which includes the establishment of subsidiaries and Joint-ventures (JV), is one of the most important forms of internationalisation used by co-operatives and by corporations in general, when internationalising.

External sourcing (also known as third party sourcing) is increasingly being used by co-operatives either to source non-competing products or complementary products, or to fill seasonal marketing windows. This last issue is especially critical in products where consumers expect year round availability, which is increasingly the case for all food products. Also foreign sourcing can broaden a co-operatives product line (USDA, 1997).

Knowledge agreements range from the simple sale of technology to licensing and franchising agreements, and it may represent the only alternative when trade and overseas investment are restricted/banned. Knowledge agreements involve minimal capital expenditure, if compared with the other servicing modes and they also represent a diversified source of income especially if technologies or managerial skills are under-utilised. On the other hand, knowledge agreements also imply risks, especially those associated with the lack of control that the licensor has over the licensee (Enderwick & Akoorie, 1996)

Co-operatives can form international alliances either with foreign co-operatives or IOFs. The alliance may be constructed either as an agreement to co-operate within specific areas (marketing, production, R&D) or it may be constructed as a mutually owned enterprise covering all operations within one specific sector. Finally, alliances with overseas co-operatives may be used as a previous step for the formation of transnational co-operatives (Normark, 1996). Although alliances are complex organizational processes, co-operatives are starting to find what IOFs have known for a while; '*Increasingly, global companies are forming strategic alliances… Globalisation mandates alliances, makes them absolutely essential to strategy'* (Omahe 1990, p. 482).

The transnational co-operative is maybe the most 'extreme' of all the forms of co-operative internationalisation and although it can be correctly argued that it cannot be considered as a FMSM because at the moment of establishing a transnational co-operative the foreign market becomes local, the formation of a transnational co-operative can be considered as the last step in the internationalisation of an agricultural co-operative. However, the concept of transnational co-operation inevitably raises the question of member unity over country borders, different languages and different cultures (Normark, 1996).

The Federation of Danish Co-operatives (2000) defined a transnational co-operative as a co-operative that has: members in two or more countries, where members are equal as regards to rights and obligations, and where members have a common commercial goal applicable. Transnational co-operatives are the results of either national co-operatives admitting members from foreign countries or mergers between co-operatives in different countries, although intermediate forms also exist, such as co-operatives with gradually affiliated foreign members or foreign supplier without influence and obligations. Joint co-operative ventures, or cross-border mergers between co-operatives constitute other feasible alternatives before the formation of transitional co-operatives (Verheijen & Heijbroek, 1994).

4. Fonterra Co-operative Group case study

4.1 Company overview

Fonterra Co-operative Group (Fonterra) is a truly global company co-operatively owned by the 13,000 New Zealand farmers-shareholders who supply it. Fonterra has 20,000 employees, over 90 subsidiary and associated companies worldwide, annual revenues of NZ$13.9 billion and assets of NZ$ 12 billion, generating over 20 percent of New Zealand’s export receipts and seven per cent of its Gross Domestic Product, making it New Zealand largest company.

In global terms Fonterra is the world’s largest exporter of dairy products, and the fourth largest dairy company in the world (Rabobank, 2002) responsible for about a third of international dairy trade. It operates, through its two main subsidiaries, NZMP (dairy ingredients) and New Zealand Milk (consumer products) in 140 countries.

Fonterra is the result of the merger of the New Zealand Dairy Group, Kiwi Co-operative Dairies and the New Zealand Dairy Board (NZDB) in October 2001, which saw the simultaneous removal of the NZDB’s statutory exporting monopoly and therefore the deregulation of the NZ dairy industry. Since its formation Fonterra has continued an aggressive programme of acquisitions, joint ventures and alliances worldwide.

The past season, starting with the supportive shareholders vote for Fonterra on June 2001, the finalisation of the merger on October 2001 and the presentation of its first annual report in July 2002, has been of record achievements for Fonterra and its farmers-shareholders including record revenues of NZ$13.9 billion, record processing of New Zealand milk of 1.1 billion kilograms of milksolids (kg ms), and a record payout to farmers-shareholders of $5.30 per kg ms. On the other hand, as the Shareholders’ Council summarised it in its Annual Report, although significant progress has been achieved, the performance of the company in a number of key areas has been disappointing.

4.2 Business internationalisation

Internationalisation, even in its most primitive forms (i.e. exporting), can easily be argued to be the only choice for most of agricultural co-operatives in New Zealand because of the very small domestic market and if Fonterra was located in the US for example, it is probable that its growth focus would be internal/national instead on the international markets, as it is the case for example with Dairy Farmers of America[2], but because Fonterra is based in New Zealand and because of historical dairy production levels it had no choice but to undertake the internationalisation path.

With a yearly production of over 1 billion of kg ms in a country of just over 3.5 million habitants there is clearly no option but internationalisation and this has been the case since the beginnings of the dairy industry in New Zealand. In fact when the name Fonterra was chosen, there was an obvious focus in choosing a name that was linguistically and culturally acceptable internationally, a name that would not limit the company to a defined geographical position or country, not even to New Zealand. Fonterra is involved in four out of the six modes of internationalisation from simple exporting to the formation of alliances, according to the model used in this study (Figure 1).

To understand Fonterra’s internationalisation it is important to understand its predecessor in terms of international marketing, the NZDB. Dobson (1992) described the internationalisation process adopted by the NZDB as a three-steps process as follows: the NZDB would initially work through an agent, then the NZDB would form a joint venture (JV) with the agent in order to expand sales and finally it would end acquiring the joint venture partner and establishing a subsidiary. Internationalisation, above the initial stages of simple exporting and use of traders, happened over a period of 30 years and it can be said that started with the objective of market diversification when the UK entered the European Union and the NZDB found itself with

[2] Dairy Farmers of America is the world biggest dairy co-operative but it is only a very small player in the international dairy markets.

a huge production and no secure market anymore, therefore it can be argued that internationalisation was a production-driven response.

An important point to noted before analysing the different modes used by Fonterra on its international markets is that because Fonterra exports 95% of its production and because of the internationalisation strategy followed, it is a net buyer of New Zealand dollars, therefore an important part of its performance in terms of turnover is based on the exchange rate of the NZ dollar against foreign currencies. In order to minimize its exposure to foreign exchange risk the company has cover mechanisms.

Fonterra finds itself now in front of new challenges, entering JVs of bigger scale than the NZDB ever did and entering into whole new foreign market service modes like the strategic alliance signed with Nestlé in the Americas.

4.3 Foreign Markets Service Modes (FMSM)

Export

Although Fonterra is a truly multinational company with wholly-owned subsidiaries and joint venture companies spread over the world, exporting is still Fonterra's foreign markets main service mode. The United States is Fonterra largest export market (over $500 million) with Japan being the second ($330 million). The company's top eight export markets are bordering the Pacific Ocean.

As declared by the company its exporting potential is greatest in markets which are net importers of dairy products such as South East Asia (especially Japan and Korea), the Middle East, North America and Latin America, Northern and Southern Africa, and China.

Foreign Direct Investment

Fonterra operates in 140 countries, having 35 manufacturing plants spread in different parts of the world (plus 29 in New Zealand). In addition to the already existing world-reaching network of companies that Fonterra inherited from the NZDB, the company has continued an aggressive programme of acquisitions and Joint Ventures (JV) with other dairy and food businesses. Major acquisitions and JVs have been completed in Europe, the Americas, Asia and Australia over the first twelve months of the company's existence (Table 2).

Table 2: Summary of overseas deals undertaken by Fonterra (season 2001-2002)

Country	Overseas business deals
US	50:50 JV with Dairy Farmers of America for commercial production of milk protein concentrate (MPC)
United Kingdom	JV with Arla Foods (Fonterra 25% and Arla 75%) Merger of existing operations and Anchor and Lurpak butter brands
Mexico	Acquisitions of La Mesa (cheese) and Eugenia (spreads) businesses Fonterra's New Zealand origin dairy sales in Mexico are expected to increase by more than $200 million annually
India	50:50 JV with Britannia Industries ($25 millions investment)
Australia	Formation of Australasian Food Holding Company Ltd (AFHL) through the merger of Fonterra's Australian and New Zealander consumer products businesses

Fonterra's interests in Australia

Of extreme importance in this analysis are Fonterra's interests in Australia both because of the strategic importance of Australia in terms of world dairy trade and because of the company's public definition of its home market considering New Zealand and Australia. Australia's strategic importance for Fonterra lies in the fact that Australia produces around 25% of the world's traded dairy products. That percentage summed to the 36% of world traded dairy products produced by New Zealand (of which Fonterra controls 95%) imply that the potentials for Fonterra in Australia are significant. Also, the fact of having a home market of 18.5 million people instead of only 3.5 million[3], creates the economies of scale in plants, processing and distribution, as well branding efficiencies across the Tasman Sea, which are easily rationalised due to the similarities of both markets.

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[3] Australia's population (15 million) added to New Zealand's 3.5 million gives a total of 18.5 million.

In July 2002, Fonterra and Melbourne based Bonlac Foods announced the merger of their consumer food products operations in Australia and New Zealand bringing together the Mainland and Tip Top businesses in NZ, with the Bonland Dairies[4] and Peters & Brownes businesses in Australia under the name of Australasian Food Holding Limited (AFHL). AFHL is the single largest operating company within Fonterra Group and the largest company in the Australasian consumer dairy business, having estimated annual sales of more than $2.3 billion. Fonterra's other interests in Australia besides AFHL and Bonlac Foods include an 18% stake in Australia's only listed dairy food company, National Foods.

External sourcing

Fonterra has 35 manufacturing plants outside of New Zealand, which receive and process milk externally sourced as well as dairy ingredients supplied from New Zealand in order to manufacture a diverse range of dairy products. *"If Fonterra wants to sell (offshore) yoghurt and semi-fresh high value products it needs to use non-New Zealand origin product. You can't export water profitably so it makes sense for us to source these ingredients from other suppliers"* – Greg Gent, Deputy Chairman, Farmlink magazine, December 2001.

On August 2001, NZMP signed an export agreement with Dairy America[5], a marketing company representing major US dairy co-operatives including DFA, Land O'Lakes and five smaller co-operatives, to export milk powder from the US on commission and by that way become the largest exporter of that category out of the US.

Strategic Alliances

On March 2002 Fonterra Co-operative Group and Nestlé S.A. signed a 50:50 alliance named 'Dairy Partners Americas' (DPA) which will set up JVs in North, Central and South America to market chilled dairy products, liquid milk and ingredient milk powders. JV companies formed under the alliance umbrella will have access to the brands of both companies. The alliance was classified by Fonterra's CEO, Craig Norgate, as *"New Zealand's biggest ever offshore commercial deal".*

DPA will initially have a staff of 10,000 and an estimated first year turnover of US$1.4 billions in a dairy market worth US$100 billion. Prior to the agreement, Nestlé was already Fonterra's largest client and largest competitor and now it has become its largest partner. It has been announced that DPA will amalgamate part of the businesses that Nestlé has in The Americas with some of the businesses Fonterra has in The Americas. Fresh milk for DPA will be sourced from the Americas itself but it will also represent opportunities for New Zealand sourced product including $300 million for Fonterra's New Zealand-origin dairy ingredients.

The logic behind DPA is the combination of both partners' complementary capabilities, in other words the combination of Nestlé's capabilities in branding and marketing (including brand management, market infrastructure, market knowledge and contacts with local governments and organisations, etc) with Fonterra's manufacturing capabilities (including large scale collection, processing, manufacturing and product development).

The possibility of becoming a Transnational Co-operative

Even though Fonterra's leaders have made a clear point in stating that the possibility of becoming a Transnational Co-operative is not in the immediate plans of the company and the debate has not been held, Fonterra's current involvement with other co-operatives overseas and international evidence of transnational co-operatives supports the theory that the possibility is not outside the realms of possibility.

Of extreme interest is Fonterra's relationship with the Australian co-operative Bonlac, when analysing the theoretical possibility of becoming an Australasian co-operative. Fonterra currently owns 25% of Bonlac Foods of which Bonlac Supply Co. owns 75%. If Fonterra eventually decides to accept overseas suppliers-shareholders there are key areas that need especial attention like a transparent payout price in order to avoid cross-subsidisation, as well as issues around the capital structure that are not the purpose of this study to analyse. Also and maybe of greater importance, before overcoming structural barriers the company will have to overcome cultural barriers[6].

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[4] Until the merger Bonland Dairies was a 50:50 JV owned by Fonterra and Bonlac Foods.

[5] Dairy America controls 70% of the US sales of skim milk powder.

[6] After the announcement of the formation of AFHL, Victoria dairy farmers president, Peter Owen, said, "*we would like the profits and money that circulate in the Australian dairy industry to stay here for the benefit of supplier*". Simultaneously, on the other side of the Tasman, NZ Dairy farmers chairman, Kevin Wooding, said, "*farmers here want to know they won't be propping up their Victorian counterparts*" (fencepost.com, 2 July 2002).

5. Zespri Group Limited case study

5.1 Company overview

Zespri Group Limited (Zespri) is the holding company of Zespri International, the world largest marketer of kiwifruit, with annual revenues of NZ$ 800 millions generated from the sale of over 65 millions trays of kiwifruit (2002 data); the group also includes Zespri Innovation and Aragorn Ltd. as subsidiaries. Zespri currently has a 25-30% year-round market share of the kiwifruit category; the percentage goes up to 60-70% when considering only the Southern hemisphere supply season. Zespri is the statutory single-exporter of all New Zealand kiwifruit to all world markets except for Australia.

Zespri is a grower-owned and grower-controlled organisation with a genuine co-operative voting system of votes tied to production levels and shares, set within an IOF/corporate structure. So unlike a traditional co-operative where growers must have shares to supply, in Zespri, New Zealand kiwifruit growers (about 2,500) can supply without shares, but in that case they do not receive the shares dividend. Therefore, for the purpose of this study, Zespri is considered as a co-operative hybrid.

The season 2001/2002 was extraordinary for Zespri, generating record revenues for the third consecutive season of NZ$800.4 million, a record net profit after tax of NZ$7.2 million and a dividend payment of seven cents per share, the first of its three years of history, for growers-shareholders. The company has made public its intention of becoming a billion dollar company in a relatively short period of time. Essential for this is the need to transform itself from a seasonal (7-8 months) marketer of New Zealand kiwifruit to a year-round marketer of kiwifruit in order to be able to supply customers on a continuous basis.

The year-round supply strategy has two parts: the first one is the marketing of Green kiwifruit produced in different parts of the world under the Zespri brand; the second part is the licensing and posterior marketing of the Zespri-owned Gold kiwifruit variety to selected producers around the world. The strategy though, is proving hard to implement due to difficulties in procuring sufficient volumes of quality offshore product and also because of the Gold variety licensing moving slower than predicted.

5.2 Business internationalisation

Based on the model being used for this study (Figure 1) we find that Zespri is involved in four out of the six FMSM: export, FDI, external sourcing and knowledge agreements. The first two have been the ones traditionally used by Zespri (and previously by the NZKMB) and only in recent years has Zespri slowly started to externally source product and to license its Gold kiwifruit variety.

Internationalisation as defined by this study has always been present in Zespri's business strategy and when the name 'Zespri' was chosen it was fundamental to select a name with no linguistic or geographical limitations. For Zespri, as a company with a 99% dependence on international sales, gaining and maintaining market access is critical. This was originally achieved by traders, further on by establishing representation offices and finally by establishing subsidiaries in selected markets[7].

"The development of offshore enterprises is the cornerstone for growth. It will enable us to enhance our leadership of the kiwifruit category, strengthen retail and consumer relationships, extend our influence through leveraging the Zespri brands and system and maximise future returns to both Zespri and Kiwifruit International shareholders" -Tony Marks, CEO Zespri, Kiwiflier letter, September 2000.

As current legislation in the New Zealand kiwifruit industry prevents Zespri from 'risking growers money by investing offshore', a separate company, Kiwifruit Internationalisation has been set up in order to somehow overcome the legislation and isolate New Zealand growers from offshore risk by underwriting Zespri's offshore activities.

5.2.1 Foreign Market Service Modes (FMSM)

Export

Although exporting is by far Zespri's main foreign market service mode, most of the volume is handled through subsidiary offices and therefore qualifies as FDI (see FDI service mode below). Because of New Zealand's counter seasonal nature, which means that in general terms Zespri starts trading New Zealand Kiwifruit when the local Northern hemisphere kiwifruit season is over, Zespri has no problems in terms of market access in any country of the world where it trades fruit[8].

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[7] For a more detailed study of the NZKMB, Zespri's predecessor, see Enderwick & Akoorie (1996).

[8] The only exception to that rule happened on the US in 1992 when the NZKMB was accused of dumping product in the US market and effectively banned from that market for eight years.

As defined on its annual report 2001, Zespri exporting strategy is to target Europe as the high volume and strong value market, Japan and selected Asian countries as premium markets (kiwifruit prices in Japan are generally 50% above the average global price) and North America for absorbing the extra Green and Gold kiwifruit. By spreading markets the company is able buffer the impact of low prices in any determined market, even though the company is highly dependent on Japan and Europe, where over 80% of its export revenues are originated.

Foreign Direct Investment

Zespri International has a number of subsidiaries, but the world is essentially divided into two marketing arms, one of them is Zespri Europe with its headquarters in Belgium, which has subsidiaries under in France, Spain, Italy and the UK. The other marketing arm is the Asia Pacific, which is based in Japan and includes the Americas-Asia Pacific area and it also has subsidiary offices in Korea and Taiwan. Zespri also has a minority equity interest in a North American fruit trading company, David Oppenheimer & Company.

External sourcing

The 12-month supply business strategy based on the complementation of New Zealand grown kiwifruit with externally sourced fruit (mainly from Italy and the US, but also from California and potentially Chile) is proving hard to achieve for Zespri; first attempts of externally sourcing Green kiwifruit were done in 1999 and after three seasons, problems in ensuring quality and sufficient volumes have kept the strategy still on its infancy and even delivering red numbers (in 2001-2002 a $136,000 financial loss was underwritten by Kiwifruit International).

Knowledge agreements (licensing)

Zespri International manages the licensing, harvesting and distribution of Gold kiwifruit. The licensing contractual relationship indicates that Zespri owns the plant variety rights of Gold, the selected growers grow the fruit on behalf of the company, who finally takes the fruit and markets it under Zespri systems. By 2002 there were over 300 hectares of Gold kiwifruit being grown in Italy, 300 hectares in California as well as small areas in France and Japan, but as the company has admitted offshore licensing is moving slower than expected. Considering that the intention of the company is to complement New Zealand's Gold kiwifruit production (currently 2000 hectares), the current 600-700 hectares are at least a third of the ideal area.

The possibility of having overseas growers-shareholder and becoming a transnational co-operative hybrid

Although Zespri has repeatedly manifested its intention of remaining New Zealand growers-owned and controlled and it is not part of the current strategy to accept overseas growers-shareholders, the potential benefits that can be obtained from having international suppliers-shareholders and also, overseas growers manifested interest in getting into partnership arrangements with Zespri make the possibility worthy of analysis.

Zespri is currently working closely with Italian and North American growers. This close collaboration implies that technical assistance is being provided to overseas growers and also that overseas growers are being trained in New Zealand. Is it possible that over time these contractual relationships will evolve to partnership agreements and accepting overseas growers-shareholders? Time will tell. If Zespri eventually decides to introduce offshore growers as shareholders there are several structural, legal and cultural barriers it has to overcome, with probably the last one being the most difficult. At this specific point in time Zespri's short-term priorities on the international side are on making the 12-month supply strategy work.

Conclusions

Internationalisation has become a reality that agricultural co-operatives cannot and are not longer ignoring, although limited research exists on this topic. In this paper a new model of Foreign Market Service Modes (FMSM) for agricultural co-operatives in the process of internationalisation was developed. The new model, proved to be useful for organising the vast array of FMSM used by the two studied co-operatives and of others found in the literature. Also identified in the research was the need to determine agricultural co-operatives can successfully internationalise without generating conflicts with their members or distancing from them.

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The impact of the 1997 swine FMD outbreak in Taiwan on demand for Australian beef

Hui-Shung (Christie) Chang, University of New England, Armidale and Chung-Jen Hsia Agricultural Marketing Division, Council of Agriculture, Taipei, Taiwan[9]

The market position of a seller depends on a number of factors such as relative prices, quality and reliability of supply, and the willingness and ability of the supplier to meet changing consumer preferences and market conditions. In terms of meeting changing market conditions, there have been a few significant events in the Taiwan meat market in recent years that provided Australian beef suppliers with opportunities for improving their market position. One such opportunity was the outbreak of foot-and-mouth disease (FMD) in pigs in March 1997.

Because pork consumption accounted for about one third of total meat consumption in Taiwan, averaging 40 kg per person per year, a significant reduction in pork demand due to food safety concerns could be expected to lead to an increase in the consumption of other meats, including beef. Because more than 90 per cent of beef consumed in Taiwan is imported, mainly from Australia, New Zealand and the United States, a move away from pork and towards beef would appear to present a marketing opportunity for all beef suppliers to Taiwan, including Australia.

The objective of this study is to determine the impact of the FMD outbreak on the demand for Australian beef in the Taiwan market. The analysis provides market intelligence on one of Australia's key export markets, which is relevant to the development of appropriate marketing strategies by the Australian beef industry for improving market position.

The paper begins with an overview of the FMD outbreak in March 1997 and a brief description of the beef market in Taiwan, including trends in beef consumption and beef imports. In the following section, the empirical models examining factors affecting beef import demand are developed and explained. The modelling results are then discussed, followed by implications for the Australian beef industry and concluding remarks.

FMD Outbreak in pigs

In March 1997 an epidemic of FMD in pigs broke out in Taiwan, more than 68 years after the last eradication in 1929. The first suspected case was noted on 14 March 1997 on a pig farm in Hsinchu prefecture south of Taipei. The case was confirmed by the Taiwan Animal Health Research Institute on 19 March and verified by the FMD World Reference Laboratory in Pirbright, United Kingdom on 25 March. The disease spread quickly throughout the island but was contained within two months by means of stamping out and blanket vaccination. During the epidemic, 1,300 farms were affected in March, followed by 3,864 farms in April, 975 farms in May, five farms in June and three in July. By the end of July, a total of 6,147 pig farms had contracted the disease, about one quarter of all pig farms in Taiwan (Shieh 1997). Among the 4.66 million pigs found on the infected farms, about 185,000 died of the disease. The remaining, including 1.01 million pigs showing clinic signs of FMD, were destroyed and disposed of by burying, incineration, rendering or burning. When the epidemic was over in July, about 40 percent of the total pig inventory was lost.

The pig price dropped dramatically, from $NT (New Taiwan dollars) 55 to $NT 17/kg immediately after the announcement of FMD outbreak by the Council of Agriculture on 20 March, and remained low at about one quarter to one half of the original price for one and a half months (Shieh 1997). In late-May, the pig price returned to $NT 40/kg temporarily but soon fell back to $NT30/kg and stayed there for quite some time. Since the cost of production was estimated to be around $NT 40/kg, the loss to producers was devastating. Monthly pork retail prices between January 1996 and December 1998 are shown in Figure 1.

There were two reasons for the significant fall in pig prices. Firstly, about 40 percent of pigmeat is exported. Japan, the biggest export market, accounted for more than 90 percent of total Taiwan pigmeat exports (Ho 1997). The outbreak of FMD meant that all pigmeat exports to Japan (about 27 million tonnes per year) were banned and had to be diverted to the domestic market, resulting in a glut, and hence the price fall, in the

[9] Dr Hui-Shung (Christie) Chang is Senior Lecturer in the School of Economics, University of New England, Armidale and Dr Chung-Jen Hsia is Research Fellow in Agricultural Marketing Division, Council of Agriculture, Taipei, Taiwan. The contact numbers for Chang are: (02) 67732855 by phone and hchang@pobox.une.edu.au by e-mail.

Taiwan market (Shu 1998). Secondly, immediately following the outbreak, consumers were very concerned about food safety and the effect on human health. Despite assurance from the government, consumers were sceptical and the demand for pork fell. The combined effect of an increase in supply and a decrease in demand contributed to the significant fall in pig prices. The food scare, and hence, the reduction in demand, was alleged to have lasted from six to 12 months (Yang et al. 1999).

The pig industry is a major livestock sector in Taiwan, accounting for 21.10 percent of total value of agricultural production in 1996. In 1997, the figure dropped to 11.79 percent. The corresponding figures for 1998, 1999 and 2000 were 13.02, 15.68 and 14.28 percent, respectively (Taiwan Provincial Government 2001). The economic impacts of the FMD outbreak on the pig and related industries were substantial. The total costs were estimated to be about $NT 106 billion (equivalent of $US3.8 billion), including the costs of vaccination and disposal of pigs, compensation to farmers[10] and losses in revenues due to the export ban and price fall (Yang et al. 1999). The loss in export revenues alone was estimated to be around $NT 16 billion (equivalent of $US 0.6 billion) per annum. The loss of jobs in the pig industry and related industries was estimated to be around 65,000. GDP was reduced by $NT 400 billion (equivalent of $US 14.34 billion). As a result, the economic growth rate in 1997 was adjusted downward by 0.5 percentage point to reflect the severity of the damage to the economy (Ho 1997).

Meat consumption in Taiwan

Pork has been the major meat item for the Taiwanese during the past three decades. Since 1995, annual per capita consumption has been about 40 kg, accounting for about one third of total meat consumption (Table 1). Total meat consumption includes pork, beef, lamb, poultry and seafood. It is clear from Table 1 that annual per capita beef consumption in Taiwan (3.29 kg in 2001) is very low, compared with pork, chicken and fish/seafood. This is because beef is traditionally not a major meat item in the Taiwanese diet and domestic supply has been limited. Beef consumption has increased slightly since the mid-1970s as a result of market liberalisation, economic growth and changing consumer lifestyles (Hsu 1997).

However, beef consumption in Taiwan is likely to remain low with limited growth (Chang and Hsia 2000). Consumer perceptions and relatively high beef prices were given as the main reasons for the slow growth in beef consumption (Asian Market Intelligence 1994). Another reason for the slow growth is that Taiwan is a mature market for animal protein and it is difficult for beef to gain a substantial foothold (CIE 1995). That is, per capita meat consumption of about 120kg (see Table 1) is similar to developed countries such as Australia and Japan. Therefore, an increase in beef consumption may have to come at the expense of other meats. In general terms, market share can be increased by providing a better product, lowering price, improving access and product promotion. However, changes in the environment may also create marketing opportunities. The FMD outbreak in March 1997 would seem to have provided such an opportunity whereby pork consumers can be lured towards eating more beef. Indeed, Tsai (1999) found that following the FMD outbreak, consumers had substituted beef and chicken for pork. Table 2 shows the changes in monthly per capita meat consumption before and after the FMD outbreak.

Beef imports

As stated above, beef production in Taiwan is quite small and over 90 percent of beef consumed is imported. Domestically produced beef came mainly from culled dairy cattle and draft yellow cattle. Since the beef market liberalisation in 1975, beef imports in Taiwan have increased from 156 tonnes in mid-1970 to 56 904 tonnes in 2001 (Council of Agriculture 2001). The ratio of total beef imports over total beef consumption has increased from 20 percent in 1974 to more than 90 percent since 1985 (Taiwan Provincial Government 2001).

Australia has been the largest supplier to Taiwan, followed by New Zealand and the United States. Based on frozen beef imports during 1989-2001, market shares, in volume terms, for Australia, New Zealand and the United States were 63, 21 and 16 per cent, respectively. The average unit import values (CIF) are $US 2.71/kg, $US 3.84/kg and $US 5.27/kg (see Table 3). It is clear that Australian beef is relatively cheaper than New Zealand beef, which, in turn, is cheaper than US beef. It is also clear that the market share, import quantity and price of Australian beef in Taiwan are more stable than the United States or New Zealand, as indicated by the coefficients of variation (CoV) in Table 3 (last column). Notice that the CoVs for prices are 0.23, 0.15 and 0.25 for US, Australian and NZ beef, respectively. The corresponding figures for quantities imported are 0.52, 0.24 and 0.52.

The price differentials reflect transport differentials and quality differentials among different sources of supply. Quality differentials of frozen beef imports are attributable mainly to differences in production methods (grass-fed versus grain-fed), degree of processing (eg whole carcass, boxed beef, bone-in versus

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[10] The compensation made to pig producers was as follows: $NT 350 per head for the suckling piglets less than four weeks old; $NT 24/kg for the fattening pigs; and $NT 4800 per head for breeding pigs (Shieh 1997).

boneless) and retail cuts (eg sirloin steak versus shin shank) (Chang and Hsia 2000). Generally speaking, US beef is considered of higher quality, comprising grain-fed beef, and is classified as "special grade" for tariff purposes (Hwang 1993). By comparison, Australian and NZ beef and domestically produced beef are classified as "general grade". The quality of beef determines where the products go. For example, US and NZ beef tend to go to the Western-style restaurants and modern supermarkets. Australian beef (comprising mostly shin shank, intercostals and other lower value parts), on the other hand, goes mainly to the Chinese restaurants and the local wet markets (Chen and Hsiao 1995; CIE 1995; NZMPB 1997).

Total frozen beef imports from January 1989 to December 2001 are shown in Figure 2. Imports from Australia, United States and New Zealand are shown in Figures 3 – 5, respectively. Note that immediately after the FMD outbreak in March 1997, there appeared to be increases in both total and Australian beef imports for three months (April, May and June), which were followed by four consecutive falls from July to October. By comparison, US beef imports seemed to fall immediately in April, increased in May, June and July, fell again in August, increased again in September and fell again in October and November. For NZ beef imports, there was an initial fall in April, followed by two consecutive increases in May and June, which were followed by four consecutive falls from July to October. So, did the FMD outbreak have an impact on beef imports? An econometric demand model was developed to help shed lights on this seemingly ambiguous situation just described.

Data sources

The data used for the empirical analysis are monthly data from January 1989 to December 2001 on volumes and values of frozen beef imports from Australia, the United States and New Zealand. Data on imports are obtained from *Monthly Statistics of the Republic of China*, published by the Directorate-General of Budget, Accounting and Statistics. The data set provides a total of 156 observations.

Empirical model

In this section, the empirical model is developed for examining the impact of FMD on the demand for beef from individual beef suppliers to Taiwan. Initially, a variety of specifications were experimented in the preliminary analyses, including the LA/AIDS model of Deaton and Muellbauer (1980a) (which uses value shares as the dependent variables) and the use of volume shares as dependent variables. Despite desirable theoretical properties associated with the Almost Ideal Demand System (AIDS) and the linear approximation of AIDS (LA/AIDS) and the attraction of using volume share (which is a common measure for market share and market position), results from the preliminary analyses indicated that the model presented in equation (1) below is most appropriate for examining the beef market in Taiwan. That is, the models yield more reasonable results in terms of goodness-of-fit, signs and magnitude of the estimated coefficients, as compared with the LA/AIDS model or the volume share specification. At the end, import demand equations for individual suppliers are specified as

$$Q_{it} = \alpha_i + \delta\, Q_{it-1} + \beta_{i2}\, P_{AUS,\,t}/P_{USA,t} + \beta_{i3}\, P_{NZ,\,t}/P_{USA,t} + \Upsilon_i\, Qtotal_t + \sum_l \phi_l\, FMD_{-l} + \sum_k \varphi_{ik}\, D_k + \varepsilon_{it}, \quad i = \text{Australia, New Zealand and the United States,}$$

where

Q_{it} = the volume of frozen beef import from source i at time t; and t = 1 (January 1989), 2 (February 1989), ..., 156 (December 2001);

Q_{it-1} = the volume of frozen beef import from source i at time t-1;

$Qtotal_t$ = the volume of total frozen beef imports at time t;

P_{AUS} / P_{USA} = the ratio of unit import value of frozen beef imports from Australia (P_{AUS}) to the unit import value of the United States (P_{USA});

P_{NZ} / P_{USA} = the ratio of unit import value of frozen beef imports from New Zealand (P_{NZ}) to the unit import value of the United States (P_{USA});

FMD = a dummy variable used to capture the impact on beef imports of the FMD outbreak in March 1997, where FMD = 1 for March 1997 and FMD = 0 elsewhere;

FMD_{-l} = FMD lagged l period; l = 0, 1,2,…,6;

D_k = a set of monthly dummy variables using January as the reference point, where k = 2 (February), 3 (March),..., 12 (December); and

ε_{it} = white noise error term which may be contemporaneously correlated.

Equation (1) states that the demand for beef import from each supply source depends on relative prices of imported beef, the volume of total imports, the FMD outbreak, and seasonality. To have a workable model, it is assumed that (1) imported frozen beef is separable from domestically produced beef and other meats and total beef imports are exogenous; (2) prices are exogenous; and (3) frozen beef from different sources are differentiable by source of origin. The separability assumption is a necessary and sufficient condition for examining demand for beef imports as a group under a multi-stage utility maximisation process discussed in Deaton and Muellbauer (1980b, pp. 127 - 134).

Product differentiation by source of supply was proposed by Armington (1969). The price exogeneity assumption is justified on the basis that total beef imports into Taiwan are small relative to total beef exports from each of the supply sources, either individually or jointly. For example, in 2000, the volume of beef exported to Taiwan accounted for only 2.8 percent of total beef exports by Australia, United States and New Zealand (ABARE 2001). Therefore, changes in beef demand in Taiwan are not expected to have an impact on individual import prices.

In addition, it is postulated that the response of beef imports to the FMD outbreak is not immediate or complete at the end of March 1997, when it first occurred. Rather, the response may be delayed, as well as distributed over a period of time. Distributed lagged responses are likely because of uncertainties surrounding the severity of, and consumer's reaction to, the outbreak. Also, the impact of the outbreak is postulated to be linear and no restriction is imposed on the lag structure.[11] That the impact of FMD lasted between 6 to 12 months, as suggested in Yang et al. (1999), was tested based on likelihood ration tests. A 6-month duration was found to best represent the demand response.

The assumption that the error terms in Equation (1) may be contemporaneously correlated means that there may be efficiency gain if the three equations are estimated as a system. Further, as a system the error variance-covariance matrix in Equation (1) is singular because individual import quantities on the left hand side of the equations add up to total imports on the right hand side. Therefore, only two equations needed to be estimated jointly.[12] However, the system results based on Seemingly Unrelated Regression (SUR) indicated that cross-equation correlation between the equation errors was weak. This means that there is little efficiency gain from the systems estimation. Indeed, when the results from SUR and Ordinary Least Squares (OLS) for US and NZ equations were compared, they were almost identical. Therefore, the three imports demand equations were estimated individually using OLS procedure.

Because autocorrelation (AR(2)) was detected in the Australian equation, it was re-estimated using the iterative Cochrane-Orcutt procedure.[13] The estimated coefficients of autocorrelation are 0.69 and 0.19 and statistically significant at the five per cent level. An AR(2) process in the residuals means that random effects on the quantity imported in this period are correlated with the random effects in the preceding two periods. All econometric work was based on Shazam (Version 8.0) (White 1996).

Estimated results

The estimated results based on equation (1) are presented in Table 4. Firstly, the estimated regression equations explain between 72 and 87 per cent of the variations in individual import demands. Secondly, all of the estimated price coefficients have the expected signs. That is, estimated own-price coefficients are negative while estimated cross-price coefficients are positive. These results are consistent with demand theory and confirm Armington's proposition that imports from different sources are potential substitutes. However, not all the estimated price coefficients are statistically significant at the 10 per cent level. This means that prices are not important in determining individual import demands. In addition, there are strong seasonality in the demand for Australian and New Zealand beef and the impact of FMD outbreak on demand is almost nil.

Estimated demand elasticities are presented in Table 5. These elasticities are defined as the percent change in quantity demanded with respect to a one percent increase in either prices or total imports. One finding is that, while demands for beef from Australia and New Zealand are inelastic with respect to their own-prices,

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[11] A quadratic distributed lag structure was tested in the preliminary analysis but rejected in favour of an unrestricted linear structure. A quadratic distributed lag means that the impact on consumer demand is assumed to be small originally but gains momentum as fear is reinforced by more deaths and negative publicity through media reports. Concerns of health hazard eventually dies off as the outbreak is under control and consumers are re-assured of food safety.

[12] The Australian equation was the equation that was deleted because the presence of autocorrelation while the US and NZ equations were free from autocorrelation. By using the latter two equations, the estimation procedure is simplified as there is no need to transform the data as would be required if the Australian equation was used.

[13] Because of monthly data that were used in the analysis, AR(12), which means that the random effects on demand in a particular month are correlated with that of the same month in the previous year, was tested for all three equations but rejected.

the demand for US beef is own-price elastic. Specifically, the estimated own-price elasticities are –0.16, -0.18 and –2.83 for Australia, New Zealand and the United States, respectively. This means a one percent increase in the own-price would result in 0.16 and 0.18 percent decreases, respectively, in Australia's and New Zealand's beef exports to Taiwan. By comparison, a one percent increase in the US beef price would result in a 2.83 percent decrease in the quantity demanded of US beef. Another finding of the analysis is that cross-price effects are positive but small in magnitude, with one exception that the estimated cross-price elasticity for Australian beef with respect to US price is 1.43. The latter result means that a one percent increase in the price of US beef will result in a 1.43 percent increase in the quantity demanded of Australian beef. This means that Australia beef is a strong substitute for US beef. There is also indication that NZ beef is not a strong substitute for either Australian beef or US beef. Some of these results need to be considered with caution since not all the estimated elasticities were statistically significant at the five percent level. Nevertheless, the differing results suggest that the beef market in Taiwan is complex and more research, perhaps more of a qualitative nature, is required to help explain the differences.

The estimated coefficients associated with total imports are positive for all three demand equations and statistically significant at the one percent level. This result implies that demands for beef from all suppliers increase with an increase in total import demand. However, the distribution of the increase is not even across suppliers. This can be seen from the somewhat different elasticity estimates associated with total imports, shown in column 5 of Table 5; the estimates are 0.96, 0.97 and 1.14 for Australia, New Zealand and the United States, respectively. They suggest that when there is a one per cent increase in total beef imports, the quantity demanded of Australian beef will increase by 0.96 per cent while the increases in NZ and US beef will be 0.97 and 1.14 per cent, respectively. The overall response to the total imports seems to suggest that although Australian demand may be increasing in absolute terms, the rate of increase is less than the overall growth. This may eventually lead to deterioration in market share of Australian beef and competitive position in the Taiwan market. One explanation suggested in Chang and Hsia (2000) was that Australian beef exported to Taiwan tended to be of lower quality, compared with NZ and US beef. This might have worked well in the past when consumers were less aware of quality differentials in beef and lower quality beef had suited traditional ways of cooking beef in Taiwan. However, as consumers become more affluent and better informed demand for higher quality products will increase.

Seasonality also appears to be strong in affecting beef import demands. In particular, the modelling results show that at the five percent level of significance, Australian demand is statistically significantly lower from February through to August and statistically significantly higher in November and December, as compared to the reference month of January.

By comparison, the demand for NZ beef is statistically significantly higher in March and statistically significantly lower in September, October and November, as compared to January. Further, the demand for US beef does not show any seasonality at all because all the coefficients associated with seasonality dummies are statistically insignificant. Since total beef imports to Taiwan were found to be significantly lower in February, September and December than in January in the preliminary analysis,[14] the seasonal patterns found here seem to suggest that when total beef import demand is at its lowest as in February, the reduced demand appears to be absorbed mostly by Australia.

One possible reason for this coincidence is the fact that Australian beef is sold mostly in the wet markets which are patronised mostly by households and small businesses. During the festival months, when households are buying more pork and chicken for ceremonial purposes, demand for beef in the wet markets is therefore substantially reduced. By comparison, US and NZ beef focuses on restaurant trade, demand for which is less affected by traditional festivities and cultural events.

When comparing seasonality among suppliers, the lack of seasonality in the import demand for US beef may be due to the nature of grain-fed beef, supply of which is less affected by weather and season and hence allowing more consistent supply throughout the year. Grass-fed beef from Australia and New Zealand, on the other hand can be affected by weather and hence has more pronounced seasonal production and hence supply.

Note that the seasonality indicated by the estimated results are not quite agreeable with those illustrated in Figures 3-5. This is because the patterns seen in those figures are a joint effect of a number of factors, including seasonality, prices, total imports and FMD. As such, the coefficient associated with the monthly dummy variable is the net effect of seasonality after the impacts of all other factors have been accounted for. Pure seasonal patterns in total and individual imports were shown in Figure 6 using monthly averages. It seems clear that seasonality are most apparent in total and Australian beef imports. Moreover, seasonality in Australian imports follows closely with seasonality in total imports.

[14] The model specification and estimated results are available from the authors upon request.

Finally, let us look at the results pertaining to the outbreak of FMD. All individual coefficients associated with the FMD variables are statistically insignificant at the five per cent level of significance with only one exception (see Table 4). The exception is that there was an increase in the demand for US beef five months after the outbreak. The FMD coefficients also were tested jointly as a group based on likelihood ratio tests. The calculated χ^2 - statistics are 7.84, 10.04 and 12.12 for Australian, NZ and US equations, respectively. They are smaller than the tabulated value of 14.07 with seven degrees of freedom at the five per cent level of significance. These results mean that although demand might have changed (some increases and some decreases) over the 6 months period, overall the FMD outbreak had had very little impact on demand for beef from individual suppliers. Again, after factoring out the impacts of other variables, the changes in import demands are not as apparent or profound as what appear in Figures 2-5. The differing results imply that evaluation of the impact of FMD using data for the adjacent months only may be quite misleading.

Policy implications

The current analysis showed that the impact of the FMD outbreak on beef consumption was marginal and only temporary, which dissipated within six months. However, that the outbreak had had little impact on the import demands from individual suppliers may suggest that there was a missed opportunity for beef suppliers, including Australian. Given that food scares are generally short-term in nature in terms of its impact on consumption patterns, a quick response and a more aggressive marketing campaign from the Australian beef industry immediately after the outbreak may have resulted in an increased sales at least in the short term and an improved market position in the longer term.

The minimal and short term effects on pork demand this time around does not necessarily suggest that consumers will continue to be forgetful and forgiving in the future. Research has shown that consumers are becoming more demanding and vigilant when it comes to food safety as they become more affluent, as well as more aware and knowledgeable of the events happening around them. This means that next time around, any food scare may have a more permanent effect on consumers' preferences and consumption behaviour, which may create a serious problem for some suppliers while providing opportunities for others depending on their readiness to respond to changing market conditions.

Moreover, Australia and New Zealand appear to be in direct competition with each other, more so than with the United States. This observation is made based on the different and opposite seasonal patterns observed between Australia and New Zealand and the fact that the estimated own-price total imports elasticities for both countries are very similar. This implies that some purchasing policies exist that seem to play Australia and New Zealand against each other. The United States on the other hand seems to be in the league of its own for some reason.

Conclusions

In March 1997, a FMD epidemic broke out in Taiwan and within four months 40 percent of the pig population was wiped out. The demand for pork fell substantially following the outbreak due to food safety concerns. The objective of this study is to determine the impact of the FMD outbreak, as well as other demand shifters, on the demand for Australian beef in the Taiwan market. Demand for beef imports from Australia, the United States and New Zealand were estimated econometrically based on monthly data from January 1989 to December 2001.

The major finding was that the FMD outbreak had little impact on the demand for Australian beef export to Taiwan. Similar results applied to beef from New Zealand and the United States. The analysis also found that there was strong seasonality in beef imports; however, the patterns of seasonality differed among suppliers. Another finding was that Australia is in direct competition with New Zealand, but less so with the United States.

The fact that the outbreak had had little impact on the import demands from individual suppliers may suggest that there was a missed opportunity for beef suppliers, especially Australia given its proximity to Taiwan. Given that food scares are generally short-term in nature regarding their impact on consumption behaviour, a quick response and a more aggressive marketing campaign from the Australian beef industry immediately after the outbreak might have resulted in increased sales at least in the short term. However, in future the effect may be longer lasting. There is evidence that consumers are becoming more vigilant, less forgetful and less forgiving, so another large-scale food scare may in fact lead to a permanent change in consumption patterns. Marketers who are not well-prepared for quick actions next time around may lose substantial sales.

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Table 1. Annual per capita red meat consumption and shares in Taiwan in selected years

	Beef/Veal		Pork		Mutton/Lamb		Poultry		Fish/Seafoods		Total
	Kg	%	Kg	%	Kg	%	Kg	%	Kg	%	Kg
1965	0.39	0.92	12.07	28.57	0.06	0.14	1.99	4.71	27.74	65.66	42.25
1975	0.94	1.50	17.51	28.00	0.17	0.27	8.36	13.37	35.56	56.86	62.54
1985	1.66	1.79	34.23	36.92	0.39	0.42	18.02	19.44	38.41	41.43	92.71
1995	3.16	2.76	39.76	34.76	1.04	0.91	32.09	28.05	38.34	33.52	114.39
1996	2.81	2.48	40.62	35.81	1.10	0.97	30.49	26.88	38.42	33.87	113.44
1997	**3.44**	**2.88**	**39.05**	**32.66**	**1.30**	**1.09**	**33.49**	**28.01**	**42.30**	**35.37**	**119.58**
1998	3.29	2.80	41.13	34.98	1.25	1.06	32.49	27.63	39.41	33.52	117.57
1999	3.75	3.09	38.76	31.91	1.36	1.12	33.89	27.90	43.72	35.99	121.48
2000	3.31	2.81	39.50	33.53	1.28	1.09	33.37	28.33	40.34	34.24	117.80
2001	3.29	2.57	41.13	32.13	1.25	0.98	32.94	25.73	49.41	38.60	128.02

Source: Taiwan Agricultural Yearbook, Taiwan Provincial Government.

Table 2. Monthly per capita meat consumption (in kg), 1996.1-1997.12

	Pork	Beef	Chicken
1996 Jan	4.364	0.268	2.418
Feb	3.941	0.167	2.038
Mar	4.294	0.189	2.303
Apr	3.405	0.227	2.436
May	3.712	0.198	2.704
Jun	2.216	0.169	2.641
Jul	3.891	0.185	2.864
Aug	4.140	0.228	2.916
Sep	3.98	0.166	2.866
Oct	4.056	0.207	2.892
Nov	4.349	0.144	2.751
Dec	4.195	0.111	3.399
1997 Jan	4.263	0.190	2.963
Feb	3.266	0.119	2.160
Mar	2.796	0.218	2.58
Apr	3.78	0.224	2.795
May	2.979	0.297	3.225
Jun	3.088	0.355	3.298
Jul	3.518	0.307	3.210
Aug	4.052	0.266	3.112
Sep	4.359	0.247	3.053
Oct	4.756	0.190	3.393
Nov	4.281	0.196	3.222
Dec	4.244	0.218	3.011

Source: Tsai, 1999.

Table 3. Descriptive statistics of the monthly import data, 1989.1-2001.12

Variable[a]	Mean	St. Deviation	Minimum	Maximum	CoV
QS_{USA}	0.16	0.07	0.04	0.34	0.42
QS_{AUS}	0.63	0.11	0.39	0.84	0.18
QS_{NZ}	0.21	0.08	0.05	0.41	0.39
Q_{USA}	632.30	326.66	114.70	1591.80	0.52
Q_{AUS}	2478.30	600.00	947.21	4356.10	0.24
Q_{NZ}	878.41	457.72	74.19	2210.20	0.52
P_{USA}	5.27	1.20	3.02	8.07	0.23
P_{AUS}	2.71	0.42	1.95	3.40	0.15
P_{NZ}	3.84	0.95	2.41	7.71	0.25
Q_{TOTAL}	3989.00	980.44	1432.10	7067.30	0.25

[a] The variables are defined as follows:
QS, Q and P are the volume share, import quantity (in tonnes) and unit import price (in $US/kg) for beef from the United States, Australia or New Zealand, respectively; and Q_{TOTAL} is the total beef imports (in tonnes) from the three major suppliers.

Table 4. Estimated results of import demand equations, 1989.1-2001.12

	Australia [a]	New Zealand	USA
Qt-1	-0.07 (-1.76)[b]	0.47 (8.52)	0.53 (10.43)
Paus/usa	-771.81 (-2.12)	172.21 (0.64)	47.64 (0.20)
Pnz/usa	100.57 (0.50)	-221.95 (-1.33)	291.77 (2.05)
Pusa[c]	671.24 (3.50)	49.74 (0.23)	-339.41 (-1.13)
Qtotal	0.60 (22.99)	0.21 (8.73)	0.18 (8.73)
D2	-360.67 (-4.96)	156.91 (1.69)	12.07 (0.16)
D3	-453.39 (-5.13)	193.79 (2.19)	59.28 (0.81)
D4	-466.94 (-5.07)	173.37 (1.87)	-63.79 (-0.87)
D5	-313.43 (-3.24)	-52.59 (-0.54)	-50.40 (-0.69)
D6	-306.03 (-3.09)	56.60 (0.62)	-73.49 (-1.02)
D7	-231.35 (-2.32)	38.76 (0.43)	-135.93 (-1.92)
D8	-290.91 (-2.93)	58.48 (0.64)	-87.68 (-1.23)
D9	-161.78 (-1.71)	-213.39 (-2.20)	-38.46 (-0.54)
D10	-37.03 (-0.43)	-194.26 (-2.31)	45.69 (0.66)
D11	237.40 (3.10)	-337.06 (-4.07)	-43.36 (-0.62)
D12	160.48 (2.39)	-151.92 (-1.83)	7.56 (0.11)
FMD	-63.31 (-0.29)	193.18 (0.91)	188.35 (1.04)
FMD-1	221.93 (0.85)	-150.73 (-0.71)	40.00 (0.22)
FMD-2	258.69 (0.90)	-98.88 (-0.46)	126.81 (0.69)
FMD-3	-180.31 (-0.59)	396.91 (1.80)	-195.84 (-1.04)
FMD-4	-251.54 (-0.85)	-269.82 (-1.23)	87.05 (0.48)
FMD-5	126.28 (0.49)	-248.79 (-1.16)	-221.60 (-1.21)
FMD-6	-108.49 (-0.49)	-316.78 (-1.49)	494.37 (2.72)
Constant	776.90 (2.81)	-290.45 (-1.81	-633.54 (-4.65)
Adjusted R^2	0.87	0.80	0.72

[a] The Australian equation is estimated using iterative Cochrane-Orcutt procedure to correct for AR(2).
[b] The figures in parentheses are t-ratios.
[c] These price coefficients are recovered from the homogeneity conditions implied by using relative prices. And their t-ratios are calculated accordingly based on the usual formula.

Table 5. Estimated demand elasticities

	Australian price	NZ price	US price	Total imports
Australia	-0.16**[a]	0.03	1.43**	0.96**
New Zealand	0.10	-0.18	0.30	0.97**
USA	0.04	0.33**	-2.83	1.14**

[a] ** indicates that the estimated elasticities are statistically significant at the five percent level.

Figure 1. Pork prices in Taiwan, 1996.1 - 1998.12

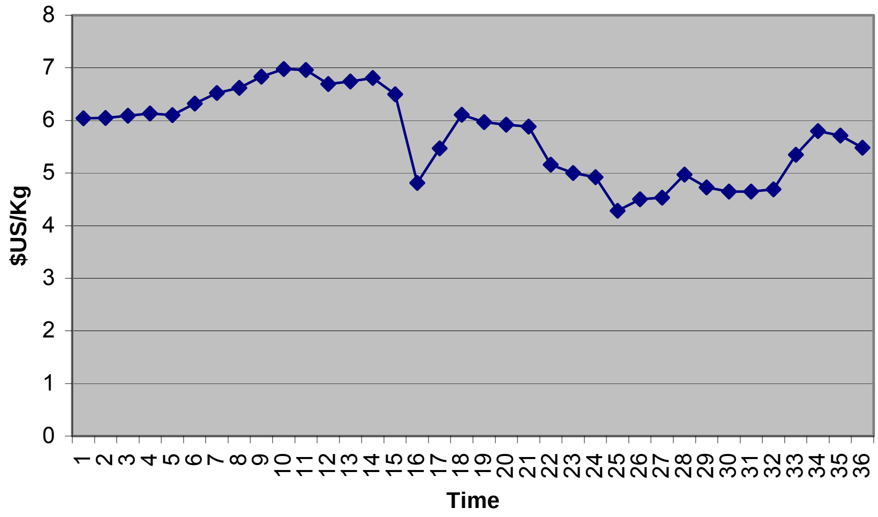
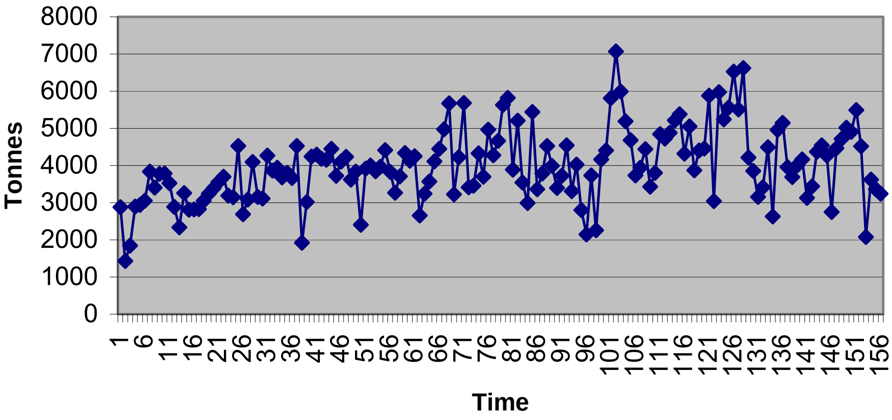


Figure 2. Total beef imports, 1989.1-2001.12



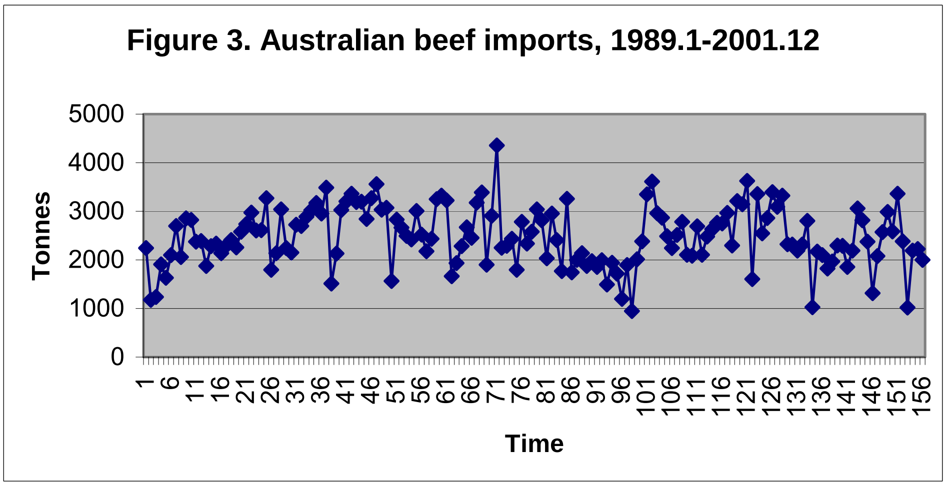


Figure 3. Australian beef imports, 1989.1-2001.12
Tonnes
Time

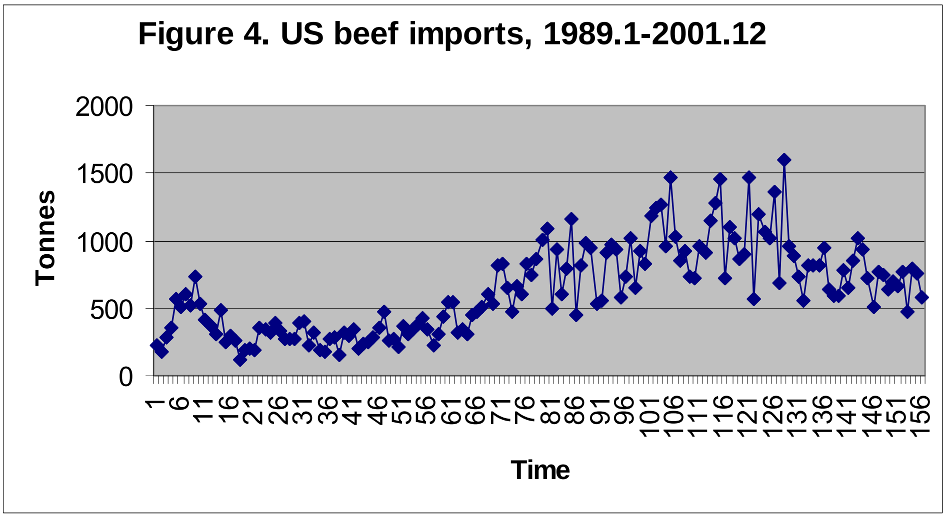


Figure 4. US beef imports, 1989.1-2001.12
Tonnes
Time

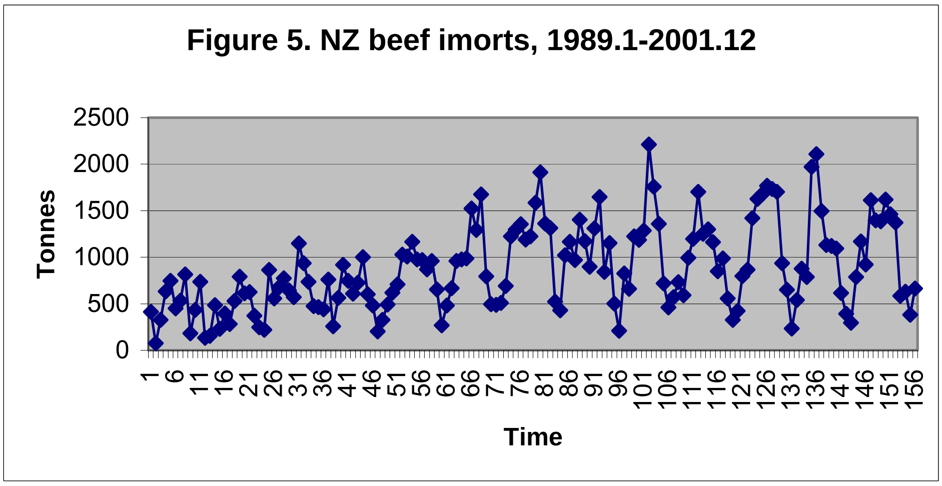
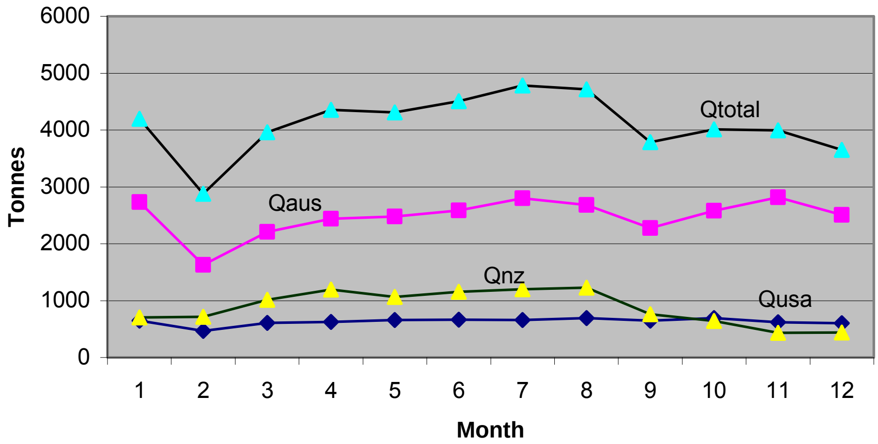


Figure 5. NZ beef imorts, 1989.1-2001.12
Tonnes
Time

Figure 6. Monthly averages of beef imports, 1989-2001



Animal Product Consumption Trends in China

Ji-Min Wang [a], Zhang-Yue Zhou [b] and Rod Cox [b] [15]

Slide 1

Slide 2

[15] [a] Institute of Agriculture Economics - Chinese Academy of Agriculture Sciences

[b] Asian Agribusiness Research Centre - The University of Sydney

Acknowledgements are due to MLA and Australian-China Council for financial support for this study.

- As a result, per capita animal product output has also increased rapidly.
- Except for milk, in 2000 per capita meat (48.4 kg) and egg output (17.7 kg) had exceeded world averages (38.7 kg and 9.1 kg, respectively).
- China has now become not only one of the largest producers of animal products but also one of the largest consumers of animal products.

Slide 3

- How China's livestock industry and animal product market will evolve has attracted much interest.
- Following China's joining the WTO in late 2001 and the subsequent reductions in tariffs, some major animal product exporting countries paid increased attention to the development of the Chinese market.
- As a major animal product producer, it is pertinent for Australia to look into the developments in the Chinese animal product market.

Slide 4

Outline of the Presentation

1. Animal product consumption in China: past experience and current situation
2. Factors affecting animal product consumption
3. Possible scenarios in future animal product consumption
4. Implications
5. Areas that need further research

Slide 5

1. Animal product consumption in China: past experience and current situation

1.1 Increasing animal production consumption

- Slower increase before the 1980s but faster increase since the 1980s.

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- 1949-1978: low level of animal product consumption. 90% calorie intake came from vegetable foods.
- 1979-1985: faster increase in animal product consumption. Improved grain availability in China resulted in spare grains for animal production.
- 1986-present: continuing increase of animal product consumption but consumption of food grains stagnated or even declined in recent years.

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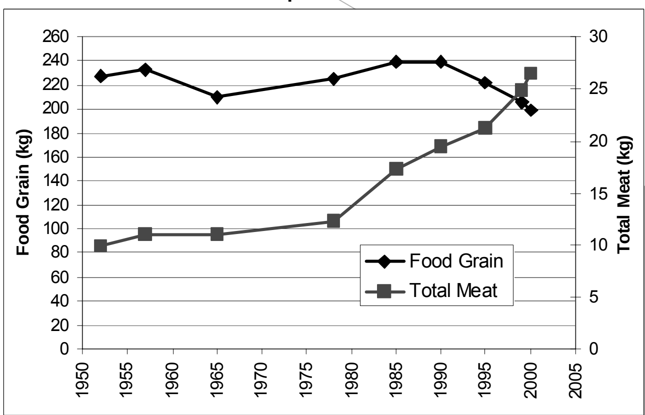
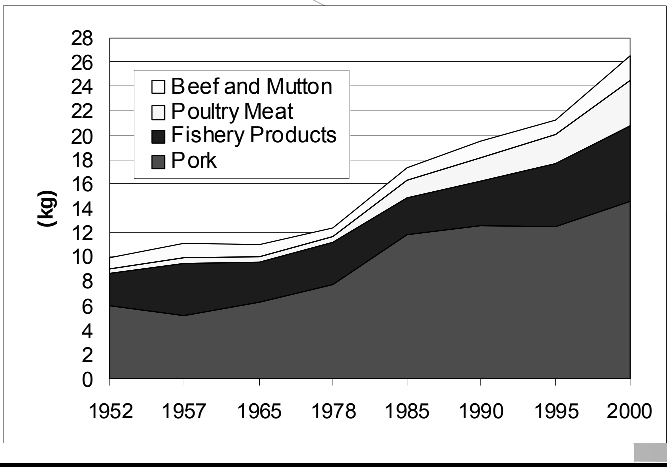
Change in food grain and meat consumption in China



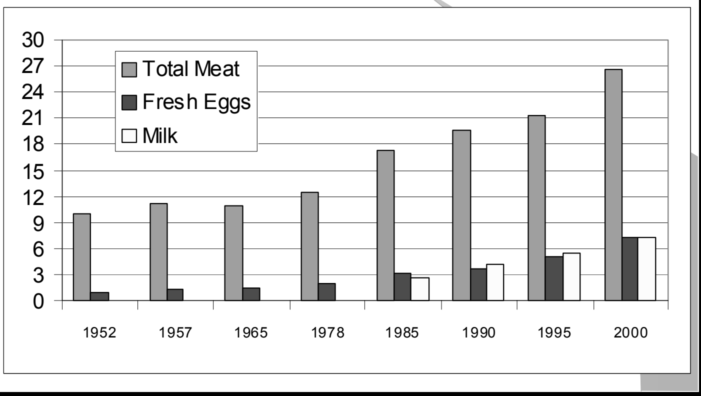
Slide 8

Consumption of meats in China



Slide 9

Consumption of meats compared to eggs and milk in China



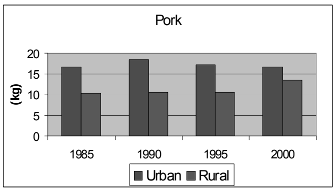
Slide 10

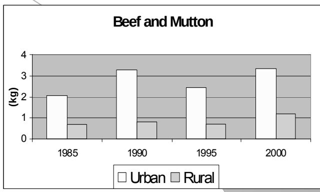
1.2 Urban and rural differences

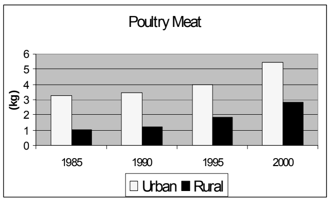
- There is a significant difference between the amount of animal products consumed by urban and rural residents.

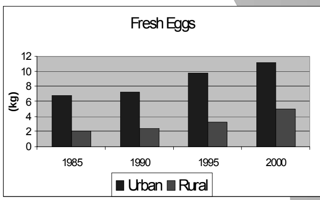
Slide 11

Consumption of animal products in urban and rural China



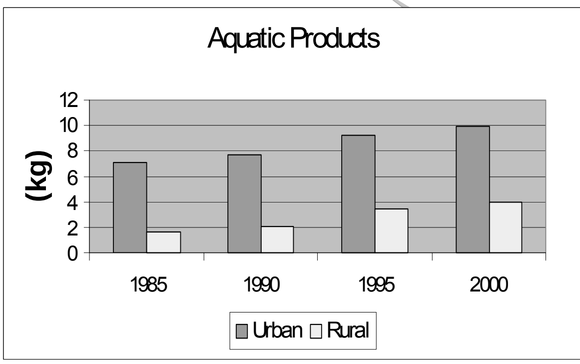






Slide 12

Consumption of aquatic products in urban and rural China



Slide 13

1.2 Urban and rural differences

- There is a significant difference between the amount of animal products consumed by urban and rural residents.
- However, the difference in composition of animal products consumed by the two groups is relatively small.

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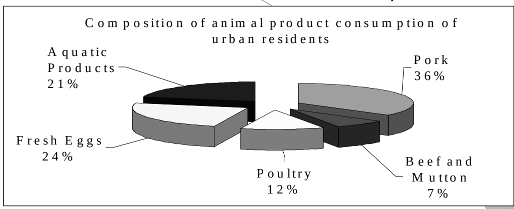
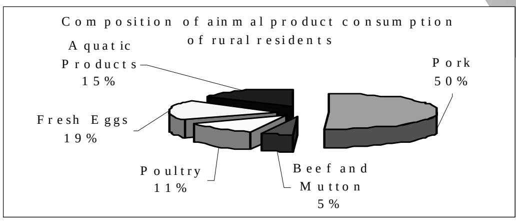
Composition of animal product consumption by urban and rural residents in China, 2000





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1.3 Regional variations

- Residents in southeast coastal region had higher consumption of meat (especially, pork and poultry meat) and aquatic products.
- In southwest region, per capita red meat (especially, pork) consumption was much higher than in other provinces.
- Central and northeast regions tended to consume more eggs.
- North pastoral region consumed more beef and mutton.

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1.4 Animal product consumption: adjusted estimates

- There is a growing gap between per capita meat consumption and production.
- Per capita meat consumption in the late 1990s only accounted for 40-46% of per capita meat output.
- Where did the rest go?

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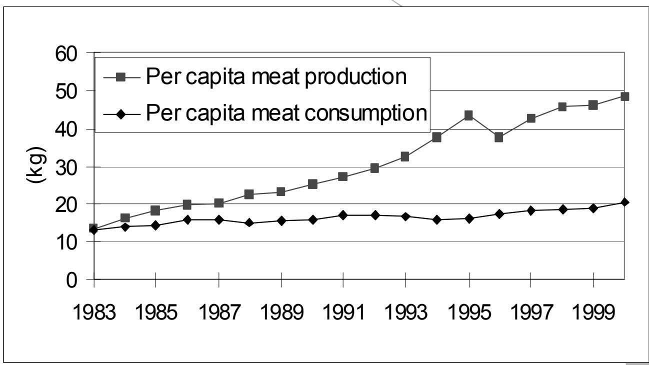
Discrepancies between per capita meat output and consumption



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- Possible reasons:
  - – Inflated outputs, or
  - – Underestimated consumption, or
  - – Both

Slide 19

- In 1997 and 98, the government adjusted downward the output of animal product.
- A large gap still existed between the per capita consumption and output.
- A household survey was carried out to investigate the actual consumption level of animal products by a research team of the Chinese Academy of Agricultural Sciences.

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- Non-inclusion of away from home consumption and the consumption of processed animal products in the household surveys by the State Statistical Bureau.
- According to the CAAS survey, per capita total meat consumption was 33.7 kg in 1998, but according to the SSB, it was only about 15 kg.
- Hence the SSB data underestimated the actual consumption level of animal products by the Chinese.

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- However, the per capita meat consumption from the CAAS survey was still 26% below the per capita meat output of the year.
- A good “baseline” is critical in projecting future demand.
- Using an “animal product balance sheet” method and the CAAS survey results, we recalculated the per capita animal product consumption in 2000, which will provide us with a more realistic base for projecting future level of consumption.

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Adjusted estimates of animal product consumption in 2000

	Total meat	Red meat	Pork	Beef	Mutton	Poultry meat	Milk	Eggs
Total output (10000t)	6125.4	4838.2	4031.4	532.8	274.0	1222.8	919.1	2243.3
Net export (10000t)	-48.1	5.6	2.3	3.7	-0.4	-53.7	1.4	4.56
Domestic consumption (10000t)	6109.1	4832.6	4029.1	529.1	274.4	1276.5	917.7	2238.7
Per capita availability (kg)	48.26	38.18	31.83	4.18	2.17	10.08	7.25	17.69
Per capita consumption in retail weight (kg)	38.48	28.89	23.87	3.09	1.93	9.58	7.25	16.80
Of which:								
Away from home (kg)	8.68	5.51	4.06	0.90	0.56	3.16	1.09	2.35
Processed (kg)	3.31	2.07	1.54	0.43	0.10	1.24	n.a.	3.36
At home (kg)	26.49	21.31	18.27	1.76	1.27	5.18	6.16	11.09
SSB (kg)	20.38	16.60	14.63	1.97		3.79	n.a.	7.23

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2. Factors affecting animal product consumption

- Consumer income
- Animal product price
- Increased urbanisation
- Changes in lifestyle
- Emerging new cooking methods
- Changes in tastes and preferences
- Changes in population age structure
- Social welfare system reforms

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2. Factors affecting animal product consumption

- Income: a major driving force

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Income level and animal product consumption (¥, kg)

Area	Item	1985	1990	1995	1999	2000
Urban	Disposable Income (Yuan)	739	1510	4283	5854	6280
	Pork	16.68	18.46	17.24	16.91	16.73
	Beef and Mutton	2.04	3.28	2.44	3.09	3.33
	Poultry	3.24	3.42	3.97	4.92	5.44
	Fresh Eggs	6.84	7.25	9.74	10.92	11.21
	Aquatic Products	7.08	7.69	9.20	10.34	9.87
Rural	Net Income (Yuan)	398	686	1578	2210	2253
	Pork	10.32	10.54	10.58	12.70	13.44
	Beef and Mutton	0.65	0.80	0.71	1.17	1.19
	Poultry	1.03	1.25	1.83	2.48	2.85
	Eggs and Related Products	2.05	2.41	3.22	4.28	4.97
	Aquatic Products	1.64	2.13	3.36	3.82	3.92

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2. Factors affecting animal product consumption (cont'd)

- Price: declining and making animal product more affordable

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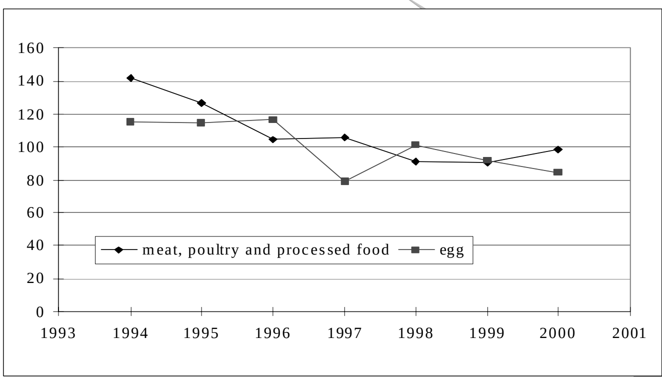
Animal product consumer price index (last year=100)



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2. Factors affecting animal product consumption (cont'd)

- Urbanisation: driving effect becomes stronger

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Urbanisation impact on per capita food consumption (kg)

Foods	Residents from rural areas moving to different city	
	Small or middle city	Large city
Food grain	-58.3	-64.2
Animal product	+4.2	+7.2
Aquatic product	+1.5	+1.7
Vegetable	-23.0	-24.9
Fruit	+8.2	+9.6
Other foods	+1.8	+3.0

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2. Factors affecting animal product consumption (cont'd)

- Life style: increased away from home and retail processed food consumption (increased holiday travel and experience of western fast foods)

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Proportion of retail processed animal product and away from home consumption in total animal product consumption in rural and urban areas, 1998 (%)

Animal products	Processed food in urban areas	Away from home in urban areas	Away from home in rural areas
Meat	10.4	33.6	11.5
Pork	9.5	26.6	9.9
Beef	20.6	37.5	16.7
Mutton	7.5		
Poultry meat	19.0	51.3	14.8
Eggs	Na	13.0	13.4
Dairy	Na	4.2	35.5
Aquatic products	3.4	43.5	13.3

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2. Factors affecting animal product consumption (cont'd)

- Cooking methods: new ways of cooking promoting increased consumption of animal products (hot pot, roasted lamb satay)

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2. Factors affecting animal product consumption (cont'd)

- Changes in tastes and preferences: increased attention to nutrition, cleanliness, and safety (but still keen on animal heads, claws, tails and offal)

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Composition of various parts of animals consumed by urban and rural residents (%)

	Animal	Head, Foot and Claws, Tails and Offal	Ribs	Fatty Meat	Lean Meat	Fatty and Lean Meat	Total
Urban	Pig	7.4	22.1	4.0	33.7	32.8	100
	Cattle	1.2	1.5	0.3	87.0	10.1	100
	Sheep	1.6	6.0	0.1	70.2	22.1	100
	Average	6.0	14.1	2.3	53.1	24.5	100
Rural	Pig	6.6	10.6	9.4	24.9	48.5	100
	Cattle	0.8	1.8	0.6	88.5	8.3	100
	Sheep	1.4	5.4	1.3	43.0	48.9	100
	Average	5.1	8.7	7.0	34.7	44.5	100

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2. Factors affecting animal product consumption (cont'd)

- Population: changing age structure

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2. Factors affecting animal product consumption (cont'd)

- Social welfare system reforms: increased expenditure on housing, education and medicare

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Composition of per capita living expenditure of urban households (%)

Year	1995	2000
Total living expenditures (yuan)	**3538**	**4998**
Composition of living expenditure (%)	100	100
Food	49.92	39.18
Clothing	13.55	10.01
Household facilities, articles and services	8.39	8.79
Medicine and medical services	3.11	6.36
Transport, post and communication services	4.83	7.90
Recreation, education and cultural services	8.48	12.56
Residence	7.07	10.01
Miscellaneous commodities and services	4.28	5.17

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Composition of per capita living expenditure of rural households (%)

Item	1995	2000
Total living expenditure (yuan)	**1310**	**1670**
Composition of living expenditure (%)	100	100
Food	58.62	49.13
Clothing	6.85	5.75
Residence	13.91	15.47
Household facilities, articles and services	5.23	4.52
Medicines and medical services	3.24	5.24
Transport, post and communication services	2.58	5.58
Cultural, educational and recreational articles and services	7.81	11.18
Other commodities and services	1.76	3.14

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3. Possible scenarios in future animal product consumption

- Based on our earlier analyses of past animal product consumption and factors affecting it, it is reasonably safe to argue that animal product consumption in China will continue to increase.
- But how fast?

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- To answer this question, various forecasting techniques may be used, from more complicated econometric modelling to relatively simpler conventional methods.
- Being a pilot study, it is less feasible to carry out any comprehensive econometric modelling work in this study.

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- Nonetheless, we employed three different techniques to project China's future demand for animal products.
- In addition, we will also offer our judgements about the possible developments in a few areas of interest.

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3.1 Per capita consumption in 2010

- We used the following three methods to estimate per capita animal product consumption in China by 2010.
  - ☞Trend extrapolation,
  - ☞Analogies method, and
  - ☞Income elasticity method.

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Per capita animal product consumption in 2010 (kg)

Method	Total meat	Pork	Beef and mutton	Poultry meat	Milk	Egg
Baseline (2000)	38.47	23.87	5.02	9.58	7.25	16.80
Trend Extrapolation	58.23	32.08	8.99	17.16	14.26	21.50
Analogies method	56.50	33.90	10.17	12.43	14.26	21.50
Income elasticity method	48.02	28.59	7.23	12.20	9.56	20.82
Range	48-58	29-34	7-10	12-17	10-14	21-22

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- Results from the above table confirm that consumption of animal products in China will continue to increase.
- Per capita meat consumption will increase from 38.5 kg in 2000 to 48-58 kg in 2010.
- Per capita egg consumption will increase from 16.8 in 2000 to 21-22 kg in 2010.
- Per capita milk consumption will increase from 7.3 kg in 2000 to 10-14 kg in 2010.

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- Among all animal products, consumption of milk, beef and mutton will increase fastest, followed by poultry meat. The increase in pork and egg will be smallest.
- Consumption of total meat (pork, beef, mutton and poultry) in 2010 will approach the level of Taiwan in the mid 1980s, but consumption of beef and mutton will be higher than Taiwan's (2.5kg), and poultry meat will be lower than Taiwan's (20kg) in the mid 1980s.

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3.2 Structural change

- Demand for processed or semi-processed animal products and away from home consumption will continue to increase.
- Processed or semi-processed animal products will reach 1/5 of total animal product consumption.
- Away from home consumption of animal products will account for 35% of total consumption.

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3.3 Urban-rural difference

- Currently, the level of consumption of animal products by rural people is 20 years behind urban people.
- By 2010, it will reduce to about 10 years.

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3.4 Retailing channels

- Supermarkets will be the main channels through which households will purchase their animal products.
- Rural animal product retail market will further develop, thus encouraging rural consumption.

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3.5 Changes in tastes and preferences

- Consumers are likely to place more emphasis on product nutrition and safety.

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3.6 Changes in animal product trade patterns

- China is likely to import beef, mutton and poultry meat.
- Mutton import will depend on the extent of shifting from grazing to feedlotting (to protect China's pasture).
- Beef import will depend on the development of large feedlots.
- Poultry meat import (mainly western poultry) will continue to increase due to low price.

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4. Implications and areas for market development

4.1 Meat exports

- At present no shortage of general quality of meats but lack of high grade beef and mutton for middle and top-end hotel and other catering service sector.
- Veal and lamb for "hot pot" and "roasted satay" are very popular but require better quality of meats.

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- Milk consumption is low: less than 1/10 of world average (in 2000, China: 7.3 kg; world: 94.3 kg).
- Chinese like to eat offal, but domestic price is relatively high.
- Opportunity for medium and high quality beef and mutton export from Australia.
- American beef is perceived to be of premium quality in China.

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4.2 Animal product processing

- Food processing increased at an annual growth rate of above 10% since 1978.
- Retail processed animal products accounted for only about 10% of total animal product consumption, far behind developed countries.
- Consumers have become increasingly receptive of retail processed products - increase in income, the need to save time, and the strong demand from the fast expanding tourist industry.
- Export opportunity of retail processed animal products to China - esp., western style; export of retail animal product processing expertise and equipment.

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4.3 Quality control

- Lack of product quality control - products of dubious background affect consumers' confidence.
- Lack of quality control standards.
- Lack of adequate inspecting technology and equipment.
- Lack of qualified inspectors - training urgently needed.
- Export of quality control expertise, technology and equipment.

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4.4 Breed improvements (dairy cattle, beef cattle, sheep and goat)

- Quality improvement is impeded by lack of better breeds.
- Import of breed animals has been on the increase.
- Recently import of dairy cattle and beef cattle breed increased rapidly.
- Export of dairy cattle breed and embryo, breed of beef cattle, sheep and goat.

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4.5 Understanding local business culture and cooperation with local firms

- Without a good understanding of the Chinese business culture, doing business in China may be difficult.
- The quick and efficient way is to cooperate with local enterprises, at least when first entering into the Chinese market.

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4.6 Promoting Australian products

- Consumers' decision to buy animal products is affected by a number of factors, e.g., nutrition, convenience of cooking, cooking methods.
- When promoting Australian products in China, it would be useful to have some sort of package plan, other than just selling meats. That is, while selling meats, consumers also well informed of many other aspects related to the consumption of the meat such as cooking methods, nutrition facts, dietary culture in the original country - the importance of BBQ in social gathering, clean-green image of Australian products - safe food, etc.

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5. Areas that need further research

- Further household surveys: to understand consumer consumption behaviours and likely changes.
- Balance sheet between supply and demand: what is the actual production and consumption level of animal products in China?
- Quality assurance: how has this affected consumers' consumption?

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- Pasture protection: if China is serious in protecting its pasture, how would this affect China’s own supply of some ruminant meats? (esp., lamb/mutton. Lamb/mutton price up, demand up, supply will be greatly affected if pasture land is protected. Limited studies on sheep industry and lamb consumption).
- Distribution channel: how are animal products distributed in China and where is the best entry point in the distribution chain for Australian firms?
- Retail animal product processing industry: its current capacity and future development.

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- Demand for animal products in the form of processed foods and fast foods: how will this demand evolve and how will this affect overall consumption level of animal products in China?
- Away from home consumption: how much, where and how?
- Commercial relationships: how to establish and maintain?

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Cost of production on New Zealand dairy farms; the impact of feed conversion efficiency and milk price.

P Salles, N M Shadbolt, J Hodgson, C Holmes & P Matthews
College of Science, Massey University

Introduction

Low milk production costs in New Zealand grazing systems are based on growing and utilising large amounts of grazed pasture. The success of New Zealand dairy production over the past years has been based on the increased amount of pasture harvested as a consequence of better pasture utilisation resulting from high stocking rates (Holmes, 1998; Matthews, 1995), combined with genetic improvement, which increased milk production and feed conversion efficiency per animal (Holmes & Matthews, 2001). Traditionally, the animal has been the buffer of the system because dairy farmers have adjusted herbage intakes to overcome feed deficits, and pasture limitations have resulted in relatively short lactation and consequently low animal performance (Matthews, 1994). Recently, a group of farmers in New Zealand changed their production policy from a focus on high production per hectare through high stocking rate to a strategy based on high production per hectare through improved animal performance. They concluded that this objective could be obtained by decreasing stocking rate and utilising supplements strategically, while still maintaining efficient pasture utilisation.

When the objective is to increase production per cow, high pasture allowances are required in order to achieve high animal intakes. However, greater herbage allowance could increase herbage wastage, leading to a conflict between pasture utilisation and forage intake (Hodgson, 1990; Matthews, 1995). When aiming at high intakes per animal, supplementary feed may replace the cow's function as the buffer of the system. The input of supplement reduces variation in farm production levels, but supplementary feed inputs, cost of production and farm profitability vary between seasons (Matthews, 1995). The amount of supplement required and the relative price of supplement and milk all have an impact on farm profitability.

A three-year Dairy Farm Monitoring Programme funded by AGMARDT (Agricultural Marketing and Research Development Trust) was established on eight farms in the Southern North Island of New Zealand in 1998. All farms were attempting to improve per cow nutrition in order to improve farm productivity and profitability. In this paper the results of the third year of the project are used to focus on a comparative analysis of pasture utilisation, feed conversion efficiency and cost of milk production for the case study farms.

Materials and Methods

Definition

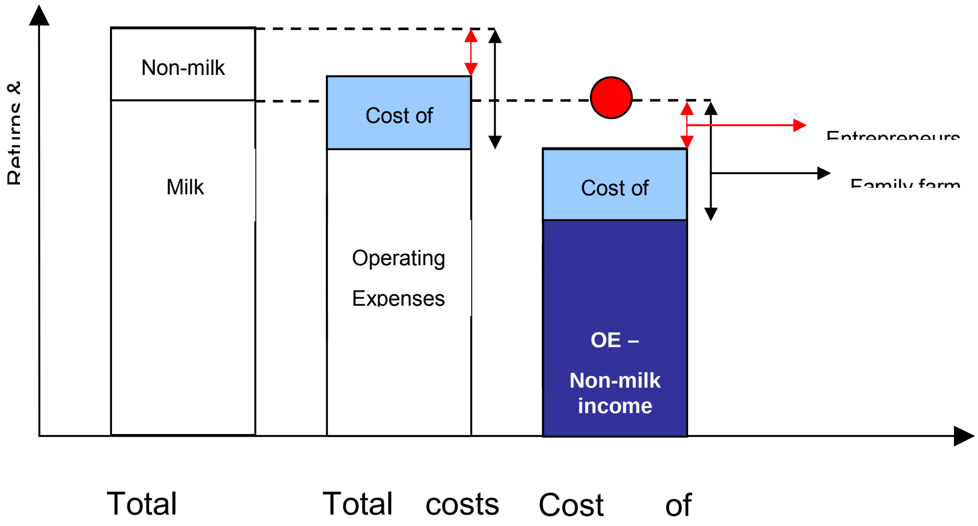
The cost of production of the eight case study farms was calculated as total farm cost and net milk cost using a full economic costing method (Figure 1). The total farm cost involved the cost to produce both milk and non-milk income. The net milk cost involved only the cost to produce milk products and was calculated as the total farm cost minus the non-milk income (IFCN, 2002). The total farm cost was the sum of operating expenses and cost of funds.

Operating expenses included cash and non-cash expenses. The cash operating expenses included farm working expenses, repair and maintenance, vehicle expenses, administration charges, standing charges and rent. The non-cash operating expenses included total depreciation (buildings, plant, machinery and vehicles), a market value of unpaid family labour and a value for the change in supplement inventory. Values of current account interest, taxation, personal drawings, personal insurance, capital items and debt servicing are not included in the operating expenses.

Cost of funds was estimated as 6% of total farm assets for all the farms, which consisted of land, buildings, plant, machinery and livestock. The cost of funds was based on the opportunity cost of capital for farming only. Farming assets are commonly leased at 5 to 7% of assets value. As the financial information was not available to more accurately identify individual farm's cost of debt and the project did not allow time to determine each farm's cost of equity, a standard 6% of all assets value was applied to all farms.

Income was divided into milk and non-milk income (Figure 1). Gross farm income (GFI) was calculated as the sum of milk and non-milk income that included stock sales minus stock purchases, plus or minus any change in livestock inventory, plus grazing, rebates and reimbursements. Milk income included milksolids payment (NZ$5.00/kg MS) and colostrum sales. The entrepreneur's profit is the difference between the price paid per kg of milksolids and the cost to produce the same unit (Figure 1).

Figure 1 - The total costs of the dairy enterprise are related to the total returns of the dairy enterprise.



Therefore, the non-milk income has been subtracted from the total farm costs in order to obtain the net milk cost that can be compared with the milk price. Adapted from IFCN (2002).

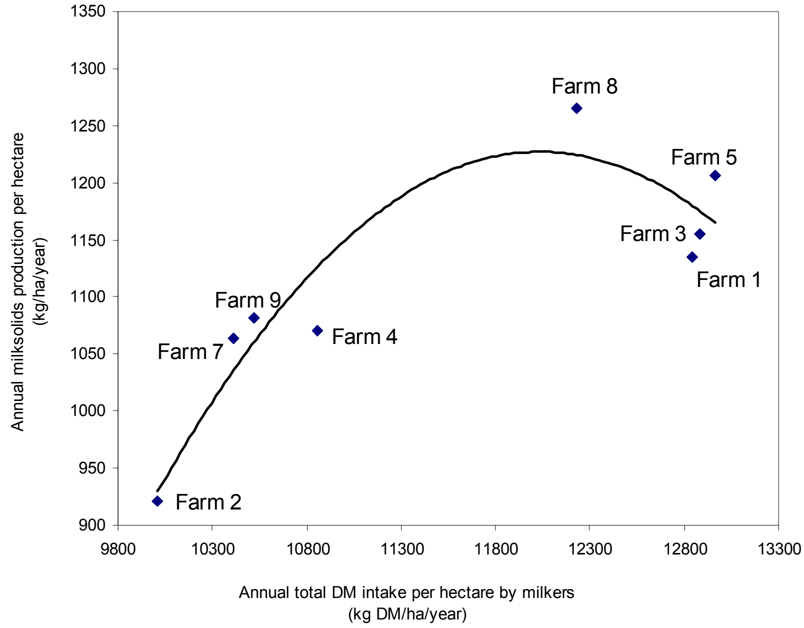
Production function

The amount of output that would be produced by different amounts of input can be described as a production function (Kay & Edwards, 1994).

On the basis that the case study farms represented a unique farming system, a "quasi" production curve equivalent to a response curve in agriculture was obtained for the group, plotting each farm's annual milksolids production per hectare (MS/H) against its corresponding annual total dry matter intake per hectare by milkers (TDM/Hm).

The best model to describe the relationship between the data was a quadratic regression (Figure 2) of the form $MS/H = -9243 + 1.73958\ TDM/Hm - 0.0000723\ TDM/Hm^2$ ($R^2 = 0.86$). The amount of production expected from using each input level is named total physical product (TPP) in economics, which is equivalent to the denomination of yield in agriculture (Kay & Edwards, 1994).

Figure 2 - Simple quadratic regression for the variables annual milksolids production per hectare and annual total DM intake per hectare by milkers, involving the eight case study farms.



The total value product (TVP) is the term used in economics to define gross income or total income. It was calculated by multiplying the quantity of output (TPP) by its selling price. Marginal value product (MVP) is "the additional income received from using an additional unit of input" (Kay & Edwards, 1994) and was calculated as:

$$\text{MVP} = \frac{\Delta \text{ total value product}}{\Delta \text{ input level}} \qquad \text{Equation 1}$$

Marginal input cost (MIC) is "the change in total input cost caused by using an additional unit of input" (Kay & Edwards, 1994).

Results and Discussion

Profitability

Economic farm surplus is a commonly used measure of farm operating profitability in New Zealand and it represents the ability of the farm to generate revenue and save costs (Rawlings, 1999). However, it does not represent the overall profitability of the business (Shadbolt, 1998, 2001), because funding costs are not included and can often contribute significantly to total farm costs.

The average economic farm surplus per hectare for all case study farms was approximately 43% higher than the top 25% farms in the Manawatu region, 7% higher than the top 10% farms in the Taranaki region and 5% lower than the top 10% farms in the Waikato region (Table 1).

Return on assets represents the earning capacity or profitability from the asset base (Boehlje, 1994).

The return on assets of 12.9% for the case study farms means that for every NZ$100 of assets, approximately NZ$13 is earned, which is similar to the top 25% and 10% farms in Manawatu and Taranaki regions, respectively, and higher than the top 10% Waikato farms (Table 1).

These values show that the case study farms are making good use of their assets.

Table 1 Economic farm surplus per hectare

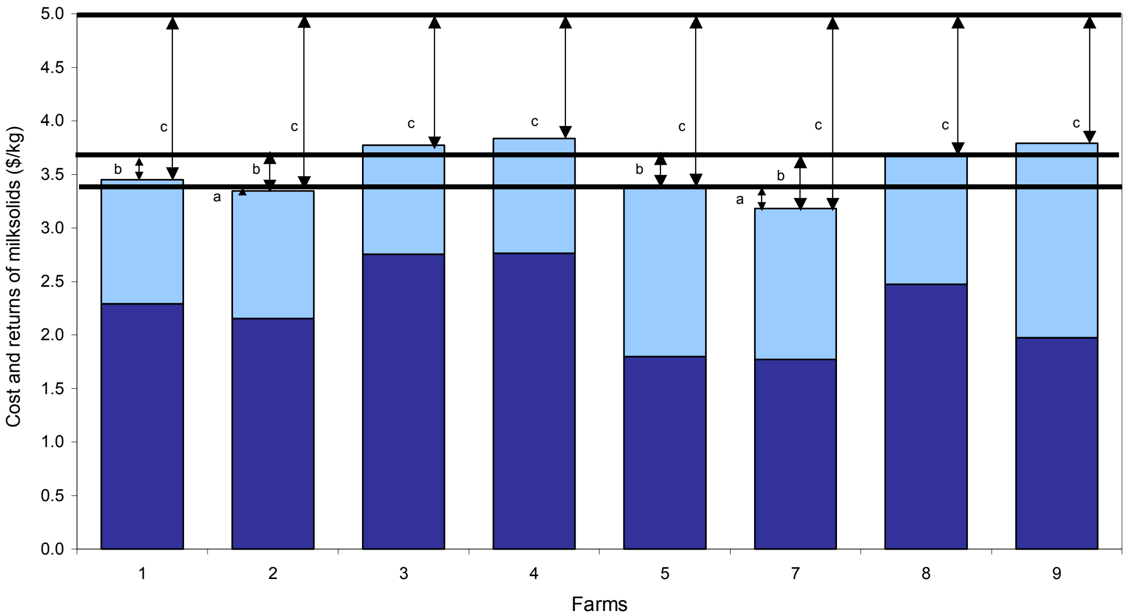
(EFS/H) and return on assets for the case study farms and Top 10% farms in Manawatu, Waikato and Taranaki (Dexcel, 2002, personal comunication).

	Manawatu region			Manawatu	Waikato	Taranaki
	Case study farms			Dexcel, 2002		
	Mean	Max	Min	Top 25%	Top 10%	Top 10%
EFS/H (NZ$)	3,077	3,867	2,425	2,153	3,235	2,879
Return on assets (%)	12.9	14.4	10.0	13%	11.8	12.8

Cost of production

The average cost of production per kg of milksolids (MS) among all farms was NZ$3.55/kg MS, ranging from NZ$3.18/kg MS to NZ$3.83/kg MS (Figure 3). Three different prices of milksolids were used to calculate the entrepreneur's profit for each farm. The milk payment of NZ$3.4 was the average of ten years (1990/91 to 1999/00) (LIC, 2001), NZ$5.0 was the milk payment for the season 2000/2001 (LIC, 2001) and NZ$3.7 is the forecast value for the season 2002/2003.

Figure 3 Cost per kg of milksolids

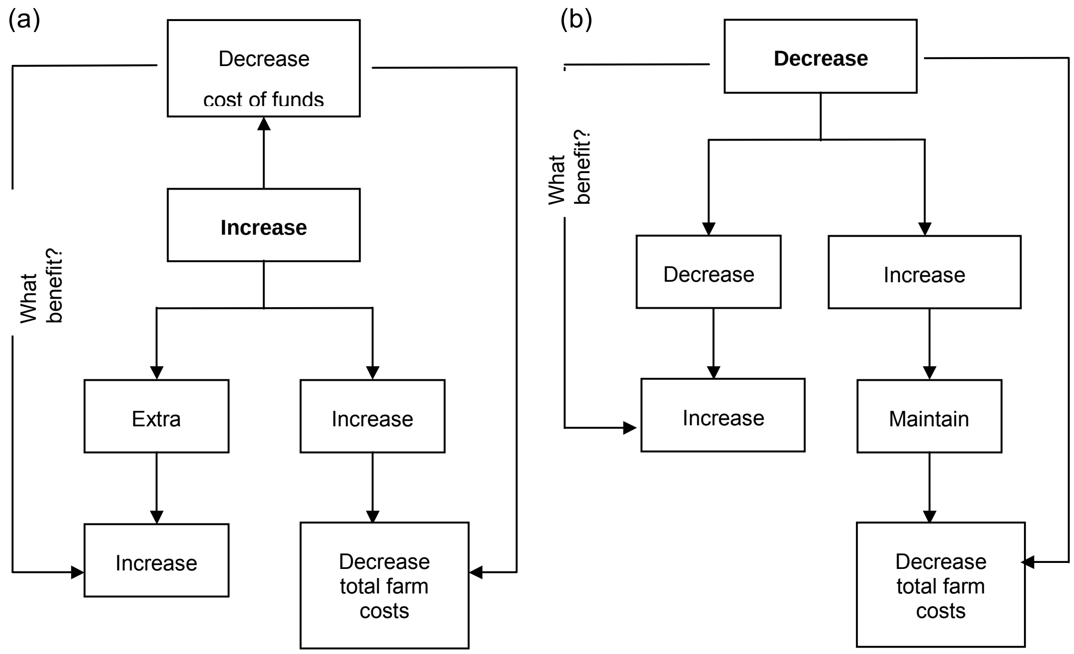


(light blue: cost of funds; dark blue: operating expenses – non-milk income) for each farm and their respective entrepreneur's profit for three prices of milksolids (MS): NZ$3.4/kg MS (a), NZ$3.7/kg MS (b) and NZ$5.0/kg MS (c).

Figure 3 shows that at a milksolids price of NZ$3.4/kg, only Farm 2 and Farm 7 achieved an entrepreneur's profit. The milksolids price of NZ$5.0 paid in the season 2000/2001 was the highest value (adjusted for inflation) since 1975 (LIC, 2001). The forecast milksolids price for the season 2002/2003 is NZ$3.7/kg, which is 26% lower than the 2000/2001 season. At this price of milk, Farms 3, 4, 8 and 9 will not receive sufficient revenue to cover their cost of production if these costs do not change.

As farmers have little, if any, control over milksolids prices, the emphasis should be on cost of production per kg of milksolids. It is possible to decrease the cost of milksolids production either by increasing milk yield with small or nil increase in total farm cost, or by decreasing total farm costs without affecting milk production. Both options seem straightforward, however there are many variables influencing the system. Increasing total milk yield could be achieved either through a better utilisation of the feed available in the system or by increasing the quantity of feed (Figure 4a). Higher milk yield resulting from an improvement in feed conversion efficiency (FCE) or from an increase of the quantity of feed at nil or limited cost (e.g. growing more grass through better pasture management) is the optimum scenario. If the alternative is to increase the amount of feed at a cost, the total marginal cost, which takes into account the increase in cash costs due to extra feed and the decrease in cost of funds due to dilution of capital cost, should be lower than the marginal revenue in order to generate a benefit. The option of decreasing cash costs per kg of milksolids could result from better utilisation of feed or any other resources on the farm, such as staff, machinery and management or from a decrease in milk yield (Figure 4b). Again, there is a trade off between decrease in cash costs and increase in costs of funds (a decrease in milk yield results in higher cost of capital).

Figure 4 Options to increase milk yield (a) and decrease cash costs (b) on dairy systems.



Feed conversion efficiency

Better utilisation of feed available is closely related to feed conversion efficiency. Feed conversion efficiencies FCE(ME) and FCE(DM) measured for the case study farms were expressed as annual milksolids produced per herd (g) divided by annual intake of metabolisable energy (ME) or dry matter (DM) per herd.

In order to facilitate the discussion regarding factors influencing feed conversion efficiencies, the farms were divided into two groups: Group one (feed conversion efficiencies lower than the average of all farms) and Group two (feed conversion efficiencies higher than the average of all farms) (Table 2).

The farms from Group two had the four highest values of feed conversion efficiency and also the lowest DM and ME intakes per animal. This resulted in lower annual milksolids production per cow in Group two than those in Group one. On the other hand, farms from group two had higher milksolids production per hectare as a result of higher stocking rate.

Table 2 - Feed conversion efficiency

Feed conversion efficiency (g MS/MJ ME and g MS/kg DM), annual metabolisable energy (ME) and dry matter (DM) intakes per animal (MJ ME/cow/year and kg DM/cow/year), annual milksolids production per cow (MS/C, kg MS/cow/year) and per hectare (MS/H, kg MS/ha/year) and stocking rate (SR, cows/ha), for Group one and Group two. The theoretical FCE(ME)md was calculated dividing the actual milksolids production per cow by the theoretical metabolisable energy intake per cow.

	Actual data							Theoretical
	FCE							FCE
Farm	(ME)md	(DM)md	ME intake	DM intake	MS/C	MS/H	SR	(ME)md
Group one (lower FCE)								
2	6.7	75	58,166	5,202	390	921	2.4	7.9
3	6.7	77	64,424	5,636	432	1,155	2.7	8.1
1	6.8	77	62,367	5,499	424	1,135	2.7	7.7
5	6.8	78	61,924	5,415	424	1,206	2.8	7.9
Mean	*6.6*	*75*	*63,403*	*5,566*	*418*	*1,084*	*2.6*	*7.9*
Group two (higher FCE)								
4	7.1	81	57,961	5,027	410	1,070	2.6	7.9
9	7.3	82	50,669	4,537	372	1,082	2.9	7.5
7	7.4	82	54,209	4,866	401	1,064	2.7	7.8
8	7.4	83	57,049	5,052	421	1,264	3.0	8.2
Mean	*7.3*	*82*	*54,972*	*4,870*	*401*	*1,120*	*2.8*	*7.8*

On average higher feed conversion efficiencies were obtained by the farms with lower intakes per cow. Another explanation for the differences in feed conversion efficiency between the two groups might be that the farms with higher milksolids production per cow were utilising feed less efficiently, due to wastage. This could be the result of lower average stocking rates for Group one than for Group two farms (Table 2).

The farms from Group one had the greatest difference between estimated and required (theoretical) ME intakes, which may be due to higher feed wastage.

The mean value of FCE(ME) of Group one farms was 16% lower than the mean theoretical feed conversion efficiency value (Table 2), whereas the mean value of FCE(ME) of Group two was only 6% lower than the theoretical value (Table 2).

Since feed waste was not measured, it was not possible to take this analysis further. Comparison between the two groups regarding economic farm surplus (EFS) did not show a clear contrast, mean values being NZ$3,069 for Group one and NZ$3,085 for Group two (Table 3).

Table 3 - Economic farm surplus per hectare

Economic farm surplus per hectare (EFS/H), gross farm income per hectare (GFI/H), return on assets (ROA), operating profit margin (EFS/GFI) and revenue per labour unit (GFI/LU) for the case study farms.

Farm	EFS/H (NZ$)	GFI/H (NZ$)	ROA (%)	EFS/GFI (%)	GFI/LU (NZ$)
Group one (lower FCE)					
2	2,640	5,127	14.4	52	267,020
3	2,657	5,769	13.5	43	281,503
1	3,114	6,260	14.2	50	360,392
5	3,867	6,813	12.2	57	354,255
Mean	*3,069*	*5,992*	*13.6*	*50*	*315,792*
Group two (higher FCE)					
4	2,425	5,342	12.7	45	376,363
9	3,274	6,739	10.0	49	293,168
7	3,436	6,101	13.8	56	290,675
8	3,206	6,344	12.6	51	222,034
Mean	*3,085*	*6,131*	*12.3*	*50*	*295,560*

Options available

Information like price of the product is necessary to determine the input level that will generate the highest profit. MVP and MIC are important tools to determine the optimum input level. It is desired that the additional cost of using one more unit of input does not exceed the additional revenue received from that input. Additional profit by using more input can be expected when MVP is greater than MIC (Kay & Edwards, 1994).

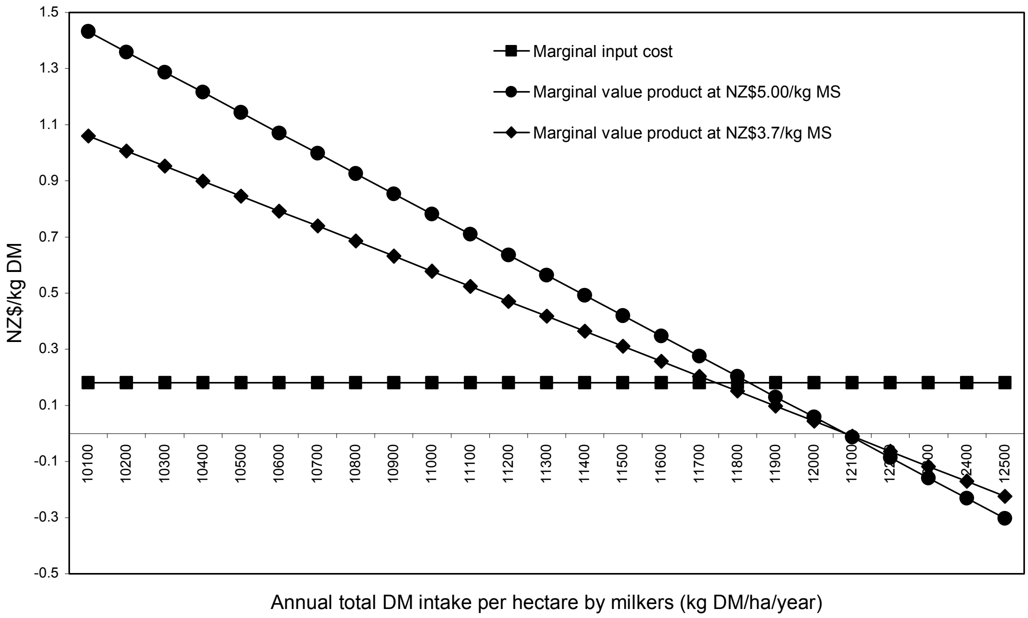
However, if MVP is lower than MIC the business would be more profitable by using less input (Kay & Edwards, 1994). An economically viable increase in milk yield from a small increase in total farm costs is achievable through higher intakes of pasture and/or supplements, providing that the cost of extra feed is lower than the marginal value product (MVP).

Assuming marginal input costs of NZ$0.18/kg DM (based on supplementary feed costs), NZ$5.0/kg MS and the group production curve, it can be seen that 11,800 kg DM/ha/year was the maximum input level where the additional income received from using one more unit of input exceeded the additional cost of supplement input (Figure 5).

Individual farms will have their own production curve, which may well differ from the group production curve. However, even if not too much can be extrapolated from the group production curve, its presentation here is to illustrate an economic level of efficiency. Assuming NZ$3.7/kg MS and the same marginal input costs of NZ$0.18/kg DM, the optimum profitability is gained from 11,700 kg DM/ha/year (Figure 5).

Even if marginal input cost is zero, such as in the case of improved efficiency (Figure 4), the MVP and MIC analysis illustrates that at both NZ$5.0 and NZ$3.7 per kg MS, our group's farm should not produce above 12,100 kg DM/ha/year (Figure 5). However, the point at which marginal value product goes negative will differ for those farms with different production curves.

Figure 5 - Maximum input level where marginal value product (MVP) is higher than marginal input cost (MIC).



Because of their high feed conversion efficiency and placement on the group production curve, there would seem to be an opportunity to increase pasture or supplementary feed intake per hectare for most farms of Group two (Table 2). A possible option to increase pasture production is by nitrogen application. The average of nitrogen used among all case study farms was 125 kg N/ha/year, ranging from 80 to 150 kg N/ha/year. The use of 200 kg N/ha/year was identified as a profitable option (Penno *et al.*, 1996) with low risk of ground water contamination (Clark, 1997). Therefore, the case study farms could invest in nitrogen application in order to increase pasture production. Supplementary feed might also be a satisfactory option to increase total feed intake for most farms of Group two. However, while these farms at current intake levels have minimal wastage and high FCE, the risk is that as they introduce more feed their efficiency could diminish due to a conflict between pasture utilisation and animal intake (Hodgson, 1990; Matthews, 1995).

On the other hand, for most farms from Group one higher performance could be achieved through more efficient feed utilisation, because they had the lowest feed conversion efficiencies. The system of achieving higher production per hectare through higher animal performance represents a new management strategy for these farmers. They still need to improve their management skills in order to improve the whole system (Figure 4). The information analysed in this project shows that there is opportunity for further improvement in feed efficiency, mainly for the farms achieving higher animal performance. While feed conversion efficiency will improve as intake decreases, the impact of this on milk production per animal is less certain (Hodgson, 1990; Matthews, 1995).

Conclusion

The case study farms' objective of high production per hectare achieved through high animal performance was expected to be obtained by decreasing stocking rates and utilising supplements strategically, while still maintaining efficient pasture utilisation. All farms were profitable under the conditions in the 2000/2001 season with milk payout of NZ$5.0. However, with the predicted price of NZ$3.7/kg MS for 2003, Farms 3, 4, 8 and 9 would not receive sufficient revenue to cover their cost of production if costs do not change. For the farms with higher feed conversion efficiency and lower animal intake, extra feed was economically viable providing that its marginal cost was lower than the marginal value product, with the risk of having their efficiency diminished as they introduce more feed. On the other hand, for the farms with lower feed conversion efficiency, more profitable performance could be achieved through more efficient feed utilisation. However, because of the trade off between pasture utilisation and animal performance, it is difficult to determine the point of optimum efficiency of this grazing system for each farm. In order to improve the new system proposed by the group farms, they will need to continually adjust their management skills to ensure optimum profit is achieved under volatile prices.

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Efficiency Measurement of Australian Dairy Farms: National and Regional Performance

Mary Graham*[16] School of Economics Deakin University and
Dr. Iain Fraser Department of Economics and Finance La Trobe University

1. Introduction

The dairy industry in Australia is currently a major growth industry in terms of value of production, employment and as an important source of exports. The Australian Bureau and Agricultural Research Economics (2001), (ABARE), in a report for the Dairy Research and Development Corporation, (DRDC), claim that although the number of dairy farms has halved since the mid-1970s, milk production has more than doubled over the past 20 years. All states have increased herd sizes, with the national average around 240 head per farm. Milk yield per cow has risen, resulting in a 160% increase in milk production per farm in 15 years. With an estimated gross value of production of around $3 billion a year, the dairy industry ranks third behind wheat and beef in terms of output value at the farm gate. It is also an important value adding industry, with four fifths of its production being used to manufacture dairy products, mainly butter, cheese and milk products. Australia is the third largest exporter behind the European Union and New Zealand and its share of the world dairy product trade has risen to around 15%.

Following dairy deregulation, the new competitive market structure places increased need for the dairy industry to be efficient both at the farm and regional level. Farm level efficiency needs to be examined and sources of inefficiencies identified and explored so that appropriate policies and extension services can be developed to improve performance and strengthen the competitive position of farms, regions and the industry both nationally and internationally.

Throughout the 1990's ABARE (2001), reports dairy farm productivity has improved due to new technologies and management techniques, such as the use of supplementary feeding, fodder conservation, soil testing, artificial insemination, and computers. Lovell (1993) argues that variations in productivity reflect differences in production technology, differences in the efficiency of the production process and differences in the environment in which production occurs.

We examine one aspect of productivity in this paper, technical efficiency. There are a number of methods available to conduct this type of analysis. In this paper we employ Data Envelopment Analysis (DEA). DEA has been used in a number of previous papers to examine technical efficiency of dairy farms e.g., Weersink et.al. (1990), Cloutier L M and Rowley (1993) Jaforullah and Whiteman (1999) and Fraser and Cordina (1999). By virtue of the data set used in this study we examine both technical efficiency and specific aspects of methodology that have important implications for the use of DEA in benchmarking analysis. In this paper the DEA methodology described in Coelli, et al. (1998) is used to measure the degree of technical efficiency in the Australian dairy industry and to show how results can vary, depending on the model specified.

Specifically, we employ a recently collected national survey of dairy farms to examine technical efficiency issues. We focus on technical efficiency within the whole sample and within different dairy regions. This analysis provides useful information regarding the distribution of technical efficiency within the Australian dairy industry. The analysis also highlights how DEA can be implemented in an inconsistent manner. That is, we show how the inclusion or exclusion of particular variables influences the results generated. This aspect of the research has implications when interpreting recent research on the dairy industry by ABARE.

The structure of this paper is as follows. In section 2 we provide an overview of the meaning of economic efficiency and how the DEA models are estimated. Next we describe the data set used. In section 4 we present our results. The results are divided into two parts. First, we present those that deal with the whole data set that is for all of Australia. Second, we present results for the various dairy regions in Australia. Finally, in Section 5 we present conclusions.

[16] *Address for correspondence:
Mary Graham, School of Economics, Deakin University, P.O. Box 423 Warrnambool 3280
Phone: 03 55 633568, Fax: 03 55 633320

2. Theory and Estimation

Efficiency has two components – technical efficiency and allocative efficiency. Technical efficiency is defined as the capacity and willingness of an economic unit to produce the maximum possible output from a given bundle of inputs and technology. Allocative efficiency focuses on the ability and willingness of an economic unit to equate its marginal value product with its marginal cost. Combining the two measures produces total economic efficiency. It is useful to be able to quantify these measures so that comparisons across similar units can occur to determine relative efficiencies and to identify the factors that are responsible for the variations between units so that appropriate policy can be developed.

Beginning with the work of Farrell (1957), a simple measure of efficiency accounting for a single output and multiple inputs was defined. Farrell introduced an input orientated measure, that is, a measure to show by how much inputs could be reduced whilst maintaining the existing level of output. Alternatively, an output orientated measure, whereby output is increased whilst employing a given level of inputs, could be developed. Both measures are equivalent measures of technical efficiency when constant returns to scale exist. However, it is practice for the orientation selected to reflect the quantities, inputs or output, over which the decision-making unit, (DMU), has the most control. Deregulation of the industry has allowed farms to expand their production base and vary inputs to maximize output. The input orientation is selected in this analysis as the most appropriate method.

DEA is a relatively straightforward and flexible non-parametric computational linear programme. It ability to accommodate a multiple of inputs and outputs, and to work with a variety of data, both real and monetary, makes it a simple but relatively effective system to monitor farm level efficiency and allows local action to deal with relative inefficiency once identified. The ability to respond locally to observed inefficiencies is an important feature on any farm extension programme aiming to raise overall standards of performance.

Chambers et al. (1998) suggest that any analysis of farms' performance should be based on a sample that has at least three times as many farms as there are inputs. Appropriate and measurable variables, whether input or output based, to properly characterise the farming system, need to be used. The selected variables need to capture all the salient features of the farm. Of particular importance is the flow of services from capital investment.

DEA envelops a data set as tightly as possible and results indicate if technical inefficiency exists. The best practices of peer group farmers need to be examined to determine how much inefficiency is due to environmental variables outside the control of individual farmers and how much is due to factors the farmer can control. Where environmental variables are measurable and can be specified in the DEA, the problem does not exist.

One of the principal disadvantages claimed of DEA is that it is sensitive to variable selection and data errors.(Kalirajan and Shand 1999) In the present study, however, the sample size is large but the analysis does highlight the significance of the variable selection process.

In addition, DEA does not accommodate measurement error or other non-measurable factors that may influence the shape and positioning of the estimated frontier. To account for such "noise" factors, an alternative method of analysis, stochastic frontiers, have been proposed. This method is not examined here. Rather the DEA methodology chosen for this study focuses on evaluating the efficiency of individual farms and regions, to assist in the development of appropriate farm management strategies to increase overall technical efficiency within the dairy farm sector of the industry.

2.1 Data Envelopment Analysis

DEA is a mathematical programme technique, and although initially developed by Farrell (1957), (Coelli, et al., 1998) report that it did not take off until Charnes et.al. (1978) coined the name "Data Envelopment Analysis". DEA is based on a linear programming specification and is used to estimate a production frontier so that from observed data, the efficiency of an economic unit can be measured. A frontier that envelops all the input-or output data is estimated, with observations lying on the frontier defined as technically efficient. Those observations that lie below the frontier are considered inefficient. It yields a relative measure, the efficiency of an economic unit relative to others in the sample. The unit's performance is compared with the best actually achieved rather than with some unattainable ideal.

DEA analysis can identify the efficient units and results for an inefficient unit will show by how much each input can be reduced (or output increased) to produce an efficient outcome. DEA facilitates the identification of excellence in terms of the best practices in a given sample of observations. The ratio of the optimally weighted output to input for the DMU gives the required measure of productive efficiency. The benchmark of a farm will be made up of more than one farm unless the farm itself is a best practice or efficient farm. DEA identifies the best practice farms in the benchmark and calculates their relative contribution to the benchmark. The inefficient farms can identify their relevant partner or peer group and emulate their better practices to eliminate sources of controllable inefficiencies and thus improve performance.

The efficiency measure can be further analyzed to determine the contribution of pure technical factors and scale, or size, factors to the overall level of efficiency. To obtain separate estimates of technical and scale efficiency, input orientated technical efficiency measures satisfying three different types of scale behaviour are specified and applied to data on Australian farms. These are constant returns to scale, (CRS), variable returns to scale (VRS), and non-increasing returns to scale (NRS). Each linear programme exercise must be solved separately for each farm in the data set.

Charnes, Cooper et al. (1978) proposed an input orientation model, with CRS. The single input (x) and output (y) orientated measure been extended to accommodate multiple inputs and outputs. Efficiency is defined as the ratio of the weighted sum of outputs to the weighted sum of inputs, $(u'y_1/v'x_1)$, where u is a M*1 vector of output weights and v is a K* 1 vector of input weights.

The optimal weights are found by solving the mathematical programming problem:

$$\max_{uv} (u'y_1/v'x_1),$$

subject to (st) $u'y_1/v'x_1 < 1$

$$u, v \geq 0 \qquad (1)$$

The aim is to maximize the efficiency of the ith unit subject to the constraint that all efficiency measures are less than or equal to 1. Formulating the ratio in this way gives an infinite number of solutions. To avoid this, could impose the constraint $v'x_1 = 1$, which provides $\max_{uv} (u'y_1)$.

Using the duality in linear programming, an equivalent envelopment function is:

$\min\theta$

st $-y_{ij} + Y\lambda \geq 0$

$\theta x_1 - X\lambda \geq 0$

$$\lambda \geq 0 \qquad (2)$$

where θ is a scalar and λ is a N * 1 vector of constants. The value of θ will be the efficiency score of the ith economic unit. It will satisfy the condition $\theta < 1$, with a value of 1 indicating a point on the frontier and thus a technically efficient economic unit. A value less than one indicates the farm, given the existing set of observations, can improve the productivity of its inputs by forming benchmarking partnerships and emulating the best practices of its reference or peer group of farms.

2.2 Existing DEA Applications

DEA has widespread application in economics and management science analysis. In terms of application to dairy farming, there have been a few studies to date. Weersink et.al. (1990), as reported in Fraser and Cordina (1999), employed a variable returns to scale specification to analyse technical efficiency for a sample of 105 Ontario, Canada, dairy farms. Various measures of farm level efficiency were estimated and analysed. Analysis found that a majority of the dairy farms are efficient.

Another Canadian study, one by Cloutier and Rowley (1993) considered technical efficiency of 187 dairy farms in Quebec, over a two year period. Using a constant returns to scale specification, they found more efficient farms in 1989 than in 1988, and suggest that their results showed that larger farms are much more likely to appear efficient than smaller ones. However, they performed no statistical tests to see if the differences were significant.

Jaforullah and Whiteman (1999) analysed scale efficiency in the New Zealand dairy industry with a sample of 264 farms for 1993. They found average technical efficiency high at 89%. In terms of returns to scale, they found more farms operating at below optimal scale. However, the study did not clarify if farms were drawn from a homogeneous geographical region and given the large variation in soil and weather in New Zealand, it was not clear if important exogenous factors had been accounted for satisfactorily.

Fraser and Cordina (1999) assessed the technical efficiency of a sample of 50 irrigated dairy farms in Northern Victoria, Australia, with data collected over the 1994/5 and 1995/6 lactation periods. Both constant and variable returns to scale input orientation models were specified to estimate technical efficiency. From the sample of farms analysed, it was found that a significant number were operating, or are very close to operating, efficiently. Although the analysis did not consider the reasons why particular farms were efficient and others are not, there is unlikely to be much variation in the production technology used. Socio economic characteristics and their significance to technical efficiency was felt to be worthy of further study.

3. Data Source

As part of the Dairying For Tomorrow project, a nationwide survey of dairy farm management practices and productivity was conducted by an independent research organisation, IRIS Research, on behalf of the DRDC in 2000. A 30 minute telephone survey to over 1800 farmers throughout Australia, over a six month period, had a response rate of eighty-four per cent. The results of this survey, made available by DRDC, are used in this paper to examine the level of efficiency in the industry. Of the 1826 farmers interviewed 84, or 4.6%, have been deleted from the analysis, due to incomplete data relating to either milk production, amount spent on fertilizer, purchased feed or the capital value of their property

The data is analysed in several ways. We examine the whole of data set (i.e., all Australia) and various sub sets of the data (i.e., specific dairy regions). Australia's dairy industry is divided into eight regions, grouped according to the DRDC 's regional development programs, and twenty sub-regions.

Dairy farm production can be measured in terms of litres of milk, or kilograms of butter fat. Measures of butter fat was converted into a common output measure of litres of milk. Thus, in this analysis, the output measure used is litres of milk, and it is matched with inputs to reflect size of operation, plus important inputs of water, fertiliser and purchased feed. A measure of capital is also included. The choice of variables was constrained by the available data and the need to avoid including too many variables in the model specification. If too many variables are used, the proportion of efficient farms will increase.

Information relating to all types of purchased feed – hay, silage, grain, pellets, dry and wet byproducts, was collected and the total feed purchased per cow was converted to total dollar cost of purchased feed. As a measure of water use, data relating to irrigation was examined. Many of the farms using irrigation did not give details on the number of megalitres used. To gain a larger response rate, the data relating to area of the farm irrigated, in hectares, was used. This refers to the area to which irrigation water was applied, thus excluding rainfall and re-use systems. The survey included a number of questions on the use of different types of fertilizers and how decisions on the application of fertilizers were made. However, no actual figure was given on the amount used. Categorical variables were used in giving expenditure on fertilisers in aggregate, and for this analysis, the mid point in each category was used as an indicator of the amount spent on fertilizer. As a measure of the capital input, the level of debt was used. Again, the mid point of the categorical variable was applied. Finally, the size of the farm was gauged from the size of the milking area, in hectares, plus the number of milking cows.

One limitation of the data set is that it did not contain any data relating to labour. Many of the farms would rely on hired as well as family labour. However, no data is available regarding this input and thus it its not considered in this analysis. The exclusion of this result will bias our results and needs to be borne in mind when interpreting the findings presented.

4. Results

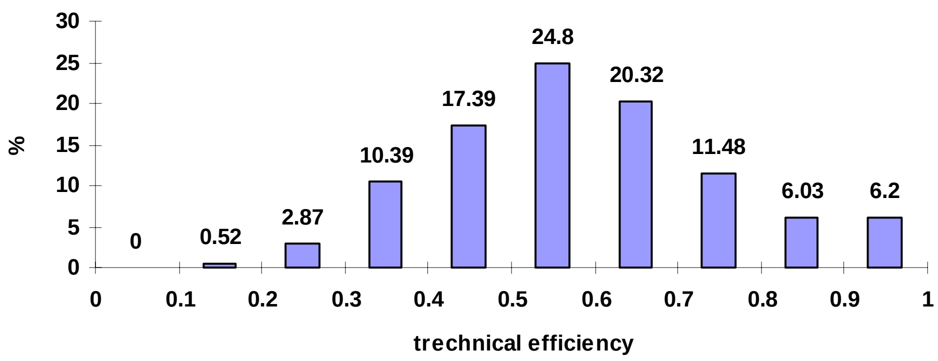
Our results are presented in the following order. We begin by presenting technical efficiency estimates for the whole data set. We present results for the whole data set as well as the various regions. We then estimate technical efficiency for the various regions independently. This allows us to examine the impact of aggregating the data across the whole survey. The reason for presenting these results is that it allows us to examine an important methodological issues. That is, analyst frequently increase sample size when undertaking DEA but the addition of data can both influence the estimates of technical efficiency derived and inappropriate production technologies can be brought together.[17]

4.1 Whole Sample

Using the constant returns to scale specification in the DEA, sixty-one(61) or 3.5% of the DMU's were regarded as being technically efficient ($\theta = 1$). The distribution of efficiency scores, illustrated in Figure 1 below, reflect a near perfect distribution, with a mean and medium of 0.59 and 0.58 respectively, in the use of the six inputs. Half the farms in the sample had an efficiency level of between 0.47 and 0.69. Given the sample size, this result is to be expected. It has been pointed out that the technical efficiency of any DMU, estimated using DEA, will decrease as the number of units included in the analysis increases (Zhang and Bartels 1998). Increasing the number of DMUs increases the chances of having units close to the frontier, and therefore the frontier constructed by DEA approaches the true frontier.

[17] The data is analyzed using the computer program developed by.(Coelli 1996), DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program

Figure 1: Farm Level Efficiency: All Australia



Efficiency scores reveal the extent to which a DMU could further increase output without consuming additional resources (McCarty T.A. and Yaisawarng S. 1993). The degree of inefficiency reveals the potential output loss due to not utilizing available resources fully. The least efficient farm with a score of 0.131, or 13.1% was located in Murray Dairy region. For this unit, inputs consumed could be reduced by 86.9% without any reduction in output.

Table 1 : Statistical Summary: Technical Efficiency (6 inputs) Australia and Regions

Region	ALL	SA	Tas	DIDCO	Gipps	Murray	SubTrop.	Western	WestVic
Number	1742	130	179	191	295	308	265	94	280
Mean	0.589	0.622	0.603	0.573	0.614	0.578	0.521	0.625	0.614
St Dev	0.175	0.184	0.186	0.157	0.155	0.168	0.186	0.150	0.181
Skew	0.385	0.231	0.665	0.407	0.318	0.503	0.821	0.152	0.111
Min	0.131	0.17	0.252	0.228	0.221	0.131	0.148	0.253	0.215
Median	0.577	0.618	0.557	0.581	0.606	0.563	0.502	0.625	0.601
Max	1	1	1	1	1	1	1	1	1

The best performing regions, that is those regions whose mean level of efficiency was above the Australian mean, were GippsDairy and WestVic Dairy regions in Victoria, Dairy Tasmania, Dairy South Australia, and Western Dairy in SW Western Australia. Western Dairy, with a mean of 0.625 was the best performer. The remaining three regions, namely Sub-Tropical in Queensland, Murray Dairy in the Murray region of Victoria and NSW, and DIDCO in NSW were the poorer performers with means of 0.521, 0.578 and 0.573 respectively. Each of these regions had between approximately one third and one half, 32% to 48.7%, of their farms operating at less than 0.5 efficiency[18]. Dairy Tasmania, although having a mean of 0.603, which is above the Australian mean, had almost one third, 31.9%, of their farms operating at 0.5 or less efficiency. Approximately fifty three per cent of the farms in this region were operating at between 0.4 and 0.6 efficiency levels, while in the three regions below the overall efficiency average there were more units below the Australian average and more below 0.4 efficiency.

Of the better performing regions, Dairy SA and Dairy Tasmania both had 10% of their farms with an efficiency score in the top decile, followed by WestVic Dairy with 7.1%. Western Dairy, although a strong performer overall, did not have so many units fully, or near fully efficient, as did the other two regions.

Performance evaluation of DMUs over all Australia brings in many variables that differ considerably across the nation. Climatic conditions differ widely and produce different reliance on, for example, the need to irrigate, or the need to introduce supplementary feeding. The production technologies adopted by farms reflect such regional differences. For example, figures obtained from the survey data, show 86% of the farms in the Murray region irrigate compared to just over one third in the West Vic. and Gipps regions. Grouping all the regions together to examine the efficiency of Australian dairy farms, gives no recognition to

[18] Figure 2 in the Appendix, shows the frequency distribution of farm efficiency in each dairy region.

such regional differences. If, for example, irrigation is included as an input in the model, the results obtained from DEA will be biased in favour of those who do not need to rely on irrigation. The model specification is of fundamental importance if the results are to be meaningful and bias avoided.

To highlight the importance of correct model specification the same analysis is conducted with only 5 inputs, leaving out irrigation. Statistical summaries are presented in Table 2 below. For Australia overall, the distribution still resembles closely a near normal distribution, with the range 0.131 to 1, but with a slightly lower mean of 0.530. Individual dairy regions all have a lower level of efficiency but some show much greater change than others.

In particular, Western region, the best performer when six inputs are specified, now ranks seventh of all dairy regions, as a result of its efficiency dropping fourteen percentage points, from 0.63 to 0.49. The Murray region, the biggest user of irrigation with 86% of farmers irrigating, comes from being ranked sixth to being second behind Dairy South Australia. The farms in Dairy South Australia and the Murray regions showed much more consistency in both analysis than farms in any other region.

The output of farms reflects various inputs, including for most farms in the Murray region, irrigation. The farms have the same output whether or not irrigation is included as an input in the model. Since most farms have a value for the irrigation input, their efficiency score does not vary much when irrigation is excluded. The farms that have a lower efficiency in the second model are those that do not irrigate.

For example, farms 473 and 687 in the Murray Dairy region, both go from being fully efficient to being 0.75 and 0.81 efficient respectively when all farms are judged without the irrigation input. Likewise in other regions. If irrigation is included as an input, the farms that do not irrigate gain an advantage. If irrigation is not included as an input, then the farms that do not irrigate tend to perform less strongly since their output may be lower with not irrigating.

Table 2: Statistical Summary Technical Efficiency (5inputs) Australia and Regions

	ALL	DairySA	DairyTas	DIDCO	Gipps	Murray	SubTrop.	WestVic	Western
Number	1742	130	179	191	295	308	265	280	94
Mean	0.530	0.581	0.545	0.511	0.536	0.563	0.475	0.533	0.493
St Dev	0.162	0.175	0.166	0.152	0.130	0.167	0.171	0.172	0.114
Skew	0.622	0.339	1.057	0.366	0.507	0.515	1.005	0.557	0.244
Min	0.131	0.17	0.222	0.165	0.189	0.131	0.142	0.213	0.238
Median	0.519	0.567	0.517	0.509	0.539	0.545	0.451	0.516	0.497
Max	1	1	1	1	1	1	1	1	0.845

Dairy South Australia performed well in both models. Dairy South Australia and Dairy Tasmania, where over 60% of farms used irrigation, both improved their ranking in terms of technical efficiency when irrigation was not specified as a parameter of the model. However, the Sub Tropical region, also with over 60% of farms irrigating, remained the poorest performer, with a mean of 0.475, well below the Australian average. Leaving out irrigation as an input resulted in a greater spread of efficiency levels except for the South Australia and Murray Dairy regions, where the minimum level of efficiency remained the same regardless of model specification.

Table 3: Number of Efficient Farms by Region
(with and without irrigation input)

Dairy Region	Fully efficient (irrigation)	Bottom 50 Performers	Fully efficient (no irrigation)	Top 50 Performers	Bottom 50 Performers
Dairy Sth. Aust.	7(5.4%)	3(2.3%)	6(4.6%)	6(4.6%)	2(1.5%)
Dairy Tasmania	12(6.7%)	2(1.1%)	6(3.3)	10(5.6%)	3(1.7%)
Gipps Dairy	3(0.2%)	1(0.3%)	2(0.2%)	3(1%)	1(0.3%)
Murray Dairy	13(4.2%)	8(2.6%)	11(3.5)	13(4.2%)	8(2.6%)
DIDCO	6(3.4%)	7(3.7%)	3(1.5%)	3(1.5%)	9(4.7%)
Sub-Tropical	12(4.5%)	18(6.8%)	6(2.3%)	8(2.8%)	16(6.0%)
Western Dairy	1(1.1%)	1(1.1%)	0	0	2(2.1%)
West Vic. Dairy	9(3.2%)	10(3.6%)	4(1.4%)	7(2.5%)	9(3.2%)
All Australia	63 (3.6%)	50(2.8%)	38(2.2%)	50(2.8%)	50(2.8%)

Table 3 above shows that all regions suffered a decrease in the number of fully efficient farms when no irrigation was used as an input into the analysis. The proportion of fully efficient farms fell from 3.6% (63 farms), to 2.2% (38 farms) and a closer examination of the regions in terms of the fully efficient and the least efficient farms reveals the importance of selecting the correct inputs for the analysis. Dairy Tasmania and the Sub Tropical regions both lost 6 efficient farms, but for Dairy Tasmania, only 2 remained outside the top 50 performers.

The Sub Tropical region experienced significant changes, with one previously fully efficient farm experiencing a fall to 0.35, and another to 0.65. The top regional performer, Western Dairy, had no fully efficient farm, the top performer achieving 0.845 efficiency. The remaining regions, Dairy South Australia, West Vic Dairy and DIDCO each had one farm whose efficiency fell to below 0.75, while the remaining farms whose efficiency decreased, did not fall below 0.75 efficiency.

Considering only the top and bottom 50 farms in the sample, the ranking of the regions does not change much regardless of whether or not irrigation is included. Table 3 above shows that when irrigation is included in the model, the region with the highest proportion of efficient farms was Dairy Tasmania with 6.7% of their farms fully efficient, followed by Dairy South Australia, Sub-Tropical region and Murray Dairy.

The regions with the poorest performers were, in both analysis, Sub-Tropical, DIDCO, WestVic and Murray. If no irrigation is specified in the model, the same regions have the higher proportion of efficient farms, only their ranking changes to the extent that Dairy Tasmania moves from being the highest ranked of the top fifty farms to being ranked third, while the Subtropical region moves from being ranked third to being ranked fourth. An examination of the bottom fifty performers leaves the ranking of regions relatively unchanged apart from the Western region moving towards the bottom of the performers.

The Spearman Rank Correlation Coefficient, SRCC, test was performed as a further check on the consistency of two models in the relative ranking of the farms. A SRCC estimate of 0.88 was obtained, indicating that the ranking of farms is relatively invariant to the choice of model specification. Examining the complete set of estimates of technical efficiency revealed some variations but the overall ranking of farms is not significantly changed.

The worst performer, DMU number 2043, with a technical efficiency of 0.131, retains the position regardless of the choice of inputs. The most consistent performers appeared in the South Australia and Murray regions, as evidenced by the small change in the mean efficiency levels for both regions. Murray region's efficiency changed 2 points, from 0.58 to 0.56, while South Australia changed 4 points from 0.62 to 0.58.

Both the SRCC test and the examination of the top and bottom fifty performers show that, while the actual efficiency estimates differ in terms of magnitude, the ranking of farms do not. The technology selected has little impact on the best and poorest performers, but does on the some of the others, notably the non-irrigators, to the extent that the region's overall performance and its ranking among the dairy regions changes.

4.2. Regional Analysis

Individual dairy regions differ not only in terms of quantity of milk output but also in production technology and best management practices in terms of the various inputs used, as shown in Table 4. For example, in the WestVic and Gipps Dairy regions, just over one third of farmers use irrigation compared to the Murray Dairy region where 86% of the farms irrigate at least some proportion of their land.

The higher irrigation regions, namely Dairy South Australia, the Sub Tropical region as well as the Murray region have lower fertilizer expenditure compared to the other regions. By contrast, Western and WestVic regions, along with Dairy Tasmania are high users of fertilizers, spending on average around $25,000 per annum.

Table 4: Farm Characteristics by Region

	South Australia	Tasmania	DIDCO	Gippsland	Murray	Sub-Tropical	Western	WestVic
Number of farms	130	179	191	295	308	245	94	280
Milk Output (megalitres)								
--mean	1,029,283	896,115	806,999	876,393	993,795	578,436	1,190,731	1,168,4 27
--min	70,000	102,564	114,830	118,475	80,600	80,000	314,459	90,000
--max	5,000,000	4,300,.000	4,000,000	5,500,000	9,000,000	2,200,000	4,500,000	7,500,0 00
Hectares								
--mean	147.1	112.3	103.2	98.1	116.5	140.8	206.5	145.8
--min	12	20	20	20	16	16	51	30
--max	1497	465	486	526	607	898	800	1300
Cow Numbers								
--mean	182	219	156	200	204	138	207	237
--min	22	32	40	36	38	30	60	30
--max	730	250	750	1150	1600	600	800	1300
Feed ($per cow)								
--mean	2.06	0.49	1.67	0.83	1.38	1.32	1.61	1.2
--min	0	0	0	0	0	0	0	0
--max	12.5	5.78	5.78	5.78	5.56	12.6	1.89	5.05
Irrigation (hectares)								
--mean	43.28	44.3	41	70.3	92.3	28.8	43.34	44.1
--min	2	4	4	4	4	4	12	2
--max	263	243	162	405	668	243	101	280
%farms	67	61	54	35.6	86	61.5	37	34.6
Fertilizer($) --mean	14,883	24,943	17,037	17,398	14,983	13,898	25,957	24,504
Capital ($) --mean	1,021,154	810,056	1,078,947	844,915	901,466	822,642	1,587,766	9,919,6 43

The use of supplementary feed is significant for all regions, except Dairy Tasmania where an average of only $0.49 per cow is spent. Feed is perhaps not so essential an input in this region where farms use both irrigation and fertilizer to promote feed growth. Climatic differences between the regions in terms of promoting pasture growth, would also be significant in terms of input use.

To make allowance for differences in production technologies, and regional differences in variables, many of which are outside the control of the individual farmer, it may be more meaningful if efficiency analysis is undertaken for each individual region where a farm will then only be compared to a farm operating under similar climatic conditions. Environmental factors within, rather than across, regions will be more constant, and efficiency analysis will reflect the use of the various inputs more accurately.

Table 5 gives the statistical summary of the efficiency of each individual dairy region when analyzed using six inputs but with no reference to the other regions. The Murray and Sub-Tropical regions, although having similar sample sizes of 308 and 265 respectively, performed differently. The Sub Tropical region, with a mean efficiency of 0.638, is once again ranked last. It has a larger number of units, 30.19%, with an efficiency score of less than 0.5, and only 35, (13%), were regarded as fully efficient. Farms in the Murray district, while having a slightly lower proportion of fully efficient farms, 37, (12%), had more with efficiency above 0.5. Only 9.08% achieved an efficiency of less than 0.5. However, with a mean of 0.728, Murray region ranked fifth.

Table 5: Statistical Summaries: Efficiency Analysis of Individual Dairy Regions

	Sub Trop.	Murray Dairy	Western Dairy	WestVic Dairy	Dairy South Aust.	Gipps Dairy	Dairy Tas.	DIDCO
No. of farms	265	308	94	280	130	295	179	191
Mean	0.638	0.729	0.822	0.737	0.794	0.705	0.722	0.729
Minimum	0.152	0.226	0.394	0.253	0.236	0.274	0.299	0.278
No. Fully Efficient	35	37	20	39	33	32	32	28

The farm characteristics, outlined in Table 4, shows the Sub Tropical region had the lowest average milk output although in terms of size, both cow numbers and hectares, it ranked in the middle of all the regions. An examination of the region on its own portrayed its performance more favourable than when part of the larger Australia sample. Although the efficiency of the poorest performer did not change greatly, namely from 0.149 to 0.152, there were many more farms whose efficiency did improve. When compared only with farms operating under similar physical conditions, 35% of the sample had 0.7 or greater efficiency, compared to only 14% when the region was examined in the all Australia sample.[19]

Of the better performing regions in the all Australia sample when six inputs were used, Western Dairy and Dairy South Australia regions had similar means yet, when analysed on their own, Western Dairy, with only 94 units in the sample, outperformed Dairy South Australia. The smaller sample size resulted in a mean efficiency score of 0.822 compared to 0.627 if this region was analysed as part of the all Australia data. Farms that were not fully efficient in the larger sample were now efficient when compared to the farms operating in this district only[20]. Dairy South Australia with 130 units in the sample, had a mean efficiency of 0.794 compared to 0.622 if the same units were examined in the larger all Australia sample. When compared to farms in the same region, only 5.39% had efficiency levels below 0.5, while 35.38% scored between 0.9 and 1.

Production technology, as reflected in input usage in the two regions, did not differ greatly except for the extent to which irrigation and fertilizer was used. Farmers in the Western region spent just under twice as much on fertilizer as did their counterparts in Dairy South Australia, while just over one third of the farmers used irrigation in the Western region, compared to two thirds in Dairy South Australia region. (Table 4)

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[19] Figure 3 in the Appendix, shows the frequency distribution of farm efficiency for each region when analyzed independently of the other dairy regions.

[20] This result supports the claim by Zhang & Bartels (1998), that mean efficiency is related to sample size

The effective use of these inputs may be reflected in the different output levels and in the degree of technical efficiency achieved, but an additional factor influencing performance is the size of the sample. Using DEA, farms are being compared to their peers and thus their performance will be judged in terms of their peer's performance. If the number of peers is reduced, performance will improve. Although statistically the size of the sample for each region is sufficient, sample size has an important influence on the efficiency level derived using DEA.

The ranking of the top regions when analyzed on their own did not vary much from the ranking when analyzed as part of Australia. The degree of efficiency improved in the smaller sample group and with being compared only to farms operating under similar physical conditions, that is, all in the same region. Gipps Dairy, with a mean of 0.705, ranked seventh, well below its equal third ranking as part of the all Australia analysis. Farm level efficiency, as illustrated in the frequency distributions charts, (Figure 3 in appendix), was much less spread compared to many other regions. Approximately sixty percent of farms achieved between 0.5 and 0.8 efficiency, but there was a smaller proportion of fully efficient farms (10.8%). By contrast, DIDCO region improved and had over seventy per cent of its farms achieving an efficiency of 0.6 or greater.

5 Conclusion

The primary objective of this paper has been to use DEA to measure the technical efficiency of a sample of dairy farms both across Australia and within individual dairy regions. The results indicate that there can be significant variation in the efficiency estimates, depending on the model specification, both in terms of model size and in the inputs included.

When using the whole data set, DEA generates measures of technical efficiency that are derived from individual farms being compared to other farms experiencing widely different climatic and other physical conditions. Variations between the eight different dairy regions of Australia, makes it difficult to specify a model that accurately reflects the conditions in each region. This is highlighted in the ranking of the Western Dairy region, which changes from being the best performer to being ranked seventh when the model specification is changed.

The size of the sample also impacts the result obtained. Reducing the sample size, for example, examining only one region, improves the overall performance of any region, but more importantly, farms are being compared to farms that are more likely to be facing similar climatic and geological factors, rendering the analysis more meaningful and helpful in suggesting or developing any extension activity.

Regardless of the model selected, there are some very efficient farms, but there are also many, in all eight dairy regions, whose output could be increased without changing the level of their input use. The DEA procedure identifies not only those particular economic units that seem to be relatively inefficient in terms of the output-input combinations being considered, but also potential benchmark partners for individual units. The farm's peers, the best performing units, can be used to develop benchmarks and local action initiated for individual farms to improve their performance. The ability to respond locally to observed inefficiency is an important feature of an extension programme aiming to improve overall standards of performance in the industry.

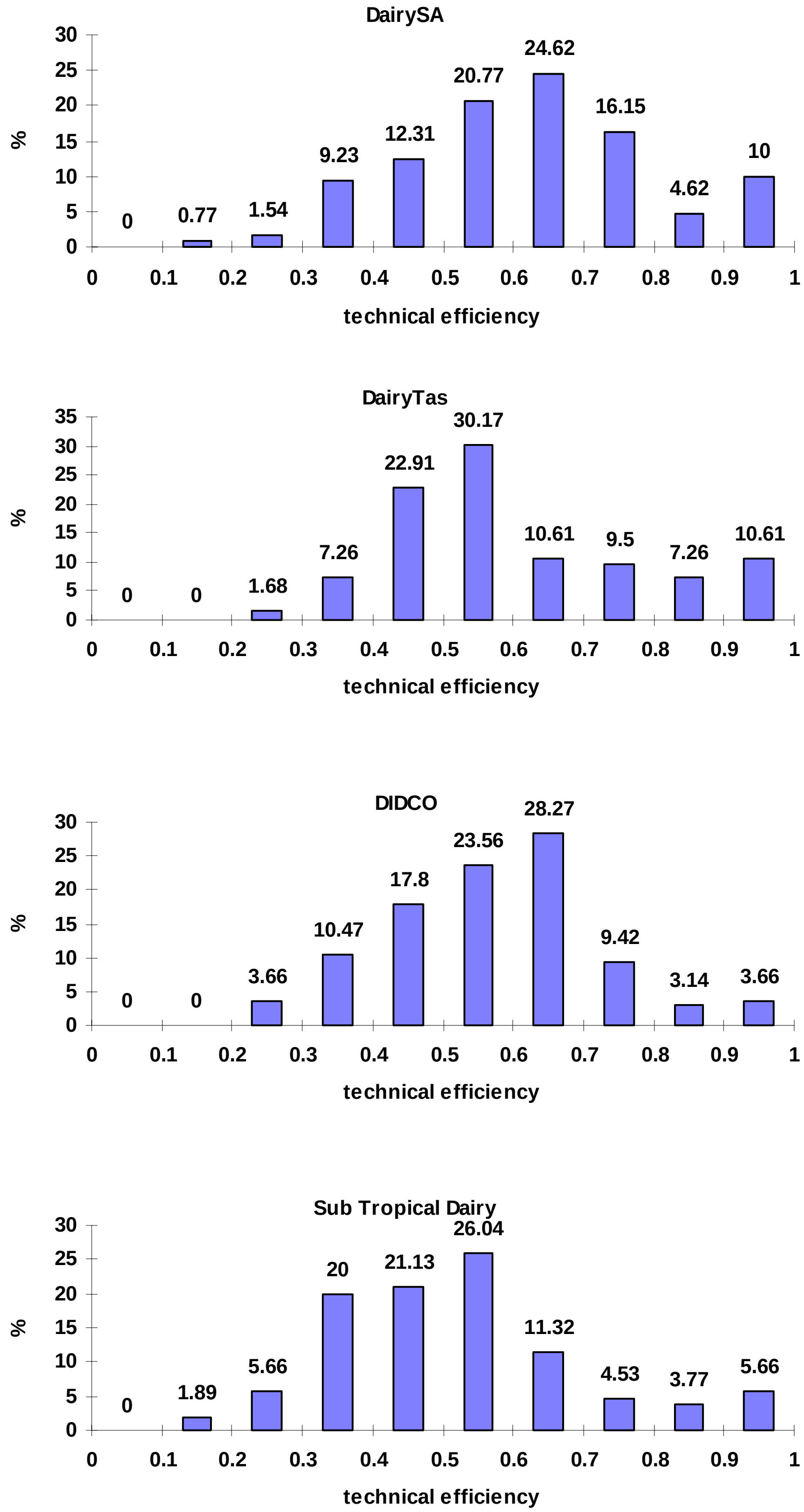
Efficiency and productivity growth over a period of time are commonly reported in many agricultural sectors. Measures used however, need to accurately capture the technology used in the production process before any meaningful policy can be developed. ABARE (2001) examine the growth of productivity over time. All areas are examined and combined with no consideration given for those areas where, for example, irrigation is important compared to areas where irrigation is not necessary.

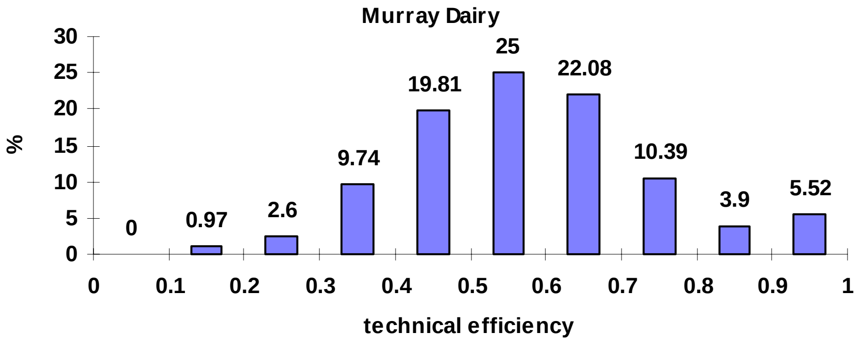
ABARE (2001), adopt Lovell's (1993) claim, that productivity variations reflect differences in the production technology used, differences in the efficiency of the production process and differences in the environment in which production occurs. The analysis here focused on the technical efficiency of the production process. The importance of specifying the correct production technology is seen when we compared results of analysis using different inputs, reflecting different technologies. Differences in the physical environment were also highlighted when we considered results obtained for individual regions, analyzed on their own, compared to being part of the all Australia analysis. The degree of inefficiency will be reflected in productivity differences, thus when examining and comparing productivity figures, care is needed and some thought about how the figures have been determined.

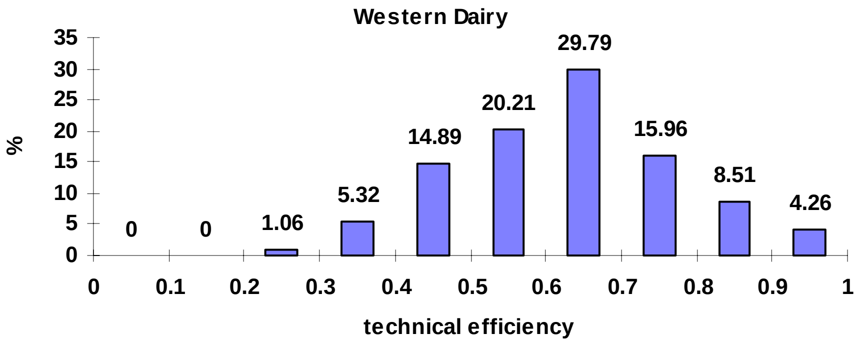
Efficiency has been examined in relation to the main inputs used and to what extent the use of the inputs could be improved. However, many other socio-economic factors may account for efficiency levels. Previous research has found that age and educational level impact on technical efficiency (Kumbhakar S.C., Ghosh S. et al. 1991), (Tauer and Siefanades 1998). The wider environmental impact of dairy farming is also of interest. To what degree does efficiency levels impact on sound environmental practices such as waste handling, water re-use? This remains an area for future research.

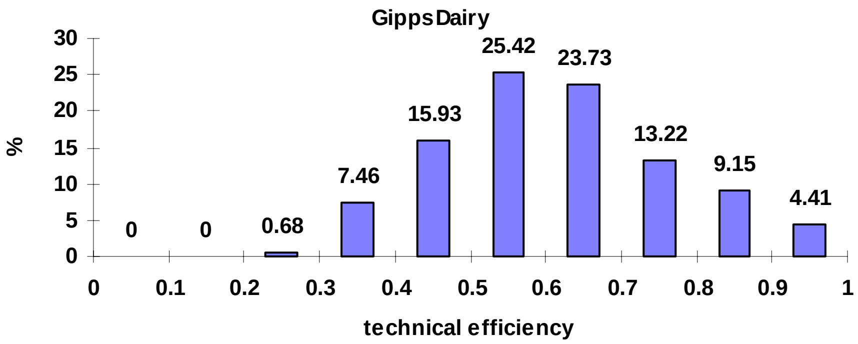
Appendix

Figure 2: Farm level efficiency by region: All Australia




Murray Dairy
%
technical efficiency
0
0.97
2.6
9.74
19.81
25
22.08
10.39
3.9
5.52


Western Dairy
%
technical efficiency
0
0
1.06
5.32
14.89
20.21
29.79
15.96
8.51
4.26


GippsDairy
%
technical efficiency
0
0
0.68
7.46
15.93
25.42
23.73
13.22
9.15
4.41

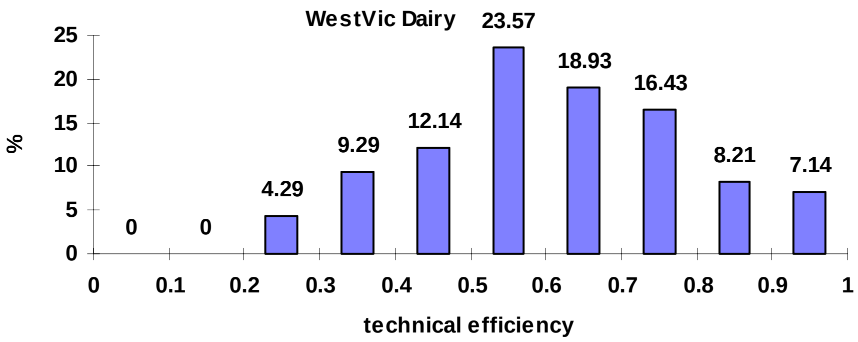
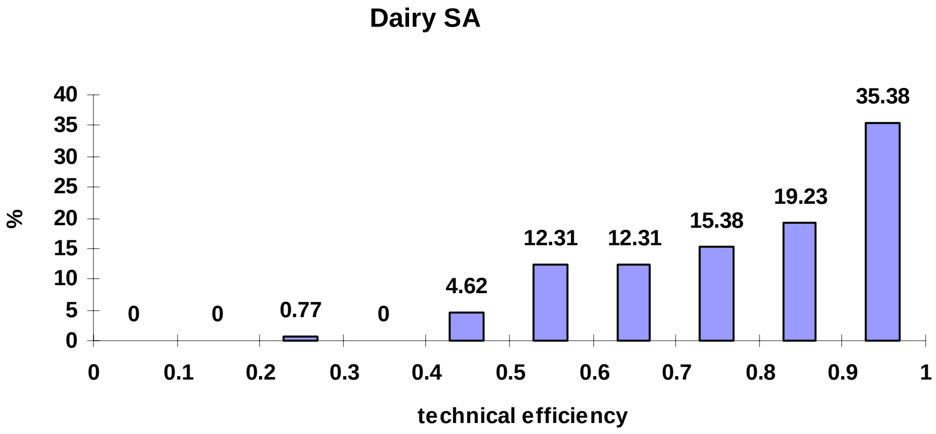
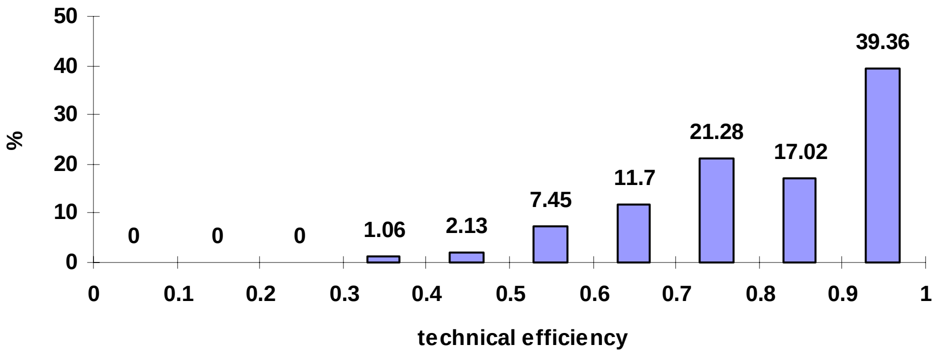

WestVic Dairy
%
technical efficiency
0
0
4.29
9.29
12.14
23.57
18.93
16.43
8.21
7.14

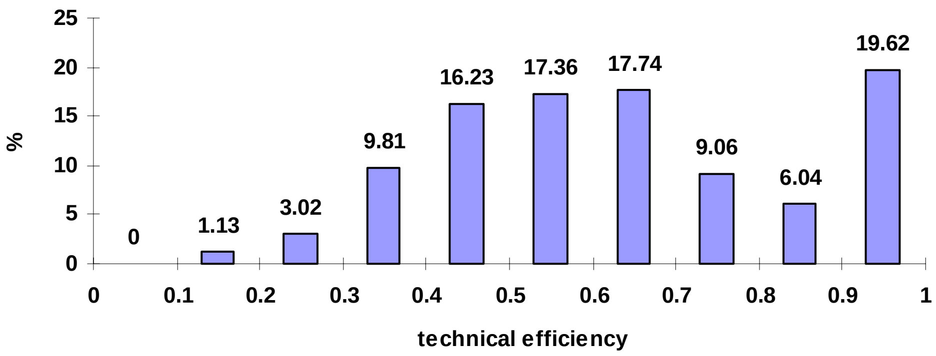
Figure 3: Frequency Distributions Individual Dairy Regions



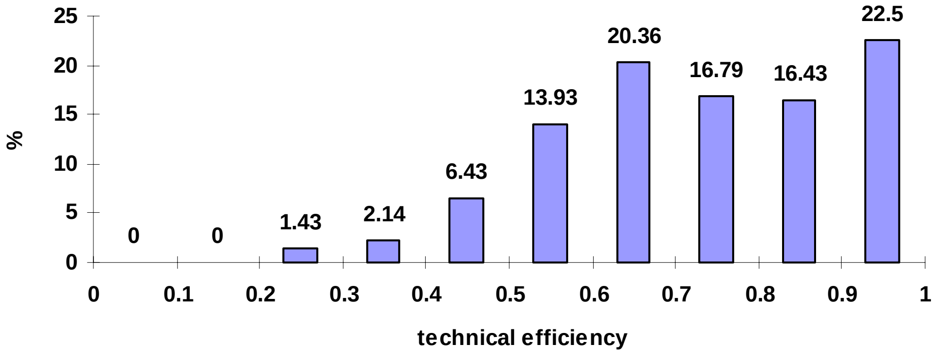
Western Dairy



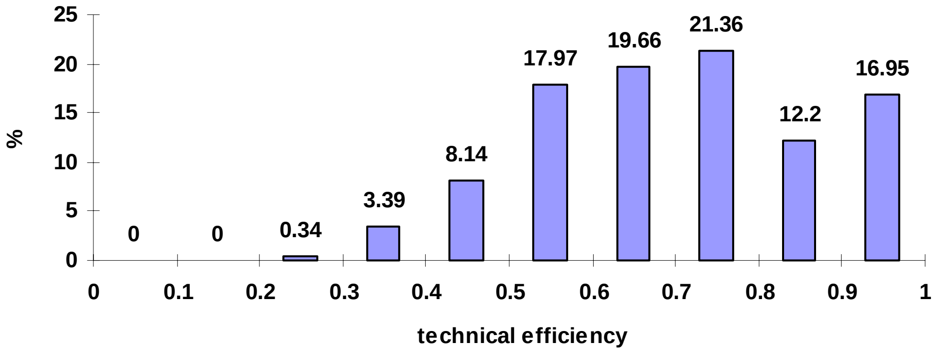
Sub Tropical Dairy



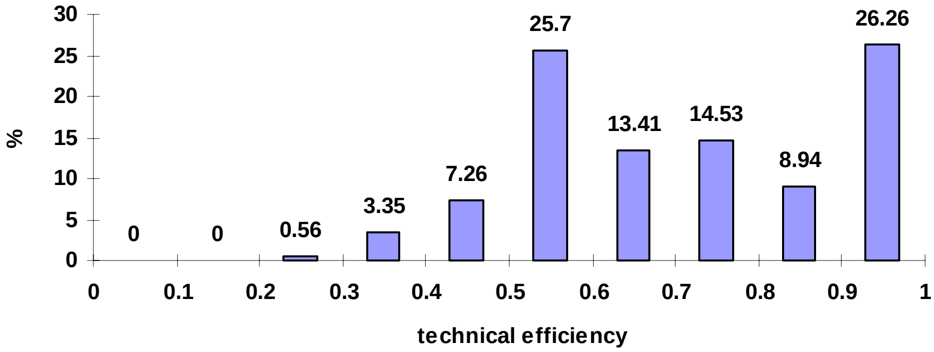
WestVic Dairy



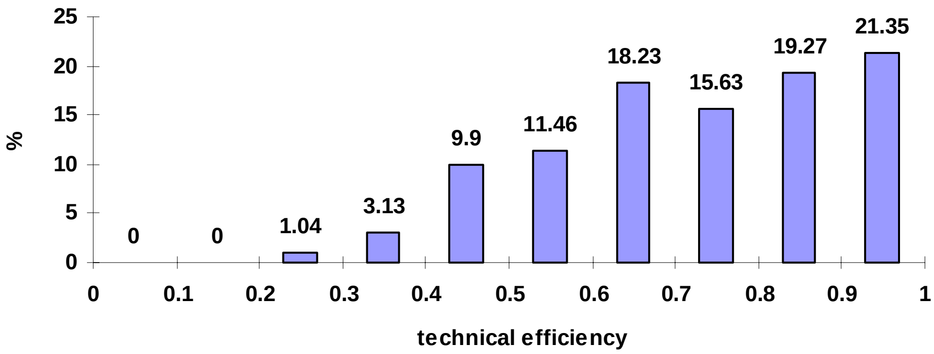
Gipps Dairy



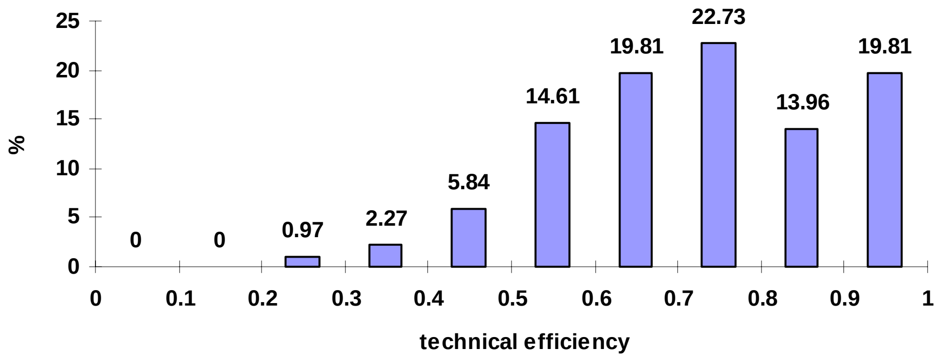
Dairy Tas



DIDCO



Murray Dairy



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Decision aid to evaluate a change in feeding systems. A dairy case study on maize silage.

Lloyd Davies,
Economist, NSW Agriculture, Tocal Agricultural Centre. NSW

Acknowledgement:

The author acknowledges the financial support from the Dairy Research and Development Corporation in developing this model.

Introduction

Maize silage is a consideration for many dairy farms because it can produce a source of energy and fibre to substitute for more expensive purchased feeds. However, a decision to alter a dairy farming system that incorporates the handling of large quantities of maize silage can involve investment in excess of $100,000. Extra machinery, bunker facilities and perhaps a feed pad are capital investments that may need to be made. Even if maize silage is the cheapest feed option on a variable cost basis, it may not be once overhead costs are taken into account. This paper describes a decision aid called the *Compare Systems Model* and uses a case study where the model has been used to generate results. The results, in this situation, indicate the adoption of a maize silage system has been very profitable.

The Compare Systems Model

The *Compare Systems Model* should be used as a screening tool to help evaluate alternative feed strategies in livestock enterprises. It uses a partial budgeting approach where only the costs and returns considered are those that alter because of the change. It calculates the additional net income expected and the return on additional capital. If projected returns on additional capital are inadequate, then it is pointless in proceeding further. If, however, returns are attractive, income and costs projections should be included in a cash flow budget to assess the cash flow consequences of making a change.

The model requires Excel 97 or later to run and requires projections of production information for the existing system as well as projections for the proposed system. It is divided into a number of inter related worksheets where the user enters the data required. In the initial data entry run, data is entered into the spreadsheet in a set sequence. A click on the macro button at the bottom of each sheet moves the user to the next worksheet and at the same time transfers some of the information from the completed sheet.

Existing system information requirements

Data is firstly entered about the existing feed system. Since the model is comparing future performance estimates, the data required for the existing system are future projections rather than production levels in the last 12 months. For example, if it is going to take two years for the proposed system under consideration to get to full productivity, the figures for the present situation should be the projections of where the present system would be in two years time. Worksheets relevant to the present situation are as follows:

q(a):- Details of the fodder production levels from the present system on an area basis.

hr(a):- Details of machinery hours spent on fodder conservation in each area.

m(a):- Details of hourly running costs and questions to determine the overhead costs of machinery.

mc(a):- Calculations of machinery and labour costs.

inc(a):- Milk and/or stock sales are estimated along with prices. Anticipated purchased feed costs are also included.

Proposed system information requirements

An identical set of worksheets named q(b); hr(b); m(b), mc(b) and inc(b) are to be filled in for the proposed system.

Use of a feed budgeting model in conjunction with the *Compare Systems Model* is recommended to ensure that feed cost and cow number estimates are achievable. An Excel based feed budget model developed by the Tasmanian Department of Primary Industries and Energy is being made available with the model. However, there is other feed budgeting software available. The advantage of alternative software is that local pasture growth rate information may already be built in and the user may already be familiar with it.

The *Compare Systems Model* is set up to take the user through a sequence of steps to arrive at an answer. Note steps 1 and 2 are completed prior to using the *Compare Systems Model* while steps 9 and 10 are recommended steps after the *Compare Systems Model* has been used.

Prior to using the *Compare Systems Model,* a feed budget detailing production and consumption of the present pastures and fodder supplies should be undertaken. A similar feed budget should be prepared for the proposed situation.

Check the feed budget for the existing system to ensure it approximates what is currently happening on the farm. If there are significant differences the figures must be revisited until the budget is similar to actual results.

Detail the machinery and other resources required for the proposed situation.

Decide which equipment can be sold and what equipment has to be purchased. The cost of silage bunkers should be included here.

Estimate the changes in costs and income that occur as a result of the change. Costs include depreciation; interest; forage crop and pasture growing; animal husbandry; marketing and labour.

Calculate the net returns (additional income less changes in costs).

Prepare a partial budget that calculates percentage return on the extra capital.

Decide if the return is attractive enough.

If return is attractive, a cash flow budget is recommended and should to be prepared especially if there are significant time lags. (not part of *Compare Systems Model*)

If cash flow budget looks acceptable, adopt the change.

The Case Study Farm Details

Owners: Graeme, Jennie and Jamie Drurie

Location: Taree, Mid-North Coast of NSW

Milkers prior to maize silage: 175 milked all year round.

The Drury farm meets the following essential requirements that must be met for a farm to consider a maize silage feeding system:

- having land capable of growing maize silage and, preferably, plenty of feed available from other paddocks during the October to January growing season. Nearby land could be leased for the purpose or a near by farmer could grow the silage on contract.
- suitable sites to store the silage (above ground bunkers have been used in the Drurys' case)
- access to a contractor to precision chop the silage and deliver it to the storage site.
- a means of feeding out the silage, preferably a feed wagon.
- a front-end loader or other machine to load the wagon (already owned).

If high quality pasture is unavailable, access to a protein source to supplement the low protein in maize silage. The mixing wagon increases the options of what can be used. In this case study, brewer's grain which is 24% crude protein has been successfully used when required.

A feed pad is also recommended to help reduce wastage, especially in wet weather. A gravel based feed pad with a strip of rubber belting is being successfully used. The cost to install this feed pad was $3,000, but a concrete pad would be many times more.

Has the new system paid dividends?

The case study farm results indicate a healthy return for the following reasons.

The maize fodder can be grown, harvested and stored at a reasonable cost. The dryland maize growing and harvesting costs are estimated to be $78/tonne dry matter (tDM) which, even allowing for a wastage factor that is inevitable with silage, is a relatively cheap feed.

Access to a feed wagon has also meant that brewer’s grain can be used. The price paid on farm varies but in Autumn 2002 it was worth $200/tDM. This is cheaper than equivalent quality grain mixes ($300/tDM). The cows really like it in the mix.

Milk quality has risen. In April 2001 the average protein was 2.89% and milk fat 3.86%. In April 2002, using the new system, protein has averaged 3.11% and milk fat 3.89%. This represents an increase of 1.4 ¢/λ for the protein and 0.1¢/λ for the fat. This may not happen for the whole year so a more conservative 1 ¢/λ has been used for an average throughout the year. Estimates of the return on capital from lower quality bonuses and a range of base milk prices are provided below.

The cows are milking better. They now receive 2kg of concentrate at milking plus 2kg DM maize silage and 4kg DM of brewer's grain as a mix at the feed pad. The previous feeding pattern was 5kg of concentrate fed while milking plus on average 1.4kg of hay per day fed in the paddock. Milk production has risen from around 23 litres per day to 26 litres per day.

As a result of the additional supplementary feed available in the winter, the ryegrass pastures have had reduced grazing pressure. As a result this spring, 50% of the ryegrass pasture has been cut for pit silage. In previous years a much smaller percentage of the farm was able to be shut up for round bale silage.

The availability of a feed wagon means that surplus ryegrass silage can now be stored as pit silage rather than the more expensive round bale silage alternative.

There are an additional 10 cows in the milking herd (13 in total including dry cows). This number should increase further when the level of silage in the pit increases.

The analysis below is a budget of the projections from the case study dairy. Details of changes in milk income are shown in detail, however, other income and costs have not been shown because of the space required. The figures below are the results from data entered into the computer model.

The existing milk production is: 165 cows @ 23λ/cow x 365 days = 1,385,175λ

New milk production is: 175 cows @ 26λ/cow x 365 days = 1,660,750λ

Additional milk (1,660,750 – 1,385,175) = 275,575λ

The benefits in $ terms are as follows:

Value of extra milk: = 275,575λ @31cents/λ	=	$85,428
Increase in value of existing milk due to quality gains = 1,385,175λ @ 1¢/λ	=	$13,852
Savings in purchased feed costs. This has fallen because the home grown silage reduces the quantity of purchases required, and the fact that brewer’s grain is currently cheaper than other grain alternatives that are fed in the dairy, and purchased hay is not required. Other high protein feeds may substitute if brewer's grain becomes too expensive, however, the economics would be less attractive.	=	$15,920
Value of extra stock trading profits @ $100/ extra cow	=	$ 1,300
Total additional income or saved costs		$116,500 (A)

Less

Levies. 275,575 @ 0.3¢/λ		$826
Additional maize and other crop growing costs	$22,520	
Extra own machinery costs		$3,457
Extra herd, shed and labour costs @ 5.8 ¢/λ		$15,983
Extra machinery labour costs		$2,235
Extra machinery overheads		$5,967
Total extra costs		$50988 (B)
Net gain/yr (A)-(B)	$65,512	

Capital required:

Extra cows 13 @ $1700		$22,100
Extra machinery		$28,000
Bunker for brewer's grain (has other uses when not required for brewer's grain)	$6,000	
Feed pad already installed.		

Total capital required
$56,100

Return on capital before interest and tax = $65,512 ÷ $56,100 x 100 = 117%

Sensitivity of results

The following tables shows the effect on return on capital from the base milk price used, projected increase in milk price due to quality bonuses and increases in yields per cow of 0,1 and 3 litres.

Effect on return on capital % to milk price. Litres/ cow the same

	Base milk price			
Improvement in milk price c/litre	20¢/λ	25¢/λ	30¢/λ	35¢/λ
0.0 ¢/λ	-9%	-2%	6%	13%
0.5 ¢/λ	4%	11%	19%	26%
1.0 ¢/λ	17%	24%	32%	39%
1.5 ¢/λ	30%	37%	45%	52%

Effect on return on capital % to milk price. Litres/ cow increases by 1 litre

	Base milk price			
Improvement in milk price c/litre	20¢/λ	25¢/λ	30¢/λ	35¢/λ
0.0 ¢/λ	6%	20%	33%	46%
0.5 ¢/λ	20%	33%	46%	59%
1.0 ¢/λ	34%	47%	60%	73%
1.5 ¢/λ	47%	61%	74%	87%

Effect on return on capital to price. Milk production up 3 litres.

	Base milk price c/litre			
Improvement in milk price	20¢/λ	25¢/λ	30¢/λ	35¢/λ
0.0 ¢/λ	38%	63%	87%	112%
0.5 ¢/λ	53%	77%	102%	127%
1.0 ¢/λ	68%	92%	117%	141%
1.5 ¢/λ	82%	107%	132%	156%

Variations in purchased feed costs is the other key variable to consider. The original budget allowed for a saving of $15,920, mainly because the silage and the brewer's grain was replacing more expensive feeds. Purchased feed costs savings may not be as high if brewer's grain prices increase or if maize silage yields are not as high as expected. The effect on return on capital for a situation where feed costs are $10,000 higher than expected is to reduce the return on capital from the original 117% to 99%. For a situation where per cow milk production increases by 1λ/hd/day and milk prices increase by ½¢/λ, $10,000 in additional feed costs alters return on capital from 60% to 42%.

In general, a return on capital of at least 15% is needed to justify the investment. A 15% return can be achieved with the following changes.

A ½ cent increase in milk price due to improved quality with other factors being constant.

A milk price of 36¢/λ with no increases in per cow production or milk quality bonuses.

A 1 litre increase in per cow production per day with a base milk price of 23-24¢/λ cents and no milk quality bonuses.

The results of the system are very attractive and based on these figures it appears as though the case study farm owners have backed a winner.

Conclusion

The *Compare Systems Model* is a useful tool to measure the financial results of a decision to change a fodder conservation system. It offers a structured approach and by using the model the user will unsure that all relevant factors are considered. Critical factors affecting the economics, are

- the scale of operation. Large machinery investments cannot be justified without scale.
- the feed price of alternative feed.
- the milk price achieved. Seasonal milk production or bonuses are factors to consider.
- the potential for labour saving. The *Compare Systems Model* is a very useful tool to calculate labour requirements.
- the capital investment that is required.
- the ready availability of a contractor at competitive prices to undertake the harvesting of maize silage.

Weather and Climate Services for Agriculture

Ian Muirhead, Grant Beard, Barry Southern, Graham de Hoedt and Blair Trewin
Steve Lellyett, Climate and Consultancy Services Manager NSW - Commonwealth Bureau of Meteorology

'The north wind is best for sowing seed, the south for grafting'

(R. E. Spencer, Weekly Weather and Crop Bulletin, 1954)

For many centuries weather folklore such as this has been used to aid decision making in agriculture. The trouble with weather proverbs is not so much that they're all wrong, but that they're not all right for all times in all places. Improvements in science and technology have improved the accuracy of agricultural related weather forecast information and provided the basis for the development of a range of meteorological products aimed at supporting decision making within the agricultural sector.

Introduction

The Bureau of Meteorology is the National Meteorological Service for Australia, and its mission is to observe and understand Australian weather and climate and provide meteorological, hydrological and oceanographic services in support of Australia's national needs and international obligations.

One of the primary functions of the Bureau, inter alia, is to assist persons and authorities engaged in primary production, industry, trade and commerce. As well as the provision of meteorological data, a range of general and specific monitoring, prediction and information services are provided in support of the agricultural activities. The Bureau is also involved in research and technology development aimed at improving weather and climate services to rural and regional Australia.

Weather and climate related products and services are disseminated through the electronic and print media, by fax, through a range of information telephone services, through email and via the internet. The Bureau has continued to enhance and extend the range of products in support of environmental and farming decision making. This presentation provides an overview of the products and services that the Commonwealth Bureau of Meteorology provides to the community in support of agricultural activities.

Monitoring information

A range of observational meteorological information is available from the Bureau of Meteorology. This information is accessible from a variety of bulletins, such as daily, weekly and monthly weather bulletins and current observations and river height bulletins. The information provided includes daily rainfall, maximum and minimum temperature, current temperature, relative humidity, wind speed, direction and gust strength, cloud amount, and atmospheric pressure. Much of this observational data, including the latest radar and satellite imagery, are accessible from the Bureau's website (Figs 1 and 2) and through facsimile services.

As part of the Bureau's commitment to improving agricultural services, systems are currently being developed to provide near real time access to other observational data including soil temperatures, wind run and pan evaporation. This information is aimed at supporting the decision making processes of major water users such as irrigators in the agricultural sector.

Figure 1. The Bureau of Meteorology website at www.bom.gov.au provides a range of meteorological information in support of the agricultural sector.

Current Weather Details for New South Wales

Based on hourly data from auomatic weather stations

Station Name	Current Observations									
	Date Time (AEST)	Temp (deg C)	Dew point (deg C)	Rel Hum (%)	Wind dir	Wind speed (km/h)	Wind speed (knots)	Wind gust (km/h)	Wind gust (knots)	Press (hPa)	Rain since 9am (mm)
Albury Airport	22 14:00	21.9	2.6	28	N	13	7	20	11	1005.0	0.0
Armidale Airport	22 14:00	23.6	4.6	29	WNW	28	15	39	21	1010.0	0.0
Badgerys Ck	22 14:00	24.0	13.3	51	ESE	26	14	33	18	1004.4	0.0
Ballina Airport	22 14:00	24.0	16.5	63	NE	30	16	39	21	1008.4	0.0
Bankstown	22 14:00	22.2	13.8	59							
Bathurst	22 14:00	23.2	-4.8	15							
Bega	22 14:00	17.1	11.0	67							
Bellambi	22 14:00	17.9	13.8	77							
Bombala	22 14:00	18.9	0.5	29							
Bourke Airport	22 14:00	30.8	-7.2	8							
Braidwood	22 14:00	19.3	-0.1	27							
Broken Hill	22 14:06	29.7	-5.1	10							
Cabramurra	22 14:00	10.7	0.5	49							
Camden	22 14:00	24.7	14.2	52							
Canberra Airport	22 14:00	19.1	2.5	33							
Canterbury	22 14:00	20.9	12.9	60							

Figure 2. An example of the type of observational information freely available from the Bureau of Meteorology website (www.bom.gov.au) .

The range of agriculturally related monitoring products has been significantly increased in the last few years, and nearly 300,000 climate related monitoring products are currently provided each year through the Bureau's website (Fig 3). These include standard rainfall deficiency monitoring products and a range of daily, weekly, monthly and multi-month map products, generated and updated automatically as, and when, the data becomes available.

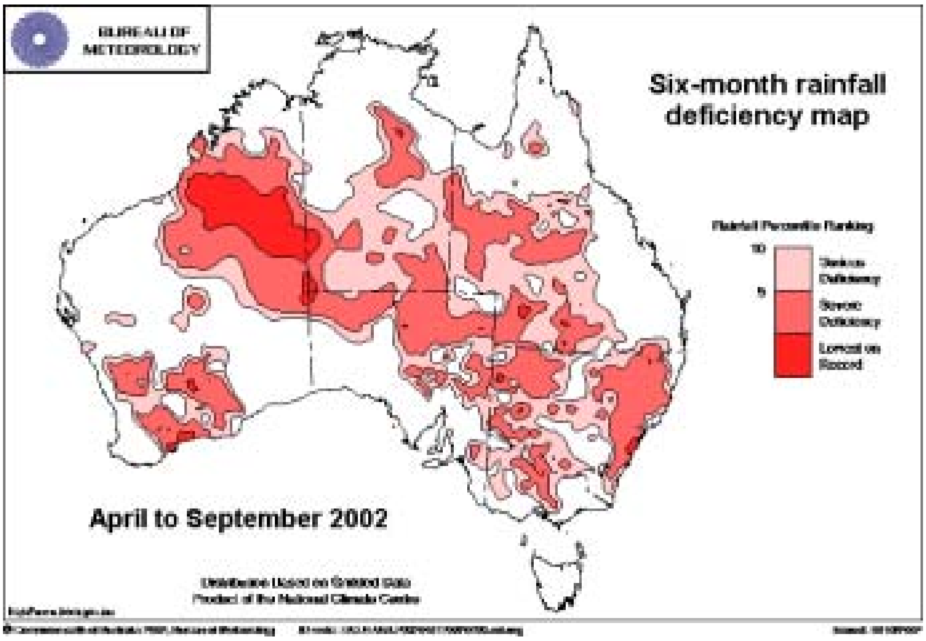

Figure 3. An example of the mapped monitoring products freely accessible through the Bureau of Meteorology's website. This type of rainfall deficiency information is used for environmental resource management and as input to the Federal Government's Drought Relief and Exceptional Circumstances scheme.

Weather forecast information

As part of its weather forecasting schedule, the Bureau provides weather forecasts for more than 170 cities and towns and 60 separate forecast districts, according to community needs. Weather warnings for agriculture, which are a significant component of forecasting services, include:

- Frost warnings.
- Farmers and graziers warnings.
- Brown rot/black spot warnings.
- Downy mildew advices.
- Land gale warnings.
- Fire weather warnings.
- Severe weather advices.

Over the last year, weather related research activities have been focused on enhancing services to regional Australia, with the ongoing development of objective forecast guidance systems in support of more accurate and detailed public weather forecasts for rural areas. There has also been a greater demand for more detailed intraseasonal (one to three-week ahead) rainfall forecasts from the agricultural community. In response to these needs, the Bureau of Meteorology Research Centre (BMRC) has been investigating techniques to monitor and predict on time scales of 10-40 days (Fig 4).

An experimental monitoring/forecast system for equatorial regions has been established and is currently being tested. Preliminary results from this scheme indicate that there is some skill in forecasting precipitation variations out to about 15 to 20 days ahead.

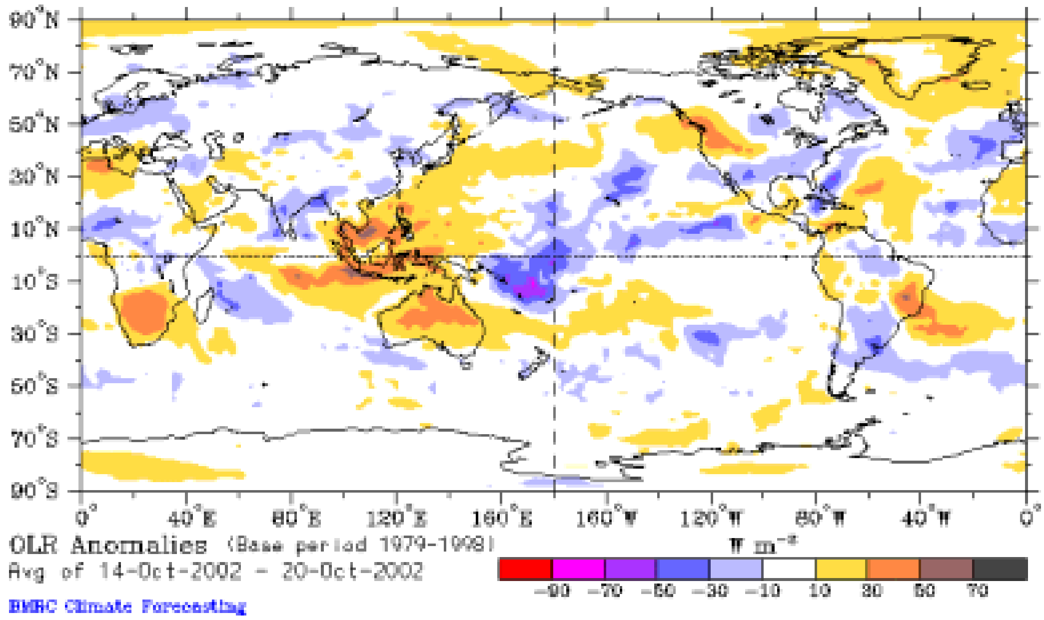

Figure 4. A map showing outgoing longwave radiation which indicates cloudiness and tropical activity across the globe – this type of global information is used by the Bureau of Meteorology Research Centre for research into intraseasonal (one to three-week) rainfall prediction.

Longer term prediction - Seasonal Outlooks

The global climate community's knowledge about the El Niño Southern Oscillation phenomenon (ENSO) continues to evolve and expand slowly with the constant flow of high quality real-time observations from the tropical Pacific Ocean. Furthermore, the ever-increasing computing power and sophistication of ocean and climate models means that our capacity to forecast El Niño events will continue to improve. However, it will still be some years before these computer models are good enough to out-perform the statistical techniques currently used for making seasonal outlooks.

The Bureau's current Seasonal Climate Outlook (SCO) service is based on historical relationships between Pacific and Indian Ocean surface temperatures and patterns of Australian seasonal rainfall and temperature. This information (Fig 5) is updated each month and made available to the media for widespread dissemination to the community. It is also freely available through the Bureau's website.

The reliability or skill of seasonal rainfall outlooks peaks in the north and east of the country in the second half of the year, as it is closely linked with the ENSO cycle. Temperature outlooks are more skilful than rainfall outlooks in both geographical spread and peak skill scores. They also have a greater spread of potentially useful skill across the year.

A full commentary on El Nino conditions is available through the Bureau's website (http://www.bom.gov.au/climate/enso/). This product, called the 'El Nino wrap up', is updated weekly and provides a broad update of all available ENSO indicators. The 'El Niño Status group', consisting of representatives from core agencies involved in climate prediction and application/impact work, is activated during such events to ensure a unified approach to communicating the status and possible impacts of El Niño events to the Australian community, and in particular to the agricultural sector.

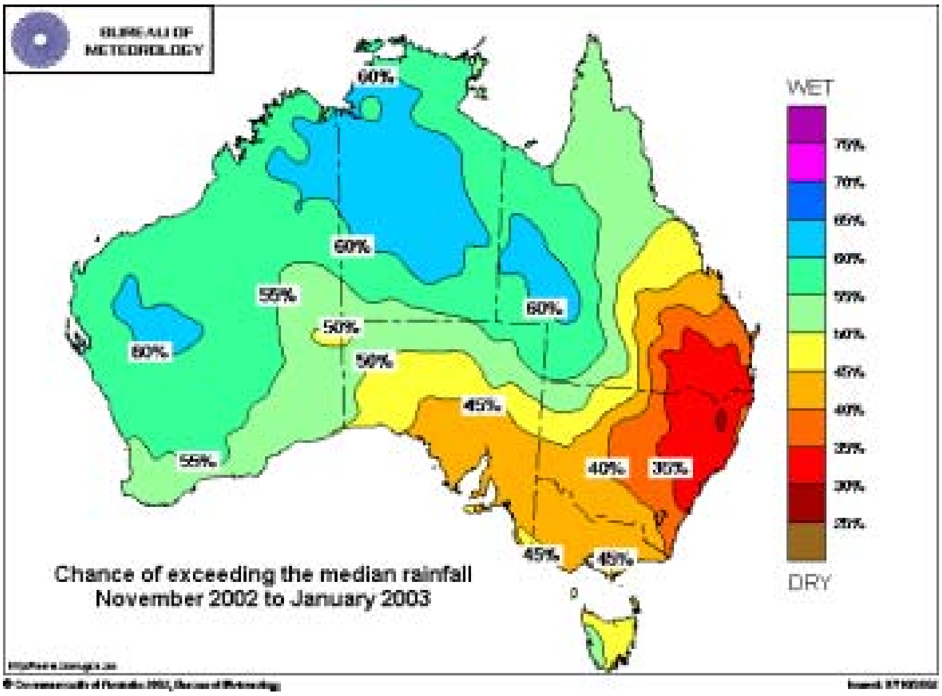

Figure 5. Rainfall prediction maps are available through the Bureau's Seasonal Climate Outlook Service. This probability based prediction information, which shows the chance of wetter/drier conditions is produced monthly and is valid for the following three-month period.

Special services for agriculture

The Bureau of Meteorology has continued to develop the SILO project, which is focused on the provision of tailored observational and prediction information to the agricultural sector.

SILO was jointly developed by the Bureau, Agriculture, Fisheries and Forestry Australia and Australia's Rural Research and Development Corporations under the Climate Variability in Agriculture R&D program (CVAP). The centre-piece of the SILO project is the SILO website (Fig 6), which aims to:

- be a central source of weather and climate information that is readily accessible to decision makers, researchers and educationalists, particularly in the agricultural area; and
- develop a coordinated information service that will facilitate further adoption of climatic risk management techniques by landholders and agribusiness.

Although primarily aimed at agricultural activities, the SILO website provides useful information for other weather and climate sensitive industries such as fire management, mining and recreation. The site provides free and subscription-based (cost-recovery) services to assist with both short and long-term decision making. One of the most popular products available are meteograms (Fig 7) - a graphical product which shows seven day ahead location-based forecast information (rainfall, temperature, relative humidity and wind), as derived from the Bureau's weather forecasting models.

It is important to note that the information provided in meteograms is taken directly from computer models and, as such, is meant to be used as guidance information – meteograms should not be treated as official Bureau forecasts.

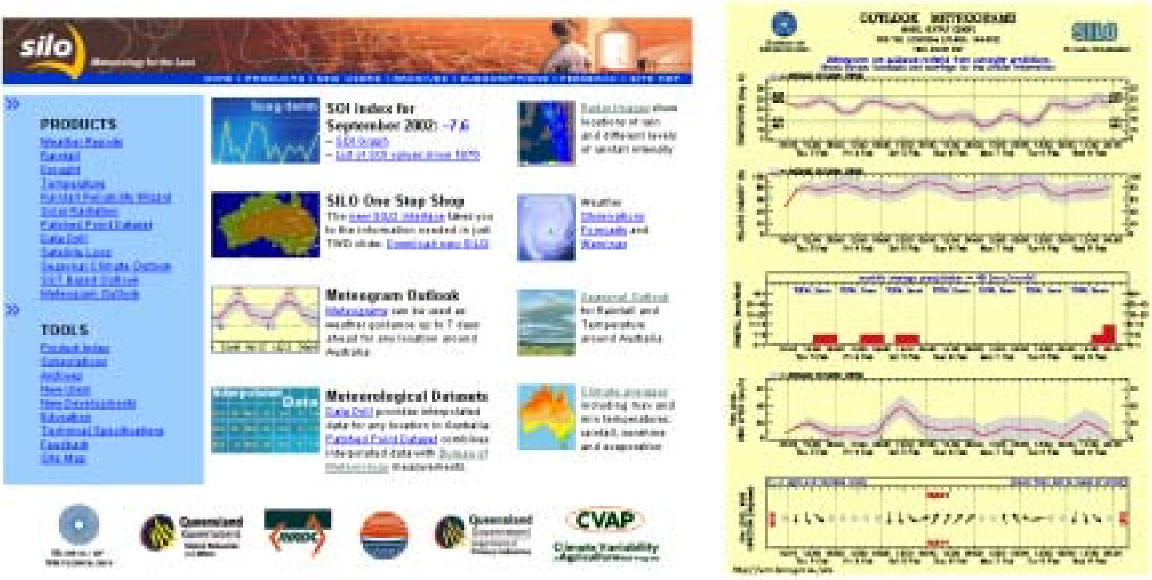

Figure 6. The jointly developed SILO website (left panel) provides access to real-time observational data as well as historical datasets and short-term and long-term prediction information. Meteograms (right panel), which are accessible through the SILO website, show seven day ahead weather information for any location in Australia. This guidance information is derived from the Bureau of Meteorology's weather forecasting computer models.

SILO also provides three-month rainfall and temperature prediction information for any (rainfall) district in Australia In addition, users can access extended satellite loop sequences, quality controlled historical climate data and interpolated and 'in-filled' climate data on SILO's sister site (which is maintained by the Queensland Department of Natural Resources and Mines).

The Bureau has continued to enhance the SILO website through the recent development of an interface to enable users to quickly locate all products applicable to their specific location. In addition, the development of systems to incorporate improved forecast model guidance into meteograms is expected to significantly enhance the accuracy of this product.

The PremiumWeather™ website (Fig 7), which is targeted at selected agricultural activities and contains information to assist in decision making, was launched in 2001. The website was developed by the Bureau's Special Services Unit under contract to Telstra Countrywide. It includes both free and fee-based weather information components. PremiumWeather™ provides:

- detailed regional weather commentary by experienced forecasters, highlighting key information such as the timing of rain events and their intensity;
- detailed 36 hour forecasts and 7 day forecasts for various locations within the district
- forecasts of temperature, rainfall, probability of precipitation, humidity, winds and frost risk;
- indications of forecast confidence in situations where weather patterns are highly variable;
- a combination of the latest computer forecasting technology with the experience of qualified meteorologists; and
- regularly updated observations for the district and State.

Figure 7. The PremiumWeather™ website includes both free and fee-based weather information for selected agricultural activities.

The Farmweather facsimile service, another Bureau initiative, provides tailored information to farmers and agribusiness. The service is aimed at improving the planning and efficiency of farm operations, and new weather related services were recently developed for the Sunraysia and Riverland districts.

Climate information

Historical and climatological data from the Bureau of Meteorology have been used in agriculture related research and crop suitability studies. A service to provide customised automated delivery of climate data is available from the Bureau's National Climate Centre. This type of information is useful in crop modelling to improve the efficiency of farming operations and produce yield.

A range of climate products, including maps and related gridded climate information is also available (Fig 8). These include monthly and annual climatological maps and grids of rainfall, temperature, evaporation, frost frequency, evapotranspiration and sunshine hours. This information is available in a number of electronic formats including GIS (geographic information system) formats.

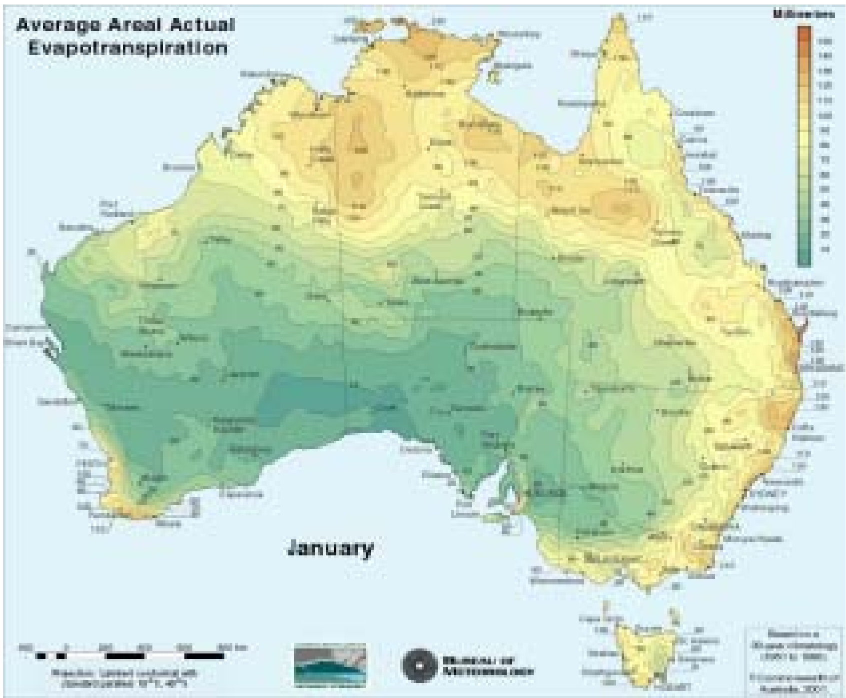

Figure 8. Average annual evapotranspiration – the map is derived from electronic (gridded) data and is part of the Bureau's suite of climatological datasets.

Surveys and feedback

As part of the processes aimed at continually improving services to all sectors of the community, research surveys specifically targeting Farmers are routinely undertaken on behalf of the Bureau. These surveys provide valuable information on how weather information is accessed and used in farming related weather-dependent decisions.

Summary information from the winter 2002 farming industries survey is shown in Figure 9. The Australia-wide survey included contributions from more than 600 farmers involved in cattle and beef, cotton, dairy, fruit growing, grain, sheep/wool, cane, vegetable growing and viticulture. Rainfall information, local observational data and forecast information are among the most relevant and accessed meteorological information. However, it is clear that farmers use and access a range of data and product types as part of the planning and decision making process.

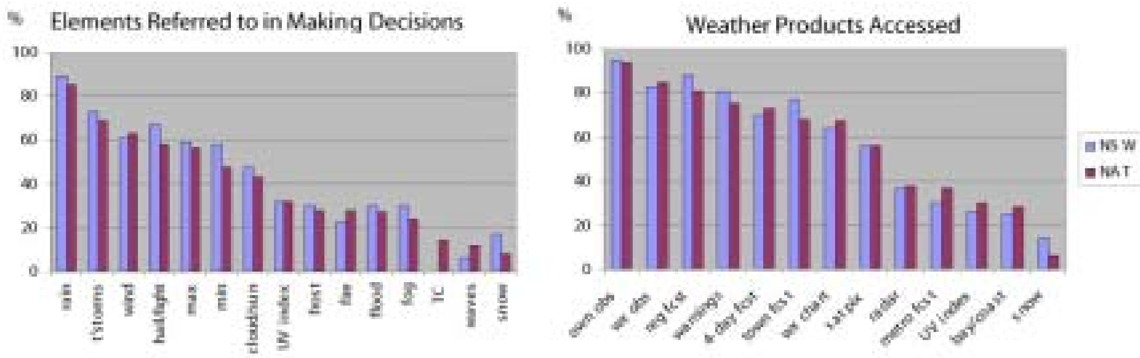

Figure 9. Meteorological elements referred to in agricultural decision making (left panel) and the type of weather products accessed (right panel) - based on the winter 2002 survey of 633 farmers.

As part of the survey, Farmers also provided useful information on ways of improving agricultural products and services. These included:

- More frequent update of satellite information.
- Increased detail in four-day forecasts.
- Increased detail of long range forecasts.
- More frequent update of radar information.
- More detailed rainfall forecasts.
- Improved internet access to remote rural areas.

The information from these surveys as well as other public feedback systems, such as the internet, is used to understand the weather information needs of Farmers and for future planning of products and services, including the most effective methods for delivering relevant weather and climate information to the community.

Interaction with the agricultural community

Communication with farmers and agribusiness people is an essential part of promoting and enhancing the Bureau of Meteorology's services to the agricultural community. The Bureau has been an active and ongoing participant in a number of Land and Water Resources R&D Corporation/Rural Industries R&D Corporation projects.

Support is also provided to the National Conferences on Agriculture and Rural Development Corporations, with Bureau staff actively involved in steering reviews, conferences and committees, such as the National Committee on Agrometeorology.

The Bureau continues to liaise with special interest groups, including the National Farmers' Federation and Agricultural Advisory groups. Staff throughout Australia regularly participate in agrometeorological conferences, agricultural field days and, in cooperation with organisation such as QCCA (Queensland Centre for Climate Applications), provide relevant training for the agricultural community.

The information gathered from discussion, consultations and agricultural related surveys will be used as a basis for gauging user requirements, setting priorities for product and service development and further strengthening relevant consultative mechanisms. The Bureau is committed to enhancing services to rural and regional Australia, and will continue to work towards improving the range and quality of weather and climate related services that are provided to the Australian agricultural industry.

Contact Information

For more information on any of the products and services you can contact the Bureau's National Climate Centre.

Phone 03 9669 4082

Fax 03 9669 4515

Email webclim@bom.gov.au

Bureau of Meteorology, PO Box 1289K, Melbourne, 3001

StockPlan - A drought decision tool for graziers

Lloyd Davies Economist,
NSW Agriculture, Tocal Agricultural Centre

Introduction

StockPlan is a suite of three computer decision support tools that enable cattle and sheep producers to explore management options in the early stages of drought and during drought. It is a useful tool to evaluate the following questions: "How much will it cost to feed livestock for a specified time?" "Is breeding replacements or buying replacements the best drought recovery strategy?" "Is it better to sell or agist cattle?" "Is agistment an option for certain classes of animals?"

The philosophy behind StockPlan is to foster drought preparedness. Sound management decisions especially early in the drought period and during drought can prevent severe financial losses!

Training workshops for StockPlan have already been held for NSW Agriculture advisory staff and for other agencies in NSW such as the Rural Lands Protection Boards and rural counsellors. FarmBiz accreditation is being applied for to make a training workshop available for farmers, graziers and their advisers in NSW. There is also considerable interest from some of the research and development agencies and the Commonwealth Government to make the software available on a national basis.

Development of the StockPlan Concept

Development of Stockplan has used a bottom-up approach that led to the formation of a team consisting of mainly of staff who were advising farmers. In addition individual team members had skills in computer programming, economics, weather, and herd modelling. Resources for the development of StockPlan were provided by NSW Agriculture. The initial work focussed on revamping an earlier DOS based program called Droughtpack. It was quickly realised that the original Droughtpack could be enhanced considerably and a wider range of drought related questions could be answered with the addition of two other decision aids. There was considerable producer input in development of the packages. Three producer workshops have been held to present the package to selected producers. Invaluable suggestions to improve the packages have been received as a result of these workshops.

StockPlan will assist producers and their advisers to improve their drought management skills, lower the risk of degrading pastures and of severe financial losses. The software encourages proactive decision making and provides a platform for producers to investigate the production and financial implications for a range of strategies available to the farm business.

Management options are explored through three StockPlan tools: Drought Pack, ImPack and FSA Pack. These programs are backed by a range of help facilities. For example if the user is connected to the Internet, there is a direct link to the NSW Agriculture drought website and various weather sites.

The following sections describe Drought Pack, ImPack and FSA Pack:

Drought Pack

Drought Pack is a stand alone computer-based decision aid that provides a 'user-friendly' snapshot of the financial consequences of management and feeding strategies for sheep and cattle enterprises through a projected period of limited pasture availability. The program requires monthly data entry and allows for a planning period of up to 12 months. A feature is the calculation of nutritional requirements of livestock based on their energy needs to predict the amount and cost of conserved fodder that would be needed to meet target weight gain (or loss). These calculations are based on information provided by the producer and include predicted monthly pasture supply, monthly stock numbers, weight of stock, pregnancy or lactation status, feeds available and their cost.

The cash flow impacts of various management options such as the sale or purchase of stock, the agistment of stock, alternative feeding options or the delay in joining can be rapidly assessed using this program

The program can be used for selected classes or all classes of sheep or cattle (e.g. weaners, dry, lactating or pregnant stock) to provide a cash flow estimate for the selected group of sheep or cattle. Alternatively, with the entry of monthly income and variable cost information for other farm enterprises not being considered in DroughtPack (eg. a cropping enterprise) plus farm overhead cost information, Drought Pack can be used to provide an estimate of the whole farm cash flow for the planning period.

The main uses of Drought Pack are:

To help users determine the quantities and costs of feeding for livestock where numbers, weight and weight gain, pregnancy status (if applicable) and pasture availability are specified. Figure 1 provides an example of the output table generated and figure 2 shows an example graph for feeding the cattle portion of the livestock over a three month period.

To generate cash flow estimates over the specified period. Figure 3 provides an example of the tabular output generated.

To estimate the break-even price that a farmer could afford to pay to replace animals in a particular stock class at the end of a drought.

Figure 1 Example output from DroughtPack showing quantity of feeds required and the estimated cost for a six month drought

Feed Summary for Lloyd

	Nov	Dec	Jan
Sheep Numbers	2000	2000	2000
Sheep Feed (t-dm)	25.5	25.8	26.1
Sheep Feed cost $	3899	3942	3986
Cattle Numbers	605	605	605
Cattle Feed (t-dm)	72.2	71.8	73.1
Cattle Feed cost $	11021	10704	10907
Total feed (t-dm)	97.7	97.6	99.2
Total feed cost $	14919	14646	14893
wheat (t-fresh)	106.9	94.3	96.0
barley (t-fresh)	1.7	14.2	14.2

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Figure 2: Example graph of feed costs in DroughtPack

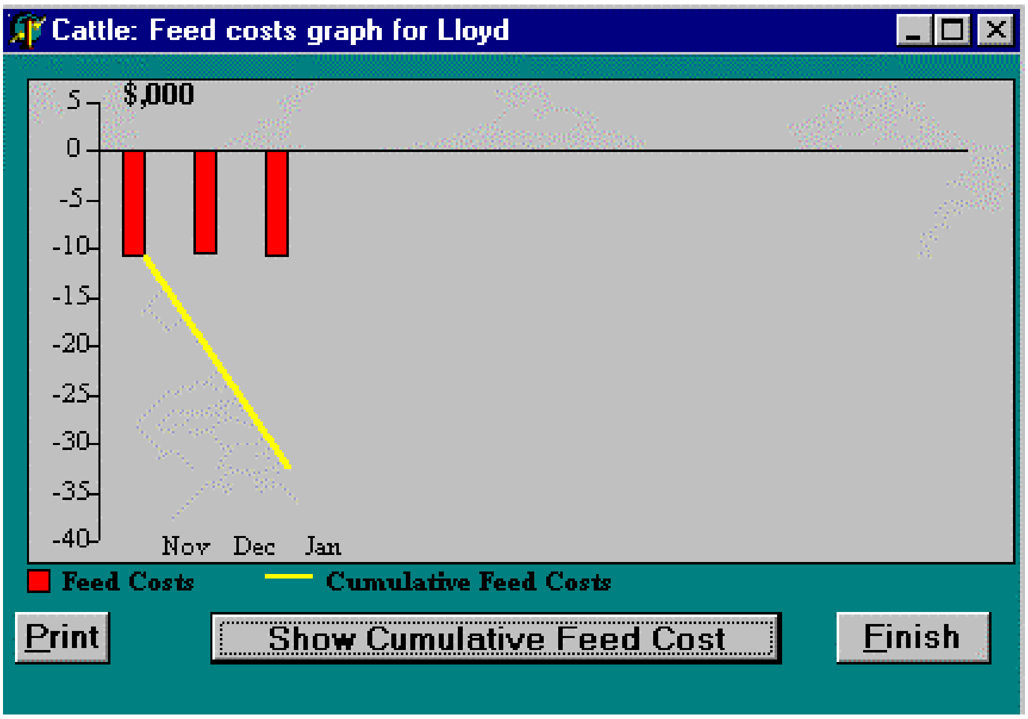
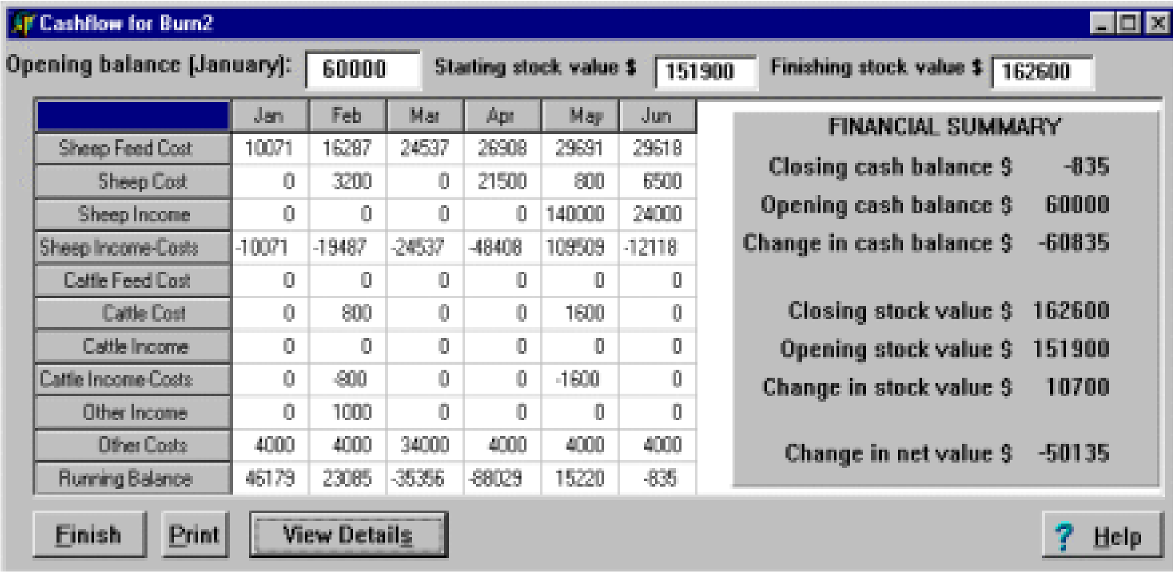


Figure 3 Example cash flow and financial summary in DroughtPack


Cashflow for Burn2

Opening balance (January): 60000 Starting stock value $ 151900 Finishing stock value $ 162600

	Jan	Feb	Mar	Apr	May	Jun
Sheep Feed Cost	10071	16287	24537	26908	29691	29618
Sheep Cost	0	3200	0	21500	800	6500
Sheep Income	0	0	0	0	140000	24000
Sheep Income-Costs	-10071	-19487	-24537	-48408	109509	-12118
Cattle Feed Cost	0	0	0	0	0	0
Cattle Cost	0	800	0	0	1600	0
Cattle Income	0	0	0	0	0	0
Cattle Income-Costs	0	-800	0	0	-1600	0
Other Income	0	1000	0	0	0	0
Other Costs	4000	4000	34000	4000	4000	4000
Running Balance	46179	23085	-35356	-88029	15220	-835

FINANCIAL SUMMARY

Closing cash balance $	-835
Opening cash balance $	60000
Change in cash balance $	-60835
Closing stock value $	162600
Opening stock value $	151900
Change in stock value $	10700
Change in net value $	-50135

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Drought Pack is designed to be easy to use. The amount of information required is deliberately limited and, as a consequence, there are some limits to its use. Some of the limitations of Drought Pack are:

Drought Pack cannot assess the risk of each strategy. It relies on the user to examine the financial consequences of a particular set of events and take risk into account. A number of runs using different assumptions may be required to assess the risk.

Estimates of future costs, prices and available pasture must be accurate to ensure the resultant cash flow projection is accurate. However, accuracy is a common problem and experience confirms it is better in drought to base tactical decisions on soundly based projections, rather than none at all. It is also important that projections are continually reassessed as conditions change.

Drought Pack takes no account of environmental or sustainability issues. There could be a long-term decline in productivity of the land if grazing pressure has been excessive. The model assumes that after a dry spell the land is equally productive regardless of the strategy used.

The possibility of pasture re-establishment costs from certain strategies could be easily overlooked. Grazing management strategies to ensure the productivity of pastures after drought should not be overlooked.

Soil loss could be another significant cost with some strategies. One millimetre of soil loss over one hectare is about 10 tonnes of soil. The highest concentration of nutrients is in topsoil and the cost of replacement will be substantial.

While Drought Pack does predict the amount of supplementary feed necessary to achieve a particular growth in livestock, these predictions are based totally on energy requirements and the user's estimate of the contribution being made by pasture. More accurate predictions of livestock nutritional requirements and predictions of livestock performance on pasture, and pasture plus supplements, are available through other programs such as GrazFeed®.

It is recommended that GST exclusive costs and income be used to simplify calculations. The cash flow as a result of the simplification will be slightly inaccurate.

Break-even calculations rely on estimates of husbandry costs and income, which are assumed to occur at the midpoint of the planning period specified. This simplification reduces data entry but the break-even estimate may be slightly inaccurate.

ImPack

This herd or flock Model is an Excel spreadsheet that can plan and track up to 10 years in advance. It estimates the progeny produced and the stock available for sale and the resultant income as a result of a stock retention and purchase decisions. See figure 4 for example output. Testing herd or flock de-stocking and build-up strategies and their likely consequences over a 10-year period allows producers to understand the impact of their decisions and the risk they are operating at.

This model has other applications beyond drought, for example, in identifying long term implications of stocking strategies following, for example, the purchase of additional land, pasture improvement or a disease control program.

Figure 4. Example calculated output from Impack

Number joined	150	176	186	195	200	200	200	200	200	200	200	200
Numbers for sale/Year	Drought	1	2	3	4	5	6	7	8	9	10	Original
Steers	166		51	72	76	80	82	82	82	82	82	82
Heifers	49	17	39	44	47	49	49	49	49	49	49	49
CFA cows	28			2	2	6	7	8	8	8	9	9
Cull cows	8	5	5	6	9	8	7	7	7	6	6	6
Dry cows	18		13	14	14	15	15	15	15	15	15	15
From age groups sold	21											161
Income from	$	$	$	$	$	$	$	$	$	$	$	Original
Steers	107900		35700	50400	53200	56000	57400	57400	57400	57400	57400	57,400
Heifers	26950	9350	21450	24200	25850	26950	26950	26950	26950	26950	26950	26,950
CFA cows	12600			900	900	2700	3150	3600	3600	3600	4050	4,050
Cull cows	3200	2000	2000	2400	3600	3200	2800	2800	2800	2400	2400	2,400
Dry cows	9000		6500	7000	7000	7500	7500	7500	7500	7500	7500	7,500
Other Income												
Age group sale, trade steers	9450											
Total income	169100	11350	65650	84900	90550	96350	97800	98250	98250	97850	98300	98300
Purchase costs												
Variable costs	6750	7920	8370	8775	9000	9000	9000	9000	9000	9000	9000	9000
Annual gross margin	162350	3430	57280	76125	81550	87350	88800	89250	89250	88850	89300	89,300
Total difference of this option compared to 11 times the "Herd Inputs" returns = -68,765												
Approx. breeding herd DSE	3260	3676	4088	4305	4440	4461	4461	4461	4461	4461	4461	4461
No Trade Steers required =	(150)											

FSA Pack (Feed, sell agist).

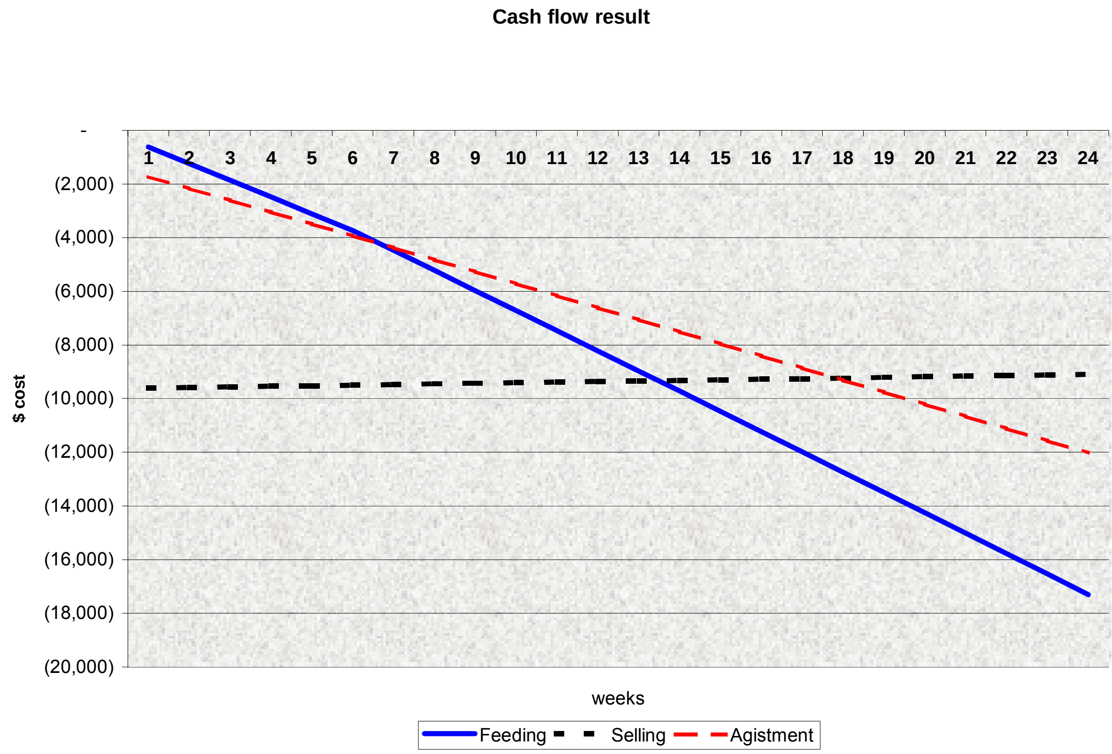
This is an Excel based spreadsheet that examines the likely financial consequences of feeding, selling and agisting a <u>specific</u> class of stock. Generally, it is used when Drought Pack indicates that the option of retaining all stock would incur a very high feed cost and the user wants to focus on destocking options.

It allows the user to look at the cash consequences of up to four possible drought lengths at any one time. It also considers a 'bottom line' result where items that do not have an immediate cash impact are accounted for. These include pasture re-establishment, any 'saved feed' distributed to other remaining stock and anticipated changes in the per head value of stock over time.

An option is available for the user to specify the probability of the four drought lengths they have selected to generate an expected cash and bottom line results for each strategy.

An example of a graphical output of the cash costs for a feed, sell agist situation is shown in Figure 5. A graphical presentation is very useful in showing the number of weeks before one option, for example selling becomes cheaper than another option, say feeding. In figure 5, feeding is the cheapest option for a period of up to six weeks. Agistment is then the cheapest option for seven to 17 weeks and selling is the cheapest option if the period of feed shortage is greater than 17 weeks.

Figure 5 Example graphical output of cash cost projections for FSA Pack



Conclusion

Some general conclusions that users of Stockplan have made after using the package provides a useful conclusion of how the software is being used. The specific StockPlan tool package that will provide these conclusions is included in brackets.

The cost of feeding for an extended time can be very expensive and generally those that make the early decisions to divest stock early expose themselves to less risk. (DroughtPack)

A profitable strategy can be to sell stock and also sell the fodder on hand. (DroughtPack)

Those that sell early generally have pastures that recover quicker putting them in a position to buy back earlier, possibly at lower prices. (DroughtPack, FSA)

Agistment of cattle (if available) can be an attractive option in situations where high growth rates are achieved. (FSA)

Comparing a buy in strategy to a breed up strategy when a herd build up is required after drought or an expansion phase. Results usually favour a buy-in strategy to achieve full stocking rates as quickly as possible. (Impack)

The value of wool on a sheep is sometimes not fully valued in drought time. In depressed market conditions, sheep nearing full wool conditions can be often worth retaining until after shearing, even if weekly feed costs are high. (DroughtPack or FSA)

StockPlan is designed to be a user friendly package that can be used by farmers and their advisers with a minimum of training. The fact that data entry requirements are kept to a minimum means that accuracy is sacrificed for ease of use and these limitations must be appreciated by the user. But the fact is we are dealing with unknowns and a good "ball park" figure is better than total ignorance.

Who Can Help the Australian Sugar Industry?

George Antony, Andrew Higgins and Mark Smith [21]

1 Introduction

The sugar industry remains one of Australia's largest agro-industrial sectors and major exporters, despite a decline in relative importance and profitability. Total Australian sugar production fell from 5.4m t to 4.6m t between 1999/2000 and 2000/01, of which 4.1m and 3.5m, respectively, were exported. In both years, substantially down from previous years, export values were some A$1.2 billion (Knopke and Nelson 2002). This compares with total Australian agricultural exports of A$16.9 billion and 20.8 billion in 1999/2000 and 2000/01, respectively (Australian Bureau of Statistics online data).

The industry is a key economic driver in many coastal regions of Queensland and northern NSW. Robinson et al. (1999) estimated the industry's direct value in the regional economy of north Queensland at around A$200m, with a flow-on to other sectors of the economy of some A$150m. Direct employment in cane growing and milling amounted to some 12,500, or one per cent of Queensland's workforce, with another 1.4% in connected industries. However, in individual regions the industry's local significance is much larger: in the Herbert region 85% of agricultural employment is in the sugar industry.

Since the end of the 1990s, declining world-market sugar prices have combined with a run of bad seasons to trigger the latest crisis of the Australian sugar industry. The industry is also facing strident demands for change from the politically savvy environmental lobby. However, the emergence of Brazil as its most formidable competitor yet poses the challenge of lowered long-term international prices. This crisis threatens the very survival of the industry in many regions, with potentially dire social consequences. In the past, government help was regularly forthcoming in crises, but now the little money that may be given is conditional on long-term sustainability. Who can help the industry, then?

We argue that recovery will require the industry to undertake major reforms and restructuring. The industry is built around institutions with deep historical roots and a long-standing culture of pervasive industry regulation. While this has served the industry and its stakeholders well in the past, in the contemporary world these structures create constraints which deny the industry the flexibility needed to gain full benefit from current or future innovation.

There are promising options available for increasing supply-chain efficiencies and whole-of-industry profitability which could be missed without industry reform. In the longer-term there is potential for creation of more flexible, diversified production systems, with sugar at their core, that could deliver win-win outcomes for profitability and the environment. Unless reform and restructuring are faced now, the prospect of a new era of industry success in the future may be wasted.

2 History and institutions

The era of external constraints

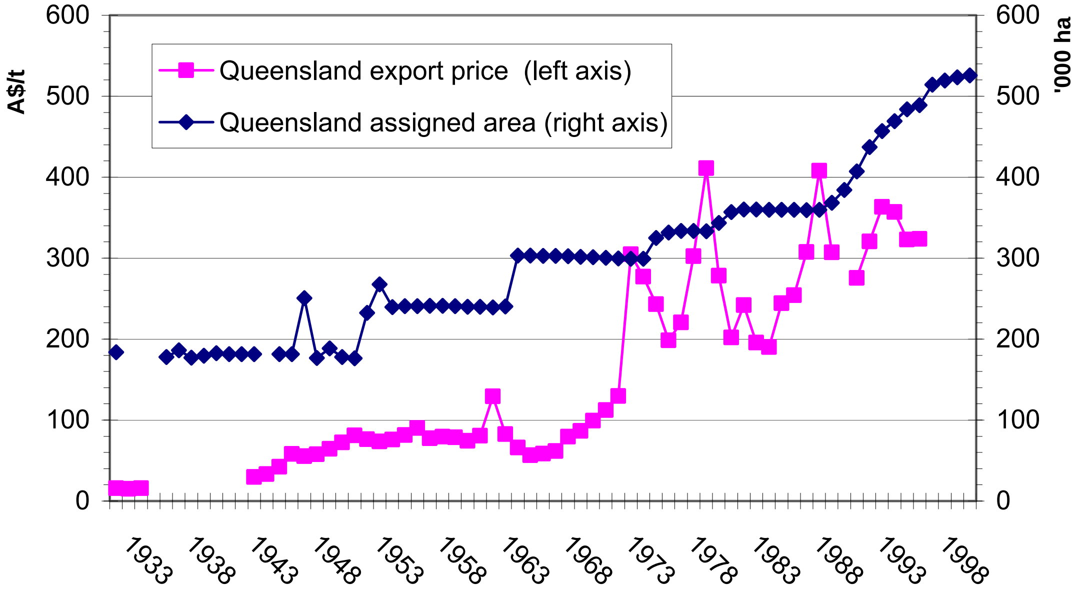
Since its beginnings in the mid-1800s, the Australian sugar industry has been a showcase of regulated development and management. Its growth was strongly promoted and subsidized by the government especially in north Queensland. In line with the times before and during WW1, government regulation of the industry was extended to cane supply (the origins of the assignment system), cane prices, marketing and pricing of raw sugar, workers' wages and conditions. It was only in 1923 that Australia became a sugar exporter, following the increase of the domestic price and an embargo on imports. Full development of the assignment system, including the regime of peak entitlements and two payment pools, was carried out between 1925 and 1930, to prevent overproduction.

Not much changed until the 1980s, apart from periodic increases in assigned area - almost always as a belated response to favourable prices (see Figure 1). The assignment system has prevented the industry from quickly capitalizing on favourable prices, as by the time increased assignments were granted the sugar price had declined again. Revenues thus missed were substantial, and these monies could have helped the industry in the long term. On the other hand, the imperative to maximize one's peak entitlement meant that

[21,2] CSIRO Sustainable Ecosystems, Tropical Landscapes Program, Brisbane and Townsville respectively.
E-mail: george.antony@csiro.au, andrew.higgins@csiro.au. and mark.smith@csiro.au

production was not reduced when low prices would have made this rational, forcing production with low or negative profitability.[22]

Figure 1: Cane assignments and export prices



The sugar industry successfully resisted the general deregulation of agricultural production and marketing until 1988. Even then, the reforms introduced (allowing imports but subject to duty, liberalization of sugar refining, streamlining of regulatory bodies) did not affect the fundamentals of the assignment system. Not surprisingly, opinions on the merits of the system differed radically. Graves (1988, p. 154-155) credits government regulation for the nurturing and growth of the Australian sugar industry, as well as ensuring its stability through difficult times, calling it "a major achievement". Industry insiders, demonstrated by their submissions to the numerous inquiries, clearly appreciated the convenience of predictable prices and production environment (Milford 1984). Others focused on the opportunities missed due to the regulatory restrictions.

ABARE (1990) has pointed to potential improvements in profitability if regulations were removed. In their assessment, land area under sugar would have been 30% larger without assignment, industry-wide gains of A$130m (1984/85 prices) could have been made via savings in transport and processing, and a A$54m (1986/87) increase in profitability could have been achieved from the rationalization of harvesting equipment. Together, potential gains amounted to 9% of production costs. Borrell et al. (1991) arrived at very similar amounts when calculating losses due to regulatory constraints on the industry.

Luckily for the Australian industry, its regulations were paralleled by its largest competitor, Brazil, with similar effects (Borrell et al. 1994). However, liberalization in Brazil, combined with technical change forced by environmental regulation, triggered an explosion in production and huge unit-cost reductions (Pinho and Neves 2000), fully utilizing the opportunities offered by size economies and full vertical integration (Guedes 2000). Figure 2 indicates the results.[23]

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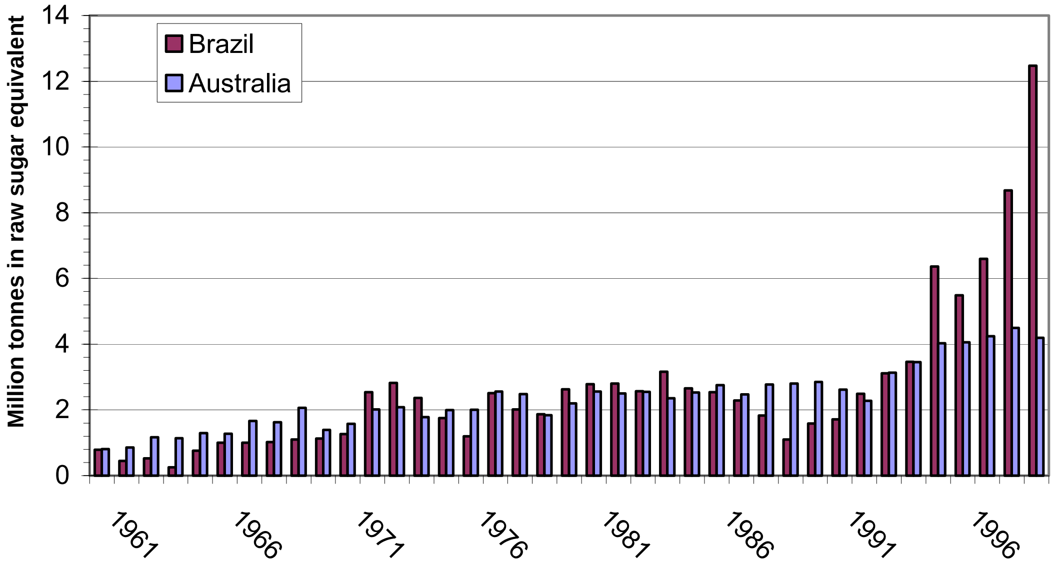
[22] The opposite of this modus operandi is that of the Australian cotton industry: by extensively forward selling the crop, cotton growers can match their acreage and costs to the price for **next** year's crop.

[23] The scenario depicted by Hannah (1999) is apocalyptic: given the expansion potential (Sicsú and Lima 2000) and low cost structure of the Brazilian industry, it might conceivably take over all but the sheltered sugar markets in the world (Japan, EU and USA). Worse still, by rejecting opportunities to expand much more than it has, the Australian industry gave away both revenues and advantages of economies of size to competitors – who then turned them against it. Arguably, the spectacular increase in Brazil's production may not have happened to the extent witnessed if the Australian industry had kept the market well supplied and prices lower.

Figure 2: Australian and Brazilian sugar exports



Data source: FAO statistical database

Improved efficiency in the Australian sugar industry were achieved after the partial liberalization of the 1980s, illustrating the point of financial losses caused by outdated insitutions in Australia (Borrell et al. 1991, p. 30). Cane area increased by 5-15% while farm numbers have declined, industry output grew by 10%, harvester throughput went up by 25%, and four mills shut down. Overall, farm productivity and mill productivity have each increased by 2.5-5% between 1985/86 and 1989/90. These, and more recent gains, however, have been insufficient to meet the Brazilian challenge. Hence, during the 1990s government controls on production and marketing have been all but removed to allow market forces greater influence in shaping the industry.

Nevertheless, an external institutional constraint that is not going to go away is ever stricter environmental regulations. Rivers draining cane land deliver sediment and dissolved material to the doorstep of the Great Barrier Reef – a World Heritage Area. In the face of criticism for their (real or perceived) environmental impact, cane farmers have been on the defensive, and they do not like it. We will address environmental aspects in more detail later in this paper.

The era of internal constraints

Liberalization of the external institutional framework did not improve the industry's competitive position to the expected extent. Self regulation replaced government control, proving an institutional constraint just as binding.

A fundamental characteristic of the industry is its egalitarian ethos: nobody in the industry is worth less than others, and nobody should be worse off than others. One practical manifestation of this sentiment is the extensive pooling of payments and risk to remove the disadvantage of some stakeholders in, e.g., transportation distances or resource endowments. However, such enforced equity imposes financial costs.

Pooling of payments occurs among bulk terminals and mill regions by Queensland Sugar Limited, and among farmers within each mill region. At the industry level, such practice removes the advantage that certain bulk terminals and mill regions might have over others in terms of efficiency and cost structures (Boston 1996, Ch. 5). Pooling at the mill-region level dulls incentives to increase harvest-group size and harvest hours, and to increase season length (Boston 1996, Ch. 6). In all cases, efficient producers' incentives to expand are reduced, and inefficient producers' production is kept artificially high through cross-subsidization from the efficient ones. Centralized marketing of sugar and cane removes individual canegrowers' and mills' opportunity to profit from their own production/marketing decisions while bearing the associated risks.

Voluntary retention of these arrangements, even after government compulsion was removed, implies that most stakeholders are happy with others making decisions for them. Equity harvesting, or harvesting of cane from all farms at the same rate through the season, is a case in point. Studies from Borrell and Wong (1986) to Higgins and Muchow (2002) proved that harvest scheduling for maximum sugar yield could provide million-dollar benefits at regional levels. However, this would involve harvesting some farms early and others late in the season, and current payment formulae do not allow for compensating the increased risk differential between early- and late-scheduled farmers. Even the introduction of better financial incentives may have limited effect. Brennan (1997) has identified a complex goal structure among farmers and harvester operators in the Mackay region. Much emphasis was placed on the ability to make one's own production decisions and preserving the lifestyle benefits of current arrangements. The extent to which profitability was a subordinate goal depended on individual circumstances: more so for small farmers cutting their own cane and less for commercial harvest operators.

The surviving assignment system is seen by canegrowers as a security guarantee against monopoly powers by mills. The size and poor profitability of small farms relegate their owners to an unequal power position in the supply chain. While, traditionally, this situation was redressed by regulation, of late alternative business models (e.g., partnerships or cooperatives) are being considered.

3 Improving industry performance

The Australian sugar industry has long considered technology and production systems as the primary targets for improving its performance. It has an impressive track record of technological development (Graves 1988, p. 149). The world's first mechanical cane harvester was built in the coastal town of Bundaberg in 1890 (Canegrowers 2000a, p. 119), and Australia has maintained leadership in cane harvesting to this day. Its bulk-handling systems are particularly effective and efficient. It has had a long and proud history of supporting research from farming to processing (Canegrowers 2000a).

Until the early 1990s, institutional research and development services to the Australian sugar industry were provided exclusively by two organizations, the Bureau of Sugar Experimentation Stations (BSES) and Sugar Research Institute (SRI). The BSES focused on farming issues such as new plant varieties (Berding et al., 1997), fertilizer application recommendations, pest management and harvesting technologies such as harvester speed and billet length (Powell et al., 2001). The SRI developed tools for daily transport scheduling (Pinkney and Everitt, 1997 and Grimley and Horton, 1997), and milling technologies (Allen et al., 1997), with an engineering focus. Such component based research addressed only specific issues within sectors of the sugar industry supply chain. This approach reaped dividends until the early 1990s, as the Australian sugar industry has benefited from many improvements as a result of such component-based research. Since the early 1990s, however, just as the sugar industry began to face several new major challenges, the effectiveness of component-based research has been in serious decline.

Since the early 1990s, researchers from universities and CSIRO were allowed to contest funding for sugar-industry research. Industry leaders began to recognize the need to address the sustainability of sugar production from an economic, social and environmental perspective. The Co-operative Research Centre (CRC) for Sustainable Sugar Production was established in 1995 with industry, research and government organizations contributing a total budget of about A$45m. The CRC focused on addressing bigger-picture issues for the Australian sugar industry. These included whole-of-industry profitability through season-length evaluation (MacDonald and Wood, 2001), natural-resource management at a regional level (Walker et al., 2001), and alternative cane-supply options (Higgins and Muchow, 2002).

The latter work relied heavily on state-of-the-art methods in information dissemination (e.g., portable and user-friendly computer applications and Web-based information systems) to facilitate the sugar industry's entry into the knowledge economy. Cane farmers proved themselves able users of information technology during the project. The promise of this research, along with the increasing threat from the integrated Brazilian sugar industry, motivated research managers to allocate a greater proportion of funding to whole-of-system solutions. Options for improving supply-chain efficiency have been known for some time, but they have not been implemented by the industry until now, despite institutional/regulatory reform and the availability of knowledge-based systems. Neither has there been enough consideration given to more distant challenges.

Strategically, the Australian sugar industry must employ a two-pronged approach in its fight for survival and profitability:

- In the short run, it must address supply-chain inefficiencies that offer quick payoffs without radical changes to the bio-physical production system.
- In the long run, it must renew the ecological and physical resilience of the production system to guarantee sustainability in the bio-physical, financial and social sense..

Both in the short- and long runs, however, changes will only be implemented if the industry's expectations and preferences match the realities of the situation.

3.1 Immediate solutions

3.1.1 The Crisis

While the Australian sugar industry must develop solutions leading to long-term triple bottom line sustainability, it faces an immediate crisis of survival that must be addressed. Along with strong competition by Brazil (from the mid-1990s) the Australian sugar industry has had the following issues in the past five years:

- 1998: very wet season; low sugar content in cane; harvest season far too long
- 1999: small crop (resulting from 1998)
- 2000: wide spread disease; very small crop and sugar content in cane; low sugar prices
- 2001: very small crop
- 2002: small crop and low sugar prices

Growers, harvester contractors and milling companies are aware of the risks of sugar production through experiences up to the mid 1990s, and keep cash reserves for such risks. However, the events of 1998 to 2002 were exceptional with the industry exhausting its reserves after the 2000 harvest season. Since 2000, many growers and harvester contractors have departed from the industry and the rest have undergone major economic hardship.

Mills are having difficulties maintaining transport and milling infrastructure and many mills (particularly in north Queensland) may not re-open in 2003. The mills that stay open for 2003 are desperately seeking to reduce their operating costs to stay in business. Many Australian sugar mill managers have been given an ultimatum that they must substantially reduce their operating costs to survive in the short term. It is as simple and as final as that.

3.1.2 Whole-of-system research

Reducing operating costs and competing with Brazil is not an easy task. Gains from sectorial or component based research have slowed down and are not likely to provide the solution. The Australian sugar industry must take advantage of the benefits from whole-of-system research, to improve integration and efficiencies across the supply chain (particularly harvesting and transport), to substantially reduce costs.

This view was endorsed by the recent independent assessment of the Australian sugar industry (Hildebrand, 2002), which recommended rationalization of the harvesting and transport system with research to address this being a priority.

Another key recommendation was for larger entities in farming and harvesting, with support from the Commonwealth government to achieve this. Larger farms and fewer harvesters would help to achieve increased efficiencies of size across the supply chain.

3.1.3 Addressing the difficulty of adoption

While many researchers and mills are aware that a whole-of-system approach to integrating the harvesting and transport system would substantially reduce costs, adoption is a major constraint. The key issues preventing adoption are:

It must be win-win for the milling, harvesting and growing sectors. Even if region-wide benefits are positive, any sectors of stakeholders no individually benefiting will not adopt the offered option – thus denying benefits to everybody else. This raises the issue of incentives and the sharing of gains throughout the supply chain.

The industry lacks the resources to adopt many of the options immediately. Modifying transport infrastructure (e.g., new rail siding, faster locomotives) to reduce operating costs is particularly expensive. It is difficult to increase farm size since other growers do not have enough money to buy out the smaller farms. A Federal Government assistance package of $150m has been made available in September 2002 to assist this change.

Growers and harvester contractors often take a militant approach to resisting change if not getting what they want. If mills or governments push for change that does not benefit every grower and harvester, the proposal will face strong objections and obstruction – typically resulting in a back-down.

Unaccustomed to change, growers and harvesters tend to be ill equipped for it. Focus groups (involving growers, harvesters, millers and independent outsiders) need to be established at each mill region to facilitate change.

The industry is beginning to look to itself for productivity improvements that overcome the issues of adoption. Sugar millers CSR and Bundaberg Sugar have initiated separate productivity reviews in partnership with other industry stakeholders in their mill regions. In addition to conventional component-based solutions, whole-of-system solutions and institutional changes are also being considered. Among the latter, options are assessed for the tighter institutional integration of mill regions, from loose partnerships to cooperative structures. A large new research project funded by SRDC (now linked with the industry initiatives) is looking at ways of improved performance of the harvesting and transport sectors via systems integration. Unlike previous projects, physical systems assessment is complemented by socio-economic analysis to ensure the development of appropriate technical solutions coupled with incentive systems that facilitate their adoption.

While the industry is completely focused on providing solutions to its short-term crisis, sustainability over the long term is triple-bottom-line issue and requires dealing with a much more complex and diverse system.

3.2 Long-term solutions

3.2.1 The track record

Even though there have been numerous studies looking at such things as crop rotations or ethanol production, the potential for improved systems sustainability through bio-physical systems development and horizontal integration remain largely unused. This is despite a track record of very successful innovations in production-system development - some widely used, others less so.

Green cane trash blanketing

Green cane trash blanketing (GCTB) re-emerged in the Australian industry in the mid-1970s as a means of reducing the risk of damage to burnt crops by rain during harvest (Wood, 1991). It was made possible by advances in harvester design and has proved to be a profitable innovation for growers. The trash blanket also has numerous additional benefits for sustainability (Table 1), for example creating a win-win solution to environmental problems such as soil erosion, as well as reducing nuisance to the wider community from smoke and ash. The trash blanket creates a ‘litter layer’ like those commonly found in natural ecosystems, which increases the beneficial activity of soil flora and fauna, and helps to control soil-dwelling pests of sugarcane (Robertson et al., 1994; Robertson and Walker, 1996). These additional benefits, together with its original purpose, have seen GCTB become the most widely adopted ‘new’ agronomic practice in the sugar industry, with 70% of the crop now harvested green.

Fallow legumes

Fallow legumes were a traditional part of sugarcane production systems in Australia until their use fell away after the 1960s, as cane growing was by far the most profitable option in coastal Queensland (Boston 1996, p. 159). Continuous cropping of sugarcane then became widespread, but fears evolved that changes in soil biology under monoculture resulted in a build-up of soil-borne crop pathogens and a consequent decline in productivity. Research in the 1990s (Garside and Bell, 2001) showed that cane yields of plant crops were 15-25 % higher after legume fallows, because of improved soil health and fertility. As with GCTB, there are numerous additional benefits, including reduced input costs and improved biodiversity (Table 1). A potential further benefit may be income from harvesting legumes such as soybeans and peanut for grain (Garside and Bell, 2001).

Trickle irrigation

One option for increasing water use efficiency in irrigated sugar production systems is the use of trickle irrigation. Cane yields can be increased by 5-20 % and water use efficiency increased by up to 50 % (Thorburn et al., 1998). In addition to the water saving benefits, higher efficiency of fertiliser use enables maintenance of crop yields with 25-40 % less nitrogen, if applied through trickle irrigation systems. (Ridge and Hewson, 1995, Thorburn et al., 2002). Simultaneously, there is less threat of contamination of water courses or groundwater, and thus increased protection of sensitive natural ecosystems, with potentially reduced pressure on the industry by the environmental lobby. To date adoption has been low, though the area of trickle irrigated sugarcane increased from approximately 1,000 to 4,000 ha in the 1990s, perhaps at least partly because of set-up costs..

Trees for rat control

Considerable success has been achieved in the Wet Tropics with the use of trees for rat control (Canegrowers 2001). Trees planted on stream banks and headlands shade out weeds and grasses within two years of planting and deprive rats of habitat and a protein source for breeding. Trials have found that rat damage and rodent numbers consequently decline by between 80 and 100 % (Canegrowers 2000b). This results in better yields and cost savings to growers. Financial benefits could be enhanced further if re-vegetation was combined with farm forestry. Significant benefits to the wider ecosystem also occur, including improved biodiversity, habitat provision, riparian protection and water quality (Table 1). Such initiatives, with win-win benefits for production and conservation, also bring the sugar industry favourable publicity in the wider community.

Table 1 Triple-bottom-line benefits from four historical innovations in sugarcane cropping systems, major drawbacks and progress with adoption.

	Innovation			
	GCTB	Fallow legumes	Trickle irrigation	Trees for rat control
Main purpose	reduced risk of damage to crop from rainfall	arrest of yield decline	water use efficiency	reduction of rat damage
Other potential benefits: Profitability	↓ costs for weed and insect pest control ↓ labour enhanced profitability	↓ pests & diseases ↓ fertiliser costs cash crop potential	↑ cane yield ↓ fertiliser costs	↑ cane production ↓ weed control costs ↓ use of rat poison potential income from timber
Sustainability	↓ in soil erosion ↓ herbicide and insecticide use ↑ soil properties nutrient retention ↑ soil organic matter ↑ soil biodiversity	↑soil biodiversity nutrient retention ↓ fertiliser use	↓ runoff ↑ efficient use of water resources protection of: groundwater water courses marine environments	↑ biodiversity habitat creation, restoration and connectivity riparian protection ↓ poisoning of non-target species ↓ chemical runoff to water courses
Social responsibility	↓ Health & Safety risk from fire ↓ smoke and ash nuisance in towns	↑ community view of soil health	↓ conflict over conservation	↓ poison handling good publicity
Drawbacks	↑ extraneous matter difficulties with: furrow irrigation harvesting large crops applying fertiliser cultivation	down time in cane production	capital costs technical expertise required rat damage	shading of crop competition potential harbourage for other pests
Adoption	High	Expanding	Low	Early
References	Wood (1991); Christiansen (2000), Small and Windle (2001); Robertson and Walker (1996)	Garside and Bell (2001)	Thorburn et al. (1998)	Canegrowers (2000b)

3.2.2 The potential

Building on such traditions, there are potential gains to production systems that are better integrated into the physical environment and ecological processes. Much of the land under sugarcane along the east coast of Australia was originally tropical or sub-tropical forest before it was cleared for agricultural development. Today, many sugar districts are fringed by the forested slopes of the coastal range and cane farms are commonly adjacent to or contain patches of remnant forest. The two systems, one natural and one agricultural, provide a contrast in ecosystem function. It may be possible to enhance the sustainability of sugarcane farming by restoring to the landscape some of the ecosystem services provided by trees and forests. Smith et al. (2002) argued that there is scope for the industry to be pro-active in responsible environmental management, and profit from this both in terms of financial returns and favourable social perceptions.

Ecosystem services

Ecosystem services are ecological processes or states that underpin human well-being, and innovative systems design for cane farming incorporating ecosystem services from forests are possible in principle. These are also potentially profitable and could ease social conflict over conservation and production. Some features of these systems innovations can be found on Australian sugarcane farms today.

An important constraint on potential innovation in the sugar industry is the requirement for sufficient returns on investment in cane transport and milling infrastructure. Mill viability can be threatened if new land uses or products result in lower cane production, unless cane productivity is increased simultaneously, more valuable products from cane are developed or new uses for infrastructure are found.

Vegetation management on-farm

Ecosystem services of forests can be most easily provided to agriculture by having more trees on farms. This can be achieved with minimal impact on cane production by incorporating the management and restoration of remnant vegetation into the farming system. Vegetation management on land not used for cropping should be improved to maximise benefits to the farming system as a whole. Use of trees for rat control in the Wet Tropics is a prime example of this. Land which incurs only costs for weed control could be re-forested, or could provide income from farm forestry or orchard production, while simultaneously providing ecosystem services. Benefits from trees could include reduced runoff and deep drainage, nutrient retention, carbon sequestration and provision of some wildlife habitat, with increased biodiversity. Close to drainage lines, creeks or rivers, additional benefits of trees would be maintenance of water quality by trapping of soil, nutrients and pesticides, bank stabilisation, less impediment of surface drainage by weed infestation, habitat connectivity between larger forest remnants and improved habitat for fish. Current re-vegetation work at Sheepstation Creek in the Burdekin, by landholders, Canegrowers, Greening Australia and Queensland Parks and Wildlife, shares many of these aims (Brett Galloway, QPWS, and Dale Hollis, Canegrowers, pers. comm.).

Landscape mosaics

Less productive land on farms may be unprofitable to use for sugarcane production, because yields do not justify the costs of inputs, planting or harvesting. Adjacent land may be highly productive and highly profitable. Thus, the financial health of a farm enterprise may benefit from ceasing cropping of land with low productivity and instead concentrating investment where increases in productivity and financial returns from inputs are highest (Mallawaraachchi and Quiggin, 2001). In principle, supply of cane to the mills would be maintained if productivity were increased sufficiently on the best land because of higher inputs or investments in new technology.

Land removed from production because it is loss-making or only marginally profitable could be re-deployed to other uses with triple bottom line benefits. The result would be transformation of the landscape from sugarcane monoculture to a mosaic of land uses, with cane grown where productivity and profitability are high and other land uses elsewhere. Land use options could include alternative crops, fruit or nut orchards, timber plantations or forest restoration, for example, with choices determined by stakeholder goals, land suitability and trade-offs among conflicting goals and constraints. Some options may provide a net financial benefit, for example from fruit or timber sales, and functional mimicry may result in ecosystems services and biodiversity conservation which improve sustainability and community harmony. Some growers are currently utilising this strategy to diversify into rainforest timbers and tropical fruits on land that is marginal for cane, for example in the Herbert, Babinda and Mossman districts.

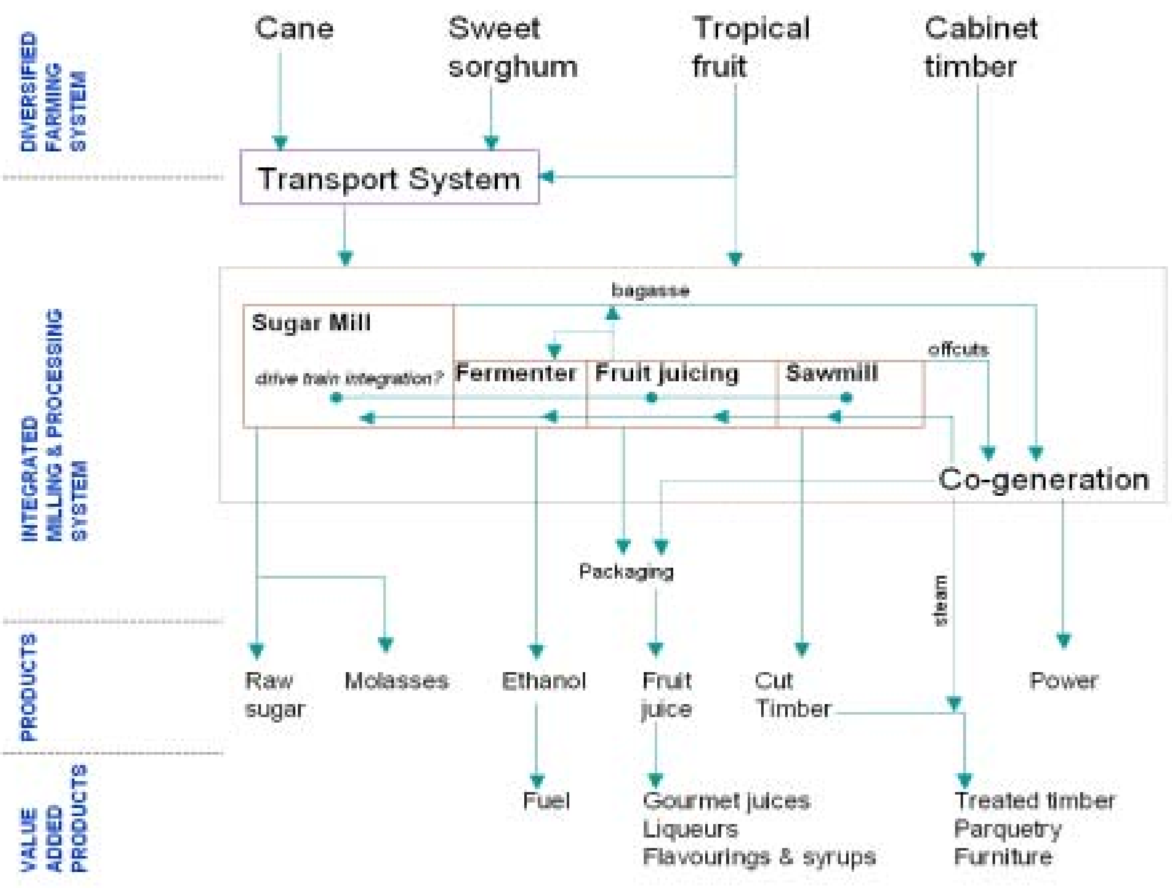
More innovative polycultures

A feature of tropical agriculture around the world is intercropping and mixtures of annual and perennial crops, trees and shrubs. Design of these systems is driven in part by the needs of low-income farmers, but also by the multiple benefits of functional relationships among species. Such polycultural systems are nearly absent from tropical agriculture in Australia. While there is a commercial imperative in Australian farming, polycultural systems may still hold lessons for tropical and sub-tropical agriculture in Australia. Could a profitable alternative to monoculture sugarcane be created, for example, by intercropping cane with companion crops, horticultural tree crops or high-value cabinet timbers? Perhaps trees could be planted around a paddock or farm, or widely spaced between broad beds of cane that are undersown with legumes. Such a system might be profitable and endow cane farming with the functional attributes of systems with long-term persistence. At present such notions seem fanciful in the Australian context, although there are examples in the industry of growers planting fruit trees around cane paddocks. The potential viability of such systems would depend, at least from a biophysical perspective, on whether the costs of competition between plant species were outweighed by the ecosystem services gained from mixing species (Lefroy, 2001). The impacts of inter-specific competition on sugarcane are currently unknown, but the development of methods for quantifying and managing competition between two species is continuing. This may create opportunities in the future to explore the efficacy of mixed species cropping systems for sugarcane.

Vertical and horizontal systems extensions

The conventional vertical structure of the Australian sugar industry consists of cane production, milling, and marketing of raw sugar and molasses. The only widespread addition to this system is a co-generation unit that converts surplus heat at the mill to electricity. The much greater potential diversity of input, processing and output options than this centuries-old model is illustrated in Figure 3.

Figure 3 Conceptual model of diversified farming and multi-purpose mill



While not all of these options will be feasible everywhere, various combinations of them will be. Current industry thinking appears fixated on ethanol production as the silver bullet, but realistically there can only be a handful of such plants. However, the Rocky Point Mill near Brisbane is proof that horizontally-integrated plants are not a pipedream.

At the mill level, government support was traditionally seen necessary for changing the status quo, from the very establishment of mills and transport infrastructure, through their rationalization, to the installation of co-generation for supplying the electricity grid, or the long-contemplated ethanol option that has only now reached the implementation stage – with government subsidy. While such options for horizontal expansion can improve profitability, they fall well short of the high expectations of some industry stakeholders (Keating et al. 2002). Potentially high payoffs are only available from such high-risk options on the drawing board elsewhere as lactic-acid production from raw sugar or even the direct production of plastics precursors in bio-engineered sugarcane plants.

3.3 The constraints

We argue that it is not the lack options that is holding the industry back. Neither is it necessarily low returns or a lack of capital – especially considering the huge overcapacity of expensive and underutilized harvesters – although the misallocation of capital may well be. There is also scope for increasing returns, but this would be accompanied by increased risks.

In the end, it is the institutional rigidities, built up over so many decades and still ingrained, that prevent the industry from realizing its potential. Some of these are due to the ethos of equality and a "fair go", others stem from wanting to preserve a way of life, yet others are mere inertia. Few of them, however, are affordable under the current market conditions. In their place, such new institutions are needed that reward creativity, innovativeness and risk taking, rather than compulsorily sharing innovators' benefits with those unwilling to try. These institutions include flexible payment systems and new levels of cooperation between industry sectors, to develop the industry supply chain into a genuine value chain that lives up to broader social expectations.

By now, most institutional constraints are either the industry's own making or within its power to change. Hence, only the Australian sugar industry can help the Australian sugar industry.

4 Conclusions

The cause of the Australian sugar industry's current crisis is not a temporary upheaval in the international markets. Rather, Brazilian competition has irrevocably lowered the benchmark production costs. This cannot be undone, nor can it be compensated by government subsidies, even if governments were willing to provide the cash.

Research results clearly indicate that the Australian industry is not without promising options in improving the physical, biological and economic aspects of its systems performance. Cane farmers have the information-technology capacity to make the most of the options of the knowledge economy. Change is not going to occur, however, without overcoming ingrained preferences for institutionalized regulation. The internally-imposed institutional framework will have to be opened up to incentives that reward innovation and risk taking. The alternative to radical reform is stark. While some mill regions are doing better than others, sticking to the status quo would make parts of the Australian sugar industry so unprofitable that they will have to shut down. In turn, reduced overall industry throughput will have further negative consequences for those still in business.

In the end, however, the choice is with the industry. While research results are already available and the government has indicated willingness to financially assist substantive reform, it rests with the industry to help itself. Regrettably, this will have to include abandoning some of the industry's philosophically attractive, but financially expensive, egalitarian traditions.

In its place, a culture of bold and imaginative innovation is required, built on a platform of targetted and strategic research and development, if future prospects for vertical and horizontal integration are to deliver on the potential they hold for improved sustainability and profitability.

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