Issues for Farm Management in the 21st Century:

A view from the West

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An Invited Paper to the 46th Annual Conference of the Australian Agricultural and Resource Economics Society, 13-15 February, 2002, Rydges Lakeside Hotel, Canberra.

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Abstract

Against a backdrop of descriptive snapshots of the years 1975, 2000 and 2025, this paper explores challenges for broadacre farm managers. Issues of particular relevance to Western Australian farm managers are emphasized. Key market, environmental, technical, structural and social challenges and their implications for farm managers are discussed.

Established and emerging trends, along with commentaries of a range of futurists, are used to develop forecasts for farm management. The paper concludes by examining the question of change in farm management: How might the farm manager in 2025 be different from one in 2000 and what are the implications for farm management training, farm management advisory services and farm management researchers?

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Introduction

In Ohio in 2000, when the Summit County Historical Society's 1950 time capsule was opened, it was found to contain letters written by a hundred people, many giving their views about life in the future. What was interesting was that most had an apocalyptic view of the future, not knowing whether nuclear bombs or a Third World War would permit the next few generations to survive (Lieberth 2000). In retrospect their views were overly pessimistic, yet at the time such scenarios of the future would have been judged as fairly plausible.

Like the residents in Ohio, I lack perfect foresight and what foresight I have will be tainted or coloured by the times in which I live, so to talk about what issues *may* be important generally for farm management in the 21st century is an uncomfortable task. History is littered with the false predictions or omissions of folk far more knowledgeable or well positioned than myself.

As I face time constraints I propose to limit my presentation to a story based on snapshots: the years 1975, 2000 and 2025. The story up to 2000 will draw on data and published analyses while the story beyond 2000 will draw on the writings of futurists, extrapolations, conversations with various folk and personal musings.

Snapshots

1975

The year began in tragedy and ended in political infamy. At the outset the nation was still reeling from Cyclone Tracy's devastation of Darwin a week earlier on Christmas Day, only to have tragedy strike again on January 5 with the collapse of the Tasman Bridge in Hobart. The year closed in political ferment with the Governor General's Remembrance Day dismissal of the Labor Government led by Gough Whitlam, followed by a December election that brought to power a Coalition Government led by Malcolm Fraser.

It was the start of colour television, wage indexation; ethnic radio; Medibank; the Australian Film Commission and Order of Australia awards. It was the year that traditional aboriginal people[1] received secure legal ownership of their traditional lands for the first time. Papua New Guinea became an independent nation, ending Australia's 69-year rule and the High Court ruled that the Commonwealth had sovereign rights over territorial seas and the continental shelf.

Australia's annual inflation was 9.2 per cent, real GDP grew by 3 per cent and an Australian dollar could be swapped for 126 US cents. Net foreign debt was only 4 per cent of GDP, food

[1] The Gurindji people of the Northern Territory were given title to some of their traditional land. They later receive inalienable freehold title to almost all of Wave Hill station—now called Daguragu.

purchases comprised 17 per cent of Australians' average consumption expenditure and the nation's population was 13.9 million.

In agriculture 1975 was a year of mixed fortunes. Wheat growers would finally savour a favourable season. The average wheat yield across Australia was 1.40 t/ha, the highest since 1966 and wheat and wool prices were roughly double those 5 years earlier. Livestock prices, however, remained subdued especially within the beef industry, and farm production costs were escalating. Some industries were still adjusting to lost export market opportunities arising from Britain's entry to the European Economic Community in 1973.

Agriculture remained dominated by wheat and wool, although beef cattle numbers peaked at 29.8 million; a population size yet to be surpassed. The area sown to cotton, oilseeds and grain legumes was 30, 292 and 152 thousand hectares respectively. The farm sector generated 38 per cent of the nation's export earnings, based on output from 180 thousand farms employing 6.2 per cent of the nation's workforce.

A range of structural and policy issues was confronting agriculture around 1975. Burvill (1979) looking back at the decade 1969 to 1979 described it as a troubled decade. The title of the book by Mauldon and Schapper (1974) reflected the mood of the time *Australian farmers under stress in prosperity and recession*. Like farmers elsewhere in the nation, in Western Australia many farmers at the start of 1975 were anxious. The Farm Management Foundation (FMF), established in 1969, ran a well-attended 2-day conference in Perth in January 1975, titled 'Managing the Squeeze'. Farmers were looking to cut costs and to improve their management skills. During the year the FMF ran 23 management courses attended by 928 'farmers and wives' (FMF 1975, p2). A small and growing band of private and public sector farm management consultants and rural bank staff were busy providing advisory services. Henry Schapper's initiative, the Farm Management Service Laboratory, continued to provide mainly farm accountancy and record-keeping services via use of the university's main-frame computer and the journal *Farm Policy* maintained its subsidized viable readership. Henry continued to endear himself to the farming community by writing newspaper articles with titles like "*Farmers are collectively schizophrenic*".

On the federal political front, the Labor Government fresh from the wilderness was keen for inquiry and change. A Green Paper on rural policy (Harris *et al* 1974) was fuelling discussion in agro-politics. The Commission of Inquiry into Poverty (1975), better known as the Henderson Inquiry, released its report on poverty in Australia with Musgrave *et al* (1975) preparing for it a report on rural poverty. The Industries Assistance Commission had been established the year before and its 1975 annual report (Industries Assistance Commission 1976) outlined assistance to agriculture and how structural change would affect the sector. The work of the Industries Assistance Commission and its successors would greatly influence agricultural policy over the next decade. Mauldon's presidential address to this society in 1975 was on agricultural policy advice and the public inquiry process (Mauldon 1975).

In 1975 all articles in the Australian Journal of Agricultural Economics, apart from Olsen (1975), dealt with agricultural commodity, production, policy and education issues. However, academic interest in farm management was continuing to wane. Musgrave (1976) as president of this society noted that 'Farm management barely existed as a branch of agricultural economics providing advice which influences the decisions of farmers' (p.138) and that the techniques of farm management research were 'a job-lot of techniques mostly of a

programming nature...producing a few unthinking technicians but not producing many useful farm managers' recommendations…' (p.139). By contrast, interest in industry policy, natural resource and environmental issues was growing (eg Birch 1975, Routley and Routley 1975) as was a systems approach to farm management[2] (Dent 1975, Dillon 1976) and the need also to consider market issues beyond the farm-gate (Tisdell 1974, AFMS 1976). Indicative of the change was that, in my state of Western Australia, Roger Mauldon, first appointed as a lecturer in farm management, had resigned and was replaced by a lecturer in marketing.

Let's fast-forward to 2000.

2000

The year began with media hyperbole. As computer clocks ticked into January the media hysteria surrounding Y2K problems evanesced and the false prophets fell silent. The year ended with the unfolding drama of the US Presidential election. The year's highlight for many was the Sydney Olympics and Kathy Freeman's performances.

On the economic front, Australia's annual inflation was 4.5 per cent, real GDP grew by 3.7 per cent and an Australian dollar could be swapped for 58 US cents. Net foreign debt was now 42 per cent of GDP, food purchases comprised about 18 per cent of Australians' average consumption expenditure and the nation's population grew to 18.9 million.

Agriculture was no longer dominated by wheat *and* wool; in relative terms wool had faded. Compared to 1975, fewer sheep, beef and dairy cattle now dotted the landscape. Sheep and beef cattle numbers were both down 20 per cent, dairy cattle numbers were down 13 per cent. The wheat area had jumped from 8.6 to 12 million hectares. Cotton, canola and lupins, minor crops in 1975, were now planted on over 4.1 million hectares and a burgeoning wine industry was emerging. The farm sector now generated 18 (down from 38) per cent of the nation's export earnings, based on output from 110 (down from 180) thousand farms employing 4.1 per cent of the nation's workforce.

Turning to my home state; the year 2000 was very dry for many farmers. The State's southeast recorded its driest growing season on record. Grain yields in most other shires were greatly reduced, often 30 percent less than the average yield from 1995 to 1999. Inadequate and late opening rains delayed farmers' cropping programs. Some intended areas were not planted - especially lupins and canola. Pasture germination was often patchy and subsequent growth was severely limited by inadequate growing season rainfall. Sale and/or agistment of sheep became necessary in many areas. Low crop production and reduced carrying capacities led to financial losses on many farms.

In season 2000, wheat deliveries were 5.3 million tonnes, down from the 8.3 million tonnes expected in April. Overall, grain deliveries were only 7.2 million tonnes, against an expected 12.2 million tonnes. Grain prices, however, were reasonable, offsetting revenue losses due to poor yields.

The main agricultural policy issues in 2000 reflected the gradual change in government priorities for agriculture. After decades of regulated assistance, the dairy industry was finally

[2] See Brennan and McCown (2001) for a full discussion of the development of the farming systems approach.

and generously to face de-regulated markets. Early in 2000, the federal government announced a dairy industry adjustment package worth $1.74 billion, still based on consumer transfer payments[3]. Also early in 2000, a revised action plan for the rural sector was announced with objectives that switched the funding emphasis away from farm production more towards supply chain, food safety, sustainability and quarantine issues. Consistent with the focus on sustainability, the federal government announced a $1.4 billion national action plan for salinity and water quality in October 2000. Another important focus of federal government activity in 2000 was assisting rural businesses to prepare for the introduction of the goods and services tax (GST).

Key Shifts or Trends from 1975 to 2000

Physical changes

For many decades prior to 1970 agricultural development in many parts of Australia had focused on the release and clearing of land for agriculture and improvements in agricultural technology and production. In Western Australia, for example, in the 1960s a million acres per year was released for farming before the severe drought of 1969 brought land release to an abrupt end. Concerns began to be raised about the impact of traditional farm practices on farmland.

Salinity and soil acidity became topical issues (Glencross and Clarke 1984, Porter and Wilson 1984, Dolling and Porter, 1994; Beresford *et al* 2001). The first national State of the Environment report (SEAC, 1996) identified extensive deterioration of natural resources through dryland salinisation, particularly in Western Australia. Nulsen and Evans (1998) estimated the agricultural area affected by salinity in Western Australia in 1996 was 1.8 million hectares and that across the State the potential area affected was 6.1 million hectares. Other land quality issues were raised such as loss of soil structure (Howell 1987, McCredie and Parker 1992), water-repellency of some soils (Blackwell 1993), waterlogging (Bligh *et al* 1983), wind erosion (Marsh and Carter 1983), traffic hard-pans (Bowden and Jarvis 1985), deterioration in remnant vegetation (Hussey 1993) and nutrient run-off causing pollution problems (Yeates *et al* 1984, Prout 1993).

The use of land for growing traditional annual pastures for sheep production came under criticism. McFarlane and George (1994), for example, considered that grazing sheep on annual pastures in the woolbelt was not ecologically sustainable. They said:

> "shallow-rooted annual pastures contribute to widespread salinity in the area, annual legumes are acidifying the soils and making them water repellent, and bare, detached soils from heavy grazing cause sheet and rill erosion during autumn storms…..To counteract this degradation, the woolbelt needs more perennial pastures and deep rooting crops, fodder shrubs and trees. Only then can it become sustainable in both economic and conservation terms." (p.16)

Policy changes

Since the early 1970s almost irrespective of jurisdiction (State or Federal) or party affiliation (Labor or Coalition), governments adopted policies with far-reaching effects on rural communities, often exacerbating the social change in those communities. Governments

[3] The Government's adjustment package is funded by an 11 cents per litre levy on retail sales of market milk.

focused on micro-economic reform, deregulation and privatisation (Productivity Commission 1998). These policies led to changes in many sectors such as banking (Blackert and Drake 1988, Hawtrey *et al* 1991), communication, electricity, transport (Brennan 1995) and health. Many industries, including agriculture, became more exposed to international markets by the floating of the Australian dollar and by removal of marketing, tariff and subsidy support.

The political weakening of the rural vote initially assisted the ease of implementing these policies. In Western Australia in 1989 a major electoral redistribution reduced malapportionment and thereby lessened the lobbying leverage of rural groups. The fiscal focus of these reforms was to reduce national and state government expenditure and allow an increasing array of services to be provided by the private rather than public sector (McCarrey 1993a,b). Tonts and Jones (1996) report their impact was severe in the wheatbelt of Western Australia. Inland rural regions experienced declining service provision, particularly regarding health and banking services, and this served to fuel political dissent.

As part of their quest for cost-savings and commitment to 'free market' solutions governments moved away from market interventions by removing subsidies, reducing tariffs and removing price guarantees. Direct government involvement in commodity marketing lessened. The guaranteed minimum price scheme for wheat, the reserve price scheme for wool and market milk pricing arrangements were all removed. Fuelling the withdrawal of direct government involvement in agricultural marketing was the Council of Australian Governments (COAG) endorsement in 1995 of the Competition Principles Agreement drawing on Hilmer *et al* (1993). All Australian governments were committed to review by the year 2002 all legislation that restricted competition.

In several agricultural industries (e.g. chicken, egg, dairy) reviews of State legislation led to a re-structuring or removal of statutory marketing. The historical rationale for establishing many agricultural marketing boards was a concern that farmers needed support and protection against the actions of powerful buyers (Piggott 1990). These sentiments still abound, fuelled by knowledge that retail prices of food products have increased more rapidly than farm-gate prices, and that the farmers' share of final product prices has declined (Griffith 2000, Paul and MacDonald 2001). In spite of farmers' misgivings, policy and market developments continue to unfold, however perhaps more circumspectly, for political reasons, since the late 1990s.

Another shift in government policy is the increased support for the correction or containment of land degradation (e.g. Western Australian Government 1996). This has involved expenditure, cost-sharing or provision of tax concessions to combat problems. Increasingly society is aware of the off-farm environmental consequences of farming (e.g. water pollution by nutrient and herbicide run-off, algal blooms, salinity, loss of biodiversity and greenhouse gas emissions). Depending on the instruments used by government to combat these on and off-site problems, agriculture may or may not be advantaged in the future.

Whether rural communities on balance have benefited from the policy changes since the 1970s is difficult to answer. The view of Tonts and Jones is not favourable: '… agricultural restructuring and the emergence of government policies based upon economic rationalism, together with the devolution of responsibility for community well-being to local governments, have undermined the viability of many wheatbelt settlements.' (p.142). Lawrence and Williams (1990) comment similarly that 'a more productive agriculture is coming to mean less productive and viable rural communities.' (p.40). However, in financial terms many farm

businesses have continued to fare well under the policy changes. Farm survey findings continue to show that most farm businesses are able to maintain high equity and experience capital appreciation (ABARE 2000a, ABARE 2000b). Further, some farm businesses continue to generate rates of return to capital consistently in the range 5 to 15 percent per annum (eg. BankWest 2000 & 2001).

Social changes

Most farm businesses continue to be owned and operated by farm families. However, because farming is a business, farm families make decisions from which they intend to benefit financially. Since the 1950s many of these decisions have involved adoption of labour-saving technologies and increases in farm size that together have reduced opportunities for on-farm employment and reduced the number of farm families. The dominance of agriculture in many parts of Australia means there are limited employment opportunities outside of agriculture in these regions. Hence, reduced numbers of farm families and reduced employment in agriculture necessarily cause an exodus of some other families directly or indirectly reliant on population size.

Rationalisation of government funding and services in rural regions has exacerbated employment opportunities, particularly in inland rural regions, and fuelled depopulation. The decline in agricultural employment has added to de-population pressures in many inland rural areas of Australia[4]. In inland regions where the local towns each had a population less than 2000 and where agriculture, forestry and fishing accounted for over 30 per cent of employment then total employment in these regions declined by 7 per cent between 1986 and 1996 (Garnaut *et al* 2001). A further encouragement to the exodus of labour is that male full time weekly earnings in agriculture are often less than in other industries and average earnings in inland regions are often less than in metropolitan regions (Garnaut *et al* 2001). An additional disincentive is that many inland agricultural regions have much less industrial diversity compared to metropolitan regions (Hogan *et al* 1999) so there is less diversity of employment and fewer career pathways.

Higher rates of employment and pay in other sectors (e.g. housing, retail trade) that typically are located in metropolitan areas attract some families away from rural regions. Other factors contributing to reduced employment and population in these areas are the trend toward providing children with more years of education away from the farm and the decline in family size. All these influences result in the depopulation of many rural regions. For example, in 1991 the population of the central wheatbelt of Western Australia was 9585 which was 34 per cent less than its population in 1966. During this same period the number of people engaged directly in agriculture in this region fell by 43 per cent from 3593 to 2057.

From 1976 to 1995 the population of Western Australia grew by 47 per cent. However almost all inland rural shires experienced population declines over the same period. Many of these shires have experienced population losses of over 20 per cent.

The reality for many farming communities is that countering the social, economic and government policy pressures that encourage depopulation is extremely difficult. Attempts to reverse the decline can be at the expense of some other adjacent region and can strain existing resources. Tonts and Jones (1996) report that 'Many services which were previously provided by state and federal government are now the responsibility of extremely small, and usually declining, country shires.' (p.143).

Remaining farmers live in districts comprising fewer and larger farms. The management of their farms is increasingly complex with farmers having access to many more options

[4] See map 2 in Garnaut *et al* (2001).

regarding technology, crop choice, input selection, rotation, marketing, and information sources.

Technical and Market changes

In broadacre agriculture in Western Australia since 1975 there have been several major technical and market changes. Some main technical changes have been:

- an increasing array of herbicides that reduced the need for tillage, stimulated investment in spray and seeding equipment and affected crop rotations and investment in crop machinery. Earlier sowing of crops was permitted and this assisted yield improvement. However, the problem of herbicide-resistant weeds, not initially anticipated (Perry *et al*. 1980), became important in the 1990s.
- an increasing array of crop and pasture options and varieties. Lupin-based rotations came to dominate land use on sandplain soils. A portfolio of high-yielding wheat varieties suited to a range of season lengths became available. More crop types (eg field peas, faba beans, canola and chick peas) became available, with canola gaining rapid adoption in the mid-1990s. New medics, serradellas, new clovers and clover selections (Nichols and Nicholas 1992) were released and incorporated in farming systems. Tagasaste became more widely grown, particularly in the West Midlands.
- new biological threats to sheep and crop production. Herbicide resistant weeds emerged to threaten crop profitability and disturb rotation sequences. Annual ryegrass toxicity (Brown and Vogel 1986) and lupinosis (Petterson and Wood 1986) emerged as potentially fatal diseases for sheep. Skeleton weed outbreaks threatened the ease of crop harvesting. Crop and pasture yields were reduced greatly by viral diseases (Jones 1987), fungal diseases (Loughman *et al* 1986, Thomas and Sweetingham 1999) and insect problems (Ridsdill-Smith and Pavri 2000).
- improved farm machinery, particularly for tillage and harvest, increased the ease and efficiency of many farm operations. One downside of the increased work rates of crop sowing was the exposure of larger percentages of crop areas to frost.
- improved communications (fax, mobile phone) and computer technology increased the speed and range of information received by farmers.
- greater variety of sheep breeds (Awassi, Damara, Dorper) preferred to merinos on international sheep markets.

Some main market changes have been:

- establishment of substantial export markets for live sheep. In the 1970s export markets for live sheep emerged. During the 1980s and 1990s this trade grew, fluctuating from 2 million to 3.6 million head per year.
- increased segregations for wheat. New segregations (eg Australian Soft, Australian Noodle) based on end-user requirements were introduced along with payments for protein.
- increased price volatility for most farm commodities. With the collapse of the Reserve Price Scheme and cessation of the Guaranteed Minimum Price Scheme for wheat, price risk management was now an additional marketing responsibility for some farmers.
- greater retail and consumer concerns about food safety and increased demands for quality assurance in production, processing and distribution of commodities (Focussed Management, 1998). For example, chemical residues in wool, meat and grain and the hygiene status of meat products became topical concerns at various times, reflected the heightened requirements for food safety.
- a continuing rate of increase in commodity prices less than the rate of increase of prices of most inputs. This is known as the declining terms of trade or the cost-price squeeze.

- a shift in market focus towards Asian and middle-east markets.
- growth in sales of non-traditional farm commodities (eg. canola and new pulses).

Associated with market change has been a world-wide trend of agro-industrialisation (Barry 1995) that is affecting the nature of farm production, marketing and food processing. Agro-industrialisation generally refers to the process of increased concentration and vertical co-ordination by agri-food firms through contract and supply chain management, along with the increased provision of farm inputs by off-farm businesses. It leads to competition not just between farms but also competition between supply chains in different regions and different countries; often underpinned by an increased emphasis on quality assurance (Drabenstott 1994, Boehlje 1996, Kennett *et al* 1998). This trend has particularly affected the dairy industry in Australia and is likely to affect other industries beyond 2000.

The increased emphasis on food safety, quality and identity preservation is leading to an increased use of contracts in farm production. As a result farmers are increasingly vulnerable to adverse changes in contract terms from processors or input suppliers either because of product perishability, few alternative buying or selling outlets or the inability to alter production in the short run. The latter is particularly important in agricultural industries (e.g. dairying) with high asset specificity, whereby the farmer must invest in capital items such as machinery and equipment that can only be used for a specific enterprise. The low transfer value of these assets weakens the bargaining position of the farmer.

The impact of these technical and market changes on broadacre agriculture has been to fuel an increase in average farm size. ABARE (2000c) report the decline in farm numbers in Australia, at least since 1960. Table 1 summarises data in McColl *et al* (1997) on changes in farm numbers according to farm size.

Table 1: Annual trend in farm numbers by size[a]: 1982/3 to 1994/5

Small	Medium	Large
-3.2% pa	-0.8% pa	3.7% pa

[a] Small farms are those categorized with an estimated value of agricultural operations of $20,000 to $100,000 in 1994/5 dollars. Medium-sized farms have an EVAO of $100,000 to $200,000 in 1994/5 dollars. Large-sized farms have an EVAO of greater than $200,000 in 1994/5 dollars. Source: McColl *et al* (1997)

There are now about half as many agricultural establishments as there was in the late 1950s. Larger farms have increased their share of agricultural production with the top 30% of farms ranked by size contributing around 70% of agricultural production.

Accompanying the decline in farm numbers has been a much lesser decline in the farm and farm services workforce (ABARE 2000c). There are several reasons for the decline in employment in agriculture (Garnaut *et al* 2001). Productivity growth, driven by biological innovation, labour-saving technical change and utilization of economies of size, has partly offset farmers' declining terms of trade. Farm output and average farm size have increased, yet the number of farms and job opportunities have fallen. Agriculture in the late 1990s accounted for around only 4 per cent of all employment (Hogan *et al* 1999).

Key Shifts or Trends towards 2025

McColl *et al* (1997)[5] outlined future challenges and opportunities for Australian agriculture. Australian farmers were predicted to benefit from growth in world demand for agricultural products, particularly in Asia. Consumers were forecast to become more quality conscious. Greater vertical integration in the chain between consumers and producers was forecast. Expansion of world agricultural production was predicted to continue to outstrip demand. The movement of the terms of trade against farmers was likely to continue but at a lesser rate due to a lesser rate of agricultural expansion and microeconomic reform in the domestic economy that would moderate input price inflation. The major form of business structure in agriculture was likely to remain the family-owned and operated farm, yet a greater focus on their business performance was predicted.

McColl *et al* also suggested a key challenge for farmers was the deterioration in the natural resource base of agriculture, yet land ownership and land management was predicted to be more separate in the future. As 2025 approaches several other major influences upon farming and farm management will be evident.

Biotechnology

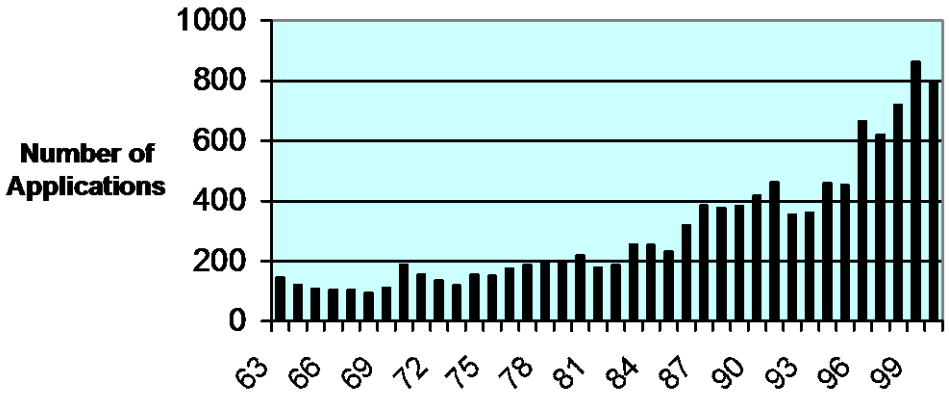
A main influence on broadacre farming towards 2025 will be the impact of biotechnology (Pardey 2001) that may assist farming systems to be increasingly crop-dominant. Consider the current developments in biotechnology. In various stages of development or commercialisation[6] are:

- herbicide resistant crops (eg Roundup® resistance, Basta® resistance)
- herbicide resistant pastures (eg bromoxynil resistance in sub-clover (Carson 1998)),
- insect resistant crops (e.g. pea weevil resistance in peas (Nichol 1998); cotton weevil resistance in cotton (Conners 1998)),
- insect resistant pastures (e.g. insect resistant clover (Jones 1998)),
- disease resistance in crops,
- quality improvement in crops (e.g. high laurate canola, high oleic and low linoleic canola).

Over the last decade as reflected in strategic policy reports (eg Department for Trade and Industry 1998, World Bank 1998, Australian Labor Party 2001) economic development is considered to be increasingly underpinned by knowledge-based industries or knowledge-based innovation. Application of knowledge is viewed as affecting productivity, production mixes, production processes and end-uses of commodities. One illustration of knowledge-based innovation in agriculture is the rapid growth in plant patents since the early 1980s (see Figures 1 and 2). Each patent potentially lasts 20 years, so the cumulative potential effect of these patents is large.

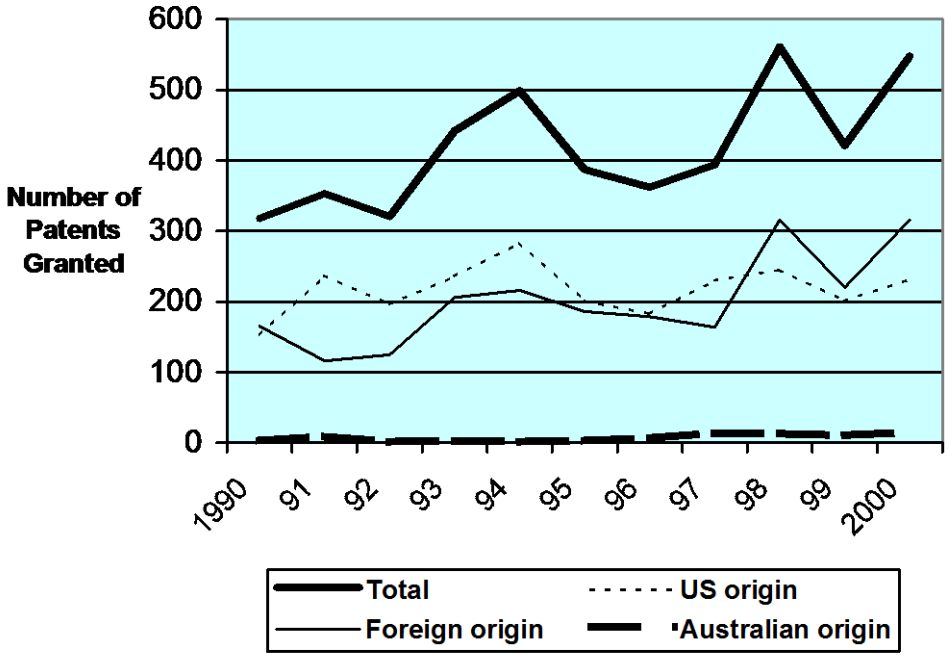
[5] See chapter 2 in McColl *et al* (1997).
[6] There are several other confidential biotechnology developments mainly applicable to broadacre crops, horticulture and floriculture.

Figure 1: Plant Patent Applications to the US Patent and Trademark Office: 1963 to 2000



Source: Compiled from US Patent and Trademark Office data

Figure 2: Plant Patents Granted by the US Patent and Trademark Office: 1990 to 2000:



Source: Compiled from US Patent and Trademark Office data

The growth in plant patents, however, only partly reflects the impacts on agriculture of knowledge-based innovation. Coinciding with this growth has been an increase in applications for all other types of patents. In 1963 the US Patents and Trademark Office granted 48,971 patents, increasing to 175,983 patents in 2000. Some of these patents, together with the plant patents, have the potential to effect the productivity and profitability of agriculture.

Developments in microelectronics, computing, communications, packaging and storage, biotechnology and materials technology all have a potential to affect agriculture.

Jefferson (2001) outlines some biotechnologies currently under development. Many biotechnologies are targeted towards large markets such as the feed grain market. Over 75 per cent of the world's corn and soybean production, for example, is used as livestock feed. Extending or lessening some aspects of the nutritional character of a feed grain will increase the feed value of the grain. Hence high-lysine, high methionine and low saturate soybeans will increase the value of soybean in animal diets. Given the predictions of increased world demand for feedgrains over the next two decades it is not surprising that genetically based improvements in feed quality and yield are being pursued (see table 2).

Table 2: Biotechnologies for corn and soybeans

Year of release	Product innovation
Corn	
1998	High oil content + high oleic
1999	High oil content + high lysine
2001	High oil content + high lysine + high methionine
Soybeans	
1997	High oleic
2000	High lysine
2001	High lysine + high oleic
2001	High lysine + high methionine
2002	High lysine + low saturate + high oleic + high methionine

Source: Kalaitzandonakes and Maltsbarger (1998)

Nutraceutical production is also commencing. For example, Agracetus, a Monsanto subsidiary, has begun clinical trials with human anti-bodies purified from genetically engineered corn and soybeans. These plantibodies are to be used as anti-cancer agents. A potato that contains an antigen for cholera has been developed. By eating the potato people become immunized against cholera. In the future plants could be modified genetically to make biopolymers or to be processed into chemicals, polymers, and fibres. Industries such as cosmetics and nutraceuticals are looking for new plant-based products. Such is the ‘brave’ new world of crop production.

Because many of the biotechnology innovations are targeting broadacre crops, it seems likely that productivity improvement in cropping enterprises will continue to outstrip that likely in the wool industry or broadacre livestock industries. Even using traditional breeding methods there is a greater likelihood of productivity improvement in broadacre cropping. Also the R&D support provided by grain growers and commercial firms in the grains industry, relative to that from the wool and meat industries, suggests that greater R&D advancement is likely in the grains industry. Also consumers are more likely to accept transgenic modification of feed grains and oilseeds than transgenic modification of animals killed for human consumption. Animal welfare concerns would be difficult to overcome in many circumstances. Accordingly the land allocation in broadacre farming could swing more towards cropping. Yet there are downsides.

Firstly, although in the United States there is general acceptance of the food safety, environmental and nutritional merits of genetically modified crops, there are concerns, particularly in Europe, about such crops and foodstuffs. Hence, although genetically modified crops may offer the advantage of higher yields, or less expenditure on inputs and eventually better qualities; difficulties are likely in marketing these products. Towards 2025 as second and third generation genetically modified crops become available it is anticipated that food safety and environmental concerns for a majority of voters and grain purchasers would be assuaged. However, to satisfy consumer concerns will require quality assurance and identity preservation systems to be in place. Preventing contamination, protecting consumer confidence and greater regulation in labelling are likely to become increasingly important to agricultural production, marketing and retailing.

Secondly, intellectual property protection increasingly applies to many aspects of varietal development. The ability of large multi-national firms to gain patent protection for certain genes and gene sequences may have serious ramifications for the grains industry. It may mean, for example, that a significant portion of the profits of growing and marketing varieties with these patented genes will flow to these multi-national companies rather than to Australian farmers. In the extreme, Australian farmers could be denied access to these genes if these companies considered that Australian access to these genes was inconsistent with the commercial aspirations of the companies.

Thirdly, a switch into more cropping means a more capital-intensive business with greater demands for working capital. With such a business structure a few poor seasons, especially if coupled with poor prices, can rapidly cripple a farm business. Hence, although farms are likely to maintain a diversity of crops (cereals, pulses and oilseeds), and although climate forecasting may improve to facilitate crop and livestock management, nonetheless managing enterprise and business risk will be increasingly important towards 2025.

Fourthly, because broadacre crop enterprises rely on scale economies, a move towards crop dominance will reinforce farm amalgamations and continue depopulation pressures, particularly in inland areas.

Although biotechnology will affect crop production, there will remain large areas of farmland unsuited to cropping which will restrict the impact of crop biotechnology. Soils may remain unsuitable for cropping due to terrain, waterlogging, soil infertility or attributes like subsurface acidity. It may not be cost-effective to ameliorate or change these characteristics to make the land suitable for cropping so these parts of the landscape will remain as grazing lands or lands providing environmental services. Also rotational, disease, salinity, pest or weed management decisions will lead to retention of pastures (annual, phase, perennial) and establishment of deep-rooted species) (trees and shrubs) on parts of the landscape.

If farming systems become more crop-dominant, and as saline-affected soils become more common, then placement of pasture in the farming system will change. New pasture species and varieties may need to be developed for the poorer soils unsuited to cropping. Deep-rooted phase pastures to combat rising water tables and herbicide-resistant weeds and GM crop contamination are likely to be introduced. Raised-bed, drainage and de-salinisation technology may become important. Simultaneously, perennials and annual crop and plant species more tolerant to salt will be developed. Niche areas of horticultural crops in

broadacre farm regions are likely to be introduced as cash crops, in some cases using de-salinised water. The area of traditional pastures on 'good' soils may diminish with the increased adoption of more crop-dominant rotation sequences.

If farming systems become more crop-dominant then the place and role of livestock in the farming system may alter. Livestock may be retained as an extensive enterprise (e.g. wool production, utilisation of saltland pastures, hill-side grazing) yet, in other cases, be a more intensive enterprise subject to livestock specialist management, involving controlled-grazing, feedlots and contract-based production systems and supply chains.

There is likely to be spatial variation in the move towards greater crop-dominance. In shires already dominated by crops there may be little transfer of additional resources into cropping. However, in many other shires, particularly in shires where average annual rainfall is in the range 425 to 700 mm, increased intensity of cropping is more likely.

More mouths, older mouths and changing palates

The world's population growth rate has fallen steadily since the late 1960's and is now about 1.5% annually. Population growth will not be uniform across the globe. Asia will continue to house around 60% of the world's population, yet India's population size is forecast to surpass China in about 2040. Over coming decades Latin America's share of the world's population will remain constant at 8%, while North America and Europe's share will fall. By contrast Africa could experience spectacular growth. Between now and 2100 its population is forecast to quadruple (van der Werff 2000), and its percentage of the world's population may double from 13% to 25%. Australia's population of 19.4 million in 2001 is projected to increase to between 24 to 28 million by 2051 (ABS 2001a).

The number of teenagers today in the world is around 735 million. Their number will grow to 900 million by 2025, but little thereafter, whereas the number of senior citizens will continue to increase. Teenagers outnumber them 2:1 today, but by 2025 the ratio will approach 1:1. In Australia the proportion of the population aged 65 and over is expected to increase substantially, from 12% in 1999 to between 24% and 27% in 2051. The proportion aged 85 and over is expected to increase from 1.3% in 1999 to around 5% in 2051 (ABS 2001a).

As a result of the changing age distribution of populations the working age population will alter. In Europe and Japan, whose populations are no longer growing, the workforce will diminish. Germany's will decrease by 40% by 2050; Italy's by 30%; and Japan's by 20%. Britain's and France's will remain stable for about two decades before decreasing slowly. The United States' workforce will grow 20% in the next two decades and remain stable for many decades thereafter. In Australia the working age population[7] will shrink from a current 67% of the population to 59% by 2051 (ABS 2001b).

Coinciding with changes in population size and age distribution are changes in habitation. An increasing proportion of populations live in urban areas, household sizes are diminishing and compositions of households are changing. Australian data and projections are given in Tables 3 and 4.

[7] The working age group is defined as the proportion of the population aged between 15 and 65 years of age.

Data in table 4 show that household size in Australia is shrinking, more people are opting not to have children and, with the aging of the population, eventually more people are living on their own. For example between 1999 and 2021 there is an expected 40 percent increase in the number of lone person households.

Table 3: Population indicators for Australia: 1901 to 2051

	Unit	1901	1947	1999	2021	2051
Total population	million	3.8	7.6	19.0	22.9	25.4
Proportion aged 0 to 14 years	%	35.1	25.1	20.7	16.1	14.4
Proportion aged > 65 years	%	4.0	8.1	12.3	18.4	26.1
Median age	years	22	31	35	41	46
Proportion living in capital cities	%	37	51	64	65	68

Sources: Census of the Commonwealth of Australia, 1911; Australian Demographic Bulletin, 1947; ABS Catalogue No. 3101.0, Australian Demographic Statistics; ABS Catalogue No. 3222.0, Population projections 1999 to 2101

Table 4: Household indicators for Australia: 1911 to 2021

	Unit	1911	1947	1999	2021
Persons per household	No.	4.5	3.7	2.6	2.2
Family households	Million	np	np	6.0	6.6
Proportion of family households that are couples with children	%	np	np	46	40
Proportion of family households that are couples without children	%	np	np	34	42
Lone person households	Million	np	np	1.9	2.7

np not published

Sources: ABS Catalogue No. 3236.0, Household and Family Projections, 1996 to 2021

Coinciding with changes in population size, age distribution and household structure are changes in consumption habits. Australian data on apparent per capita consumption of commodities are presented in Table 5. The final column in the table contrasts per capita consumption in 1998-9 to that in 1938-9. Consumption has shifted away from beef, veal and mutton toward pig and poultry. Consumption of tea and butter has declined and beer consumption displays a current downward trend. Large increases in consumption of coffee, cheese and wine are recorded.

Accompanying the change in food consumption are several social changes. Figure 3 (from Kinsey (2000)) shows consumption trends in the United States since 1929. Although total food expenditures are a declining proportion of disposable income, the amount of away-from-home food purchases is a slightly increasing share of disposable income. Senauer (2001) also reports an increase in food purchases away from home.

McKinsey and Company (1996) classified eating occasions for US consumers and found only 25 per cent of meals were prepared at home from basic ingredients. Most meals were either fully or partially prepared away from home (yet were eaten at home) or were consumed away from home. Senauer (2001) found that eating habits were increasingly individualistic with fewer households having a wife or mother who acted as a "gatekeeper" in purchasing and preparing the same meal for the entire family. The traditional household unit of a married couple with children was a diminishing proportion of the population of households. This is also true for Australia (ABS 2001b).

Table 5: Apparent per capita consumption of commodities in Australia: 1938-9 to 1998-9[a]

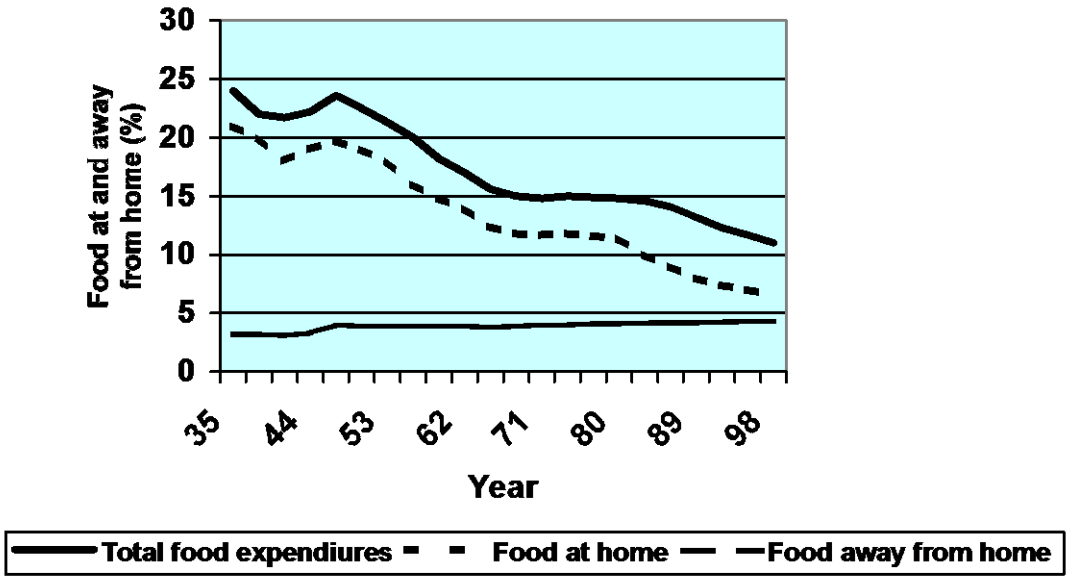
Commodity	Unit	1938-9	1948-9	1958-9	1968-9	1978-9	1988-9	1998-9	Ratio of 1998-9 to 1938-9
Beef & veal	kg	63.6	49.5	56.2	40.0	64.8	40.0	36.4	0.6
Lamb	kg	6.8	11.4	13.3	20.5	14.4	14.9	11.8	1.7
Mutton	kg	27.2	20.5	23.1	18.8	3.6	7.3	4.5	0.2
Pig	kg	3.9	3.2	4.6	6.7	13.3	17.5	19.0	4.9
Poultry	kg	na	na	na	8.3	17.1	24.1	30.8	3.7[b]
Milk	L	106.4	138.7	128.7	128.2	100.5	101.7	102.4	1.0
Cheese	kg	2.0	2.5	2.6	3.5	5.3	8.8	10.7	5.4
Butter	kg	14.9	11.2	12.3	9.8	5.1	3.2	2.9	0.2
Margarine	kg	4.4	5.6	na	9.8	17.0	18.0	12.8	2.9
Tea	kg	3.1	2.9	2.7	2.3	1.7	1.2	0.9	0.3
Coffee	kg	0.3	0.5	0.6	1.2	1.6	2.0	2.4	8.0
Beer	L	53.2	76.8	99.7	113.5	133.2	113.1	93.2	1.8
Wine	L	2.7	5.9	5.0	8.2	14.7	20.2	19.8	7.3

[a] average 3 years ending na not available [b] Ratio of 1998-9 to 1968-9
Sources: Based on data from the Australia Dairy Corporation and data in ABS Catalogue 4306.0

Many of these same consumption trends are observed in many other developed countries. However, in developing countries, changes in consumption patterns favour commodities such as beef, veal and dairy products.

Kinsey (2000) also presents data on the source of food in diets of various age groups and shows that older age groups compared to teenagers purchase less of their diet from fast food outlets, more from restaurants and more from food stores. The health properties of food types also become more important for some older age groups.

Figure 3: Total food expenditures and food eaten at and away from home as a percentage of disposable personal income: 1929 to 1998



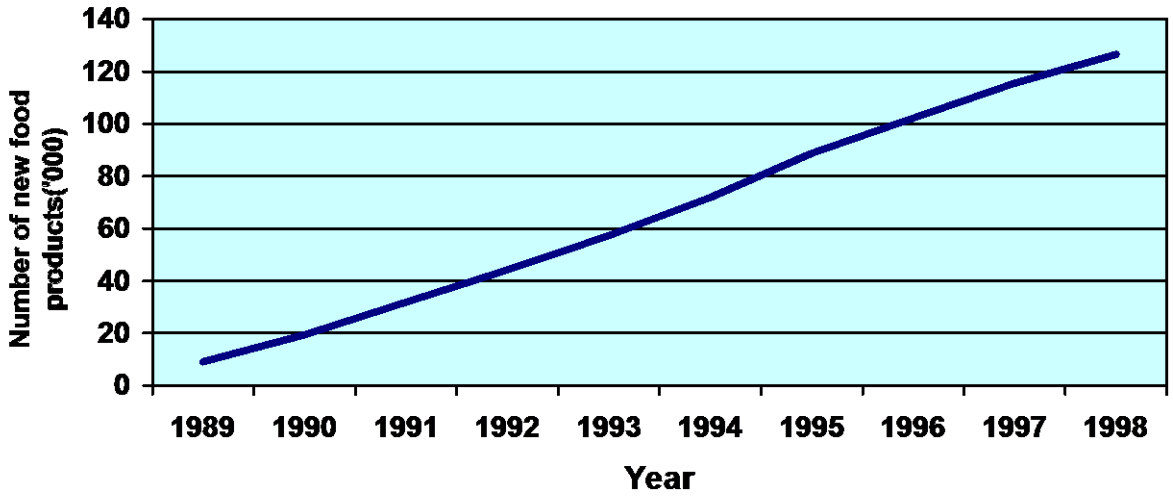
Source: Based on data in Kinsey (2000)

The changing food palate of households and individual consumers is also reflected in the transformation of raw agricultural products into new product lines. The cumulative tally of new food product lines available consumers in the United States since 1989 is shown in Figure 4. Development of product lines requires increased dependence upon the food processing and distribution sectors. Goldberg (2000) notes that in the 1950s food processing and distribution accounted for half the value-added for agricultural goods in the United States yet he projected this share to exceed 80 per cent by 2028.

One stimulus to developing new product lines is the growing demand for convenience in food preparation. For example, in the mid-1980s whole chickens accounted for around half of all poultry sold yet now de-boned chicken and chicken pieces account for 90 per cent of sales (Olinger *et al* 2000). In the 1950s in the United States the expected time to prepare a meal was around an hour whereas by the 1990s the expected time shortened to around 15 minutes (Kinsey 2000). Food preparation is moving up the supply chain. Consumers are looking for quick and convenient meals in their busy world.

Back in 1975 in the United States only 45 per cent of married women with children under 18 years of age were participating in the workforce. By 1995 their participation had risen to 70 per cent, increasing the demand for convenience foods. Indicative of time pressures are findings of a shopper survey by Katsaras *et al* (2001) that identified only 22 per cent of shoppers as discriminating leisure shoppers. A related study by Mangaraj and Senauer (2001) classified 37 per cent of their sample of shoppers as time-pressed convenience seekers.

Figure 4: Cumulative number of new food products available



Source: Based on Kinsey (2000)

The aging of populations may suggest many will have more time in which to cook and therefore the demand for convenience food will slacken. However, developments in food technology and higher incomes of superannuated retirees may maintain demand for convenience foods. Also 'slow' food outlets (restaurants and cafés) may expand to cater for this retiree market.

In markets where the wealth of consumers is likely to increase towards 2025 then the price of food may not necessarily always be the first-order issue driving consumption decisions. Antle (1999), for example, suggests a stylized demand function:

$X = D(P,I,N,C,Q)$

where demand (X) depends on the price of the commodity and other goods (P), income (I), population (N), characteristics of the population (C), and non-price attributes of the product (Q). These non-price attributes or quality factors will include nutritional content, safety, convenience traits and production method characteristics (eg non-GM, free range, organic).

In many other markets where the wealth of consumers is likely to not increase towards 2025 then the price of food will remain a first-order issue. The predictions of Coates *et al* (1998) are that by 2025, of every 20 people living, 5 will struggle to get enough food and will suffer recurring famine, 12 will get enough food but will not be very prosperous, and 3 will have a wide variety of food types available and most easily afforded.

The variation in purchasing power within and across countries will provide a range of niche market opportunities as well as maintained markets for bulk and processed commodities. The development of low-cost identity preservation systems, biotechnologies and improvements in handling, storage, packaging, processing and transport technology will ensure that many Australian farmers can share in the benefits of servicing these markets.

The historical export-oriented nature of Australian agriculture has meant it already has a long history of responding to changes in market opportunities. For example, in the late 1940s and early 1950s the United Kingdom imported one-third of all Australian exports, including 80% of all beef and 90% of all butter. However, by the mid-1980s, the United Kingdom was taking less than 2% of Australian rural exports. Australia's major importers of rural products had become Japan 21%, the Middle East 15%, North America 12%, the European Union [8] 11%, Eastern Europe 9%, South East Asia 9% and China 5%.

Towards 2025 an emerging issue for some farmers will be whether or not to become equity partners in supply chain ventures that target particular market or product niches. Further de-regulation of grain marketing and handling, and the emergence of niche market opportunities made possible by new technologies will provide some farmers with new investment opportunities.

More environment-friendly farm practices

Environmental quality and landscape amenity are likely to be increasingly important influences upon farm practices towards 2025. In Australia an increasingly urban population with its heightened awareness of environmental issues is likely to press for land management change. Also in some international markets, mainly Europe, environmental concerns may require incoming agricultural goods to be produced in ways that verifiably do not harm the environment.

Already it is known that among OECD countries, Australia has a higher percentage of threatened mammals than USA, Japan, Finland, Ireland and Norway (OECD 1999) and a high number of extinct and threatened plants.[9] Land use, mainly for agriculture, has caused nearly 90% of temperate woodlands and mallee to be cleared (Industry Commission 1998, Productivity Commission 2001), replaced mainly with annual crops and pastures.

Currently 60% of birds and 80% of mammals, listed as threatened (State of the Environment Advisory Council 1996, NSW Biodiversity Strategy 1999), have suffered habitat loss. Also introduced pests and weeds are affecting not only agricultural production but also bushland, reducing its native flora and fauna. Yet over 70% of international visitors to Australia identify the main reasons for their visit as the unique flora and fauna and the open landscape (Working Group on Tourism 1991).

In several States, and in Western Australia and New South Wales in particular, large scale clearing and planting of agricultural plant species is resulting in increasing problems of dryland salinity (Beresford *et al* 2001). Farm lands, rural infrastructure, waterways and bushland are being affected by salt. Certain farm practices, including fertiliser and pesticide applications, are linked to off-site problems of waterway contamination. Draining wetlands or reducing water flows to water courses and wetlands have become politically sensitive issues.

One of the initiatives of the United Nations Framework Convention for Climate Change, the Kyoto Protocol, has the potential to alter Australian agriculture. The protocol is an agreement that requires ratifying countries to restrict greenhouse gas emissions to a specified percentage

[8] then known as the European Economic Community
[9] see the IUCN red list of threatened species at http://www.wcmc.org.uk

of 1990 emissions (UNFCCC 1997). Australia is a signatory to the protocol, but has not ratified it. If Australia ratifies then greenhouse gas emissions will be restricted to108 percent of 1990 levels in the first commitment period of 2008 to 2012.

Most Australian emissions have their source in the burning of fossil fuels (55% in 1996); and agriculture is the second biggest contributor (20 percent in 1996). Ruminant livestock are the greatest source of emissions in the agricultural sector, contributing 70% of agricultural emissions. If tree crops are accredited as carbon sinks under the Kyoto Protocol then (especially in the presence of emission trading) their area is likely to increase (Peterson *et al* 2001). Increased tree planting will reduce water recharge, and its consequent salinity effects, and will affect other land management decisions of farmers.

In concert, rising environmental concerns, changing market signals and changes to government policy are likely to lead to farmers more readily adopting land management practices less harmful to the natural environment. Accordingly, crop establishment methods, crop and animal enterprise selection, crop and animal management and marketing will be influenced increasingly by environmental considerations.

New Actions of Government

The tide of environmental concern will continue to flow, affecting actions of governments, consumers and researchers. In our Society it is interesting to note that in the calendar year 2000 approximately a quarter of articles published in the Society's journal featured natural resource and environmental issues. Society members are writing books with titles such as *The Choice Modelling Approach to Environmental Valuation* (Bennett and Blamey, 2001) and *The Environment in Corporate Management: New Directions and Economic Insights* (Lesourd and Schilizzi, 2002).

The greater emphasis on environment is being reflected in federal government funding initiatives such as formation of the Australian Natural Resource Management Ministerial Council in August 2001 which has responsibility for sustainable management of land, water, vegetation and other natural resource issues. The council oversees the National Action Plan for Salinity and Water Quality ($1.4 billion) and the Natural Heritage Trust ($2.5 billion). Its responsibilities extend to environmental flows, conservation of endangered species and ecological communities, migratory birds and wetlands.

The rise in importance of environmental issues, and to a lesser extent food processing and food safety issues, is also reflected in the renaming or re-organisation of government departments and education facilities. In Britain, for example the long-standing Ministry of Agriculture, Fisheries and Food (MAFF) disappeared in May 2001 and its functions were incorporated into a new super-ministry christened the Department for Environment, Food and Rural Affairs (DEFRA). Note that agriculture has disappeared from the Ministry's title and environment and food now have prominence. Similarly in Australia, new names for various bodies often reflect the relatively lesser social, economic and political importance of

agriculture[10]. In a few universities, faculties of agriculture have been or are being renamed or reorganised, often diluting the emphasis on traditional broadacre agriculture[11].

Implementation of National Competition Policy in the 1990s stimulated or accelerated marketing reforms resulting in less statutory marketing bodies and greater reliance on delivery of services by private sector firms rather than public agencies. In spite of some farmers' misgivings, similar policy and service provision developments are likely to continue to unfold. However, as the age structure of Australia's population alters in coming decades, governments may shift focus toward using public funds, regulation or legislation to ensure enhanced service provision to the elderly. Social services such as rural health, community, tourism and information services are likely to receive increased funding, perhaps at the expense of funds for agricultural industry support and development.

The urban voter relative to the inland rural voter will continue to grow in political importance. Hence, urban voters' views on land and water management, sustainable farm production methods, biotechnologies and animal welfare will be accommodated increasingly in emerging government policies and actions. It is very likely that environmental and social concerns will lead to the area of land used for agricultural purposes to decline. Revegetation and acquisition of land for biodiversity, water quality and infra-structure protection will occur, funded by private and government actions.

Queensland and Western Australia are forecast to have the highest economic growth rates of all Australian States over the next 15 years or so (ABC 2002). In Western Australia energy and mineral production, urban housing and infrastructure and growth in the services sector are predicted to be the main sources of growth. As a result the economic role of the agricultural sector will diminish in relative economic importance. Towards 2025, increasingly the actions of government in Western Australia will be less constrained by the political, social and economic importance of the agricultural sector.

Electronic Technology

Increasingly, within and beyond the farm gate a range of electronic technologies will affect farm production and farm management. Computer chip technology will feature in farm machinery, equipment and vehicles; improving their safety, efficiency and performance. Many machines will have in-built 'intelligence' to reduce the risk of operator error and the efficiency, reliability, safety, ease-of-use and effectiveness of machines will continue to improve.

Information technology will increasingly be used in farm management for monitoring farm performance and to accelerate and improve decision-making. Supply chain management and quality assurance systems will be supported by computer-based process control technology and biological markers. On-line management will become standard practice facilitating the purchase and supply of inputs, product marketing, disease and pest identification and

[10] For example, the Victorian Department of Agriculture has been subsumed in a Department of Natural Resources and Environment where agriculture is but one of 12 divisions.

[11] For example, at the University of Western Australia, the Faculty of Agriculture has been replaced in 2002 by an enlarged Faculty of Natural and Agricultural Sciences. At the University of Melbourne the School of Agriculture and Forestry is now the School of Agriculture and Food Systems and is one of three schools in the Institute of Land and Food Resources.

treatment. Real time voice and vision communication will be common-place, facilitating off-site management. Advanced computer modelling and better data sets will lead to improved accuracy of weather reports and seasonal forecasts (Drosdowsky and Allan 1999).

A downside of the impact of information technology will be the ease of access to a range of information. Burris (2001) points out that information overload increasingly will be a problem. Managing electronic pollution and managing risks of loss or damage to electronic data and information systems will be a feature of farm management towards 2025.

Implications for Broadacre Farm Management towards 2025

Towards 2025 traditional broadacre farming is likely to become characterised by:

- fewer, larger farms and fewer people employed directly in farming;
- maintained diversification of farm businesses (cereals, pulses, oilseeds, pastures, livestock, fodder shrubs and off-farm investments);
- agricultural commodity prices continuing to decrease in real terms (Pinstrup-Andersen and Pandya-Lorch 1998, Tweeten 1998) and the cost-price squeeze continues;
- more volatile agricultural commodity prices (Tweeten 1998);
- increased demand for and supply of animal feeds;
- production growth from yield improvement and an increased proportion of the landscape sown to crops (grain and fodder). Biotechnology, not just transgenic technology, particularly in the plant sciences, will underpin productivity improvement and new product development. Market acceptance of many biotechnologies, once increasingly negative (Thompson 1998, Kolodinsky *et al* 1998) will improve with emergence of crops offering health and environmental benefits;
- changing dietary patterns, increasing incomes and shifts in population structures in many countries will be an increasingly important market driver;
- broadacre farming will maintain its emphasis on exports, productivity improvement, product and market development. Farmers will continue to invest in improvements in technical and scale efficiency, and pursue input and product innovation;
- participation in supply chains as an equity partner as well as a raw product supplier will be an emerging option;
- the *relative* importance of agriculture in the nation's economy will continue to decline;
- a greater commitment to sustainable farm practices due to regulatory and market pressures;
- greater emphasis on quality assurance, production certification, identity preservation, environmental amenity, supply chain management and food safety;
- an increasing source of price and production risks will be risks surrounding contract and marketer relationships and changes in consumers' perceptions of food health, safety and environmental impacts;
- greater use of contract services by farmers (eg machinery management, plant and animal health services, information management services, labour training and management);
- greater dependence on electronic technology (AFMS 1997) and electronic management;
- effects of global warming largely addressed through incremental technological improvement and plant breeding improvements.

Coates *et al* (1998) see the futuristic farmer as manager, operator and chief executive of an increasingly electronic enterprise. An implication for farm management is that the emerging

generation of farmers will need an increased practical knowledge of information technology, computers and software, as well as the traditional skills of farm management.

Karpin (1995) suggests that the skills required for a 'good' manager in the early part of the 21st century are an appetite for "whole-of-life" learning, being adaptable, having organisational and prioritization skills and displaying energy or industriousness. In spite of the identified need for "whole-of-life" learning it is interesting to note the findings of Coopers and Lybrand (1995a & 1995b) that most small business managers in Australia (including farmers) had little interest in participating in any training due to its perceived irrelevance, time pressures on these managers and their primary concern for an immediate return on any investment. The Boston Consulting Group (1995) also reported on the likely desired characteristics of business managers and listed as important:

- people skills (Bolton 1987);
- leadership skills;
- an orientation towards international market opportunities and
- entrepreneurship.

Karpin (1995, p.136) also notes that abilities to manage systems and skills in coping and adaptation will be important requirements for management. Coates *et al* (1998) see the challenge for many farmers as more than maintaining profitability. Making the social and personal life on the farm more attractive and appealing, particularly to the next generation, is a major challenge.

As farming systems and farm businesses become larger and more complex, more sophisticated management will be required. More production and marketing alternatives, more input options, more combinations of production systems, an increasing array of opportunities for new technologies and more off-farm investment opportunities, all increase the demands on management. Farmers' need for specialist advice as well as integration advice will increase and many farmers will be prepared to pay for this advice. As farm size increases and family size decreases and children spend more years off-farm in formal education then farm businesses are likely to depend more on hired labour. So labour management and purchase of services that improve farm profitability and facilitate farm management will be an increasingly important part of farm management.

Family needs, education expenses and the reduced social and employment diversity in inland rural regions may lead some farm families to reside off their farms, at least for some years during their period of ownership and management of the farm business. For example, some farmers may opt to commute to their properties when their children reach their mid-teens. By residing off-farm, the farm family may avoid expensive school boarding fees, enjoy a greater array of social and part-time employment opportunities and benefit from a superior quality of educational services.

Kohl (2001) lists six ingredients for success in farm management in the next decade as:

- passion. Peak farm managers will have a passion for their business and industry that allows them to be persistent and creative.
- a sustainable lifestyle. Historically, most farm families were willing to sacrifice income, standard of living and personal enjoyments for the good of the business. In the future, this may be less common. The combination of high equity of many farm businesses, smaller family size, family break-up pressures and more investment choices outside the business, means a fine balance will have to be maintained regarding the financial and social viability

of the farm business. If the farm business does not provide a standard of living within desired family obligations and aspirations then the long-term legacy of the family business may be in doubt.

- traceability. The ability to manage and trace inputs and outputs of the farm business is likely to become an increasingly important feature of farm management. Food safety, product differentiation and environmental concerns will dictate the need for this form of management.
- public interface. Farmers will need to be networked with neighbours, agri-business and industry in order to capitalise on market opportunities and ensure farmer views are represented in policy-making.
- benchmarking. Kohl believes that the peak-performing manager will need to analyze their farm performance against their peer size and type of enterprise to guide their farm decision-making. However, the cautionary comments of Ferris and Malcolm (1999) about the merits of benchmarking are worth noting.
- lifecycle planning. This involves anticipating the life-style and education needs of family members as well as the need for succession planning.

Farm management is likely to depend on new emphases such as biotechnology, information and electronic technology, business analysis, group labour and process management, accreditation and contractual services. However, farm management will also involve more of the same such as decisions on the farm's enterprise mix, machinery replacement, land leasing or purchase, labour hiring and off-farm investments. As Malcolm (2000) observes; 'A glance through history suggests that in the most important ways, the fundamental elements of managing a farm has altered little.' (p. 40).

Towards 2025 in many parts of inland Australia, many farmers will:

- be richer;
- have fewer neighbours;
- perhaps feel more socially isolated;
- be more informed and more educated;
- have more business opportunities;
- be more reliant on electronic communication;
- will travel more to access personal and social services;
- mostly still enjoy the lifestyle and environment of farming.

Their portfolio of enterprises, in many cases, may be greater. The switch in relative emphasis of various enterprises may be more rapid and the demands on their management and knowledge may be greater. They will have access both to more information and more specialist farm management and business services.

Concluding Remarks

If these mooted changes do occur over the next two decades then what are the implications for farm managers? Firstly, if farm managers in the future are to be better educated then what are desirable ingredients in their evolving education? A short-list of tuition topics would include development of skills and knowledge of:

(i) time management, planning and prioritization;

(ii) practical management of new crop and animal enterprises and emerging technologies;
(iii) personal communication and network formation;
(iv) financial and investment assessment and management;
(v) information and risk management;
(vi) basic legal and commercial considerations for farm businesses;
(vii) plant, animal, land and equipment management including applied knowledge of computers, peripherals and information and communication technology;
(viii) adaptation and stress management.

Not only will farmers of the future spend more years in formal education preparing to be a farm owner, operator and manager but they will engage in 'life-long' learning where skills and knowledge are updated regularly. Hence, a challenge for many current farmers is firstly to anticipate the educational needs of the farm business, both for employees and family members, and secondly to identity providers of education and training services that are cost-effective, relevant and easily accessible.

If farming systems become as large and as complex as suggested, then farm managers in the future will be more like musical conductors than instrumentalists or more like generals than foot soldiers. Managers of large and complex farm businesses will be involved in assembling and assisting a pool of talented and reliable workers and advisers that facilitate decision-making and ensure that farm operations and the strategies and tactics employed by the farm business generate high rates of return. Hence, issues like business planning, team formation, staff selection, skill improvement, business appraisal, design and monitoring of work schedules, risk management and establishment of appropriate reward structures are all likely to feature in farm management towards 2025. Many of these skills are taught in the humanities rather than technical disciplines. A challenge for many farmers will be to anticipate their changing role and to then gradually equip themselves with the necessary training and skills to facilitate their farm management.

A colleague in Perth says of farm management that some farmers need to spend more time working *on* their business rather than working *in* their business. The implication is that some farmers would benefit from spending less time doing paddock-based farm work and spending more time in their farm offices undertaking tasks such as analysing their farm performance, planning and understanding the fundamental sources of profit for their business. The farmer in 2025 is increasingly likely to be involved in planning, organising and monitoring the performance of their farm business.

A majority of broadacre farmers in the future are likely to be third or more generation farmers, many with relatively high wealth and high equity in their businesses. Whereas during the 20th century the twin problems of low income and low equity triggered forced periods of structural adjustment, in the 21st century the trigger to adjustment may increasingly be based on lifestyle and family considerations. The challenge for many farm businesses will be maintaining the growth and profitability of their farm businesses while generating lifestyle benefits for the farm family.

The wealth of farm businesses will become a disincentive to governments for many forms of direct assistance to farmers in the future. Increasingly governments will look to wider public benefits from the allocation of taxpayer dollars to the farm sector. A challenge for farm managers will be to develop self-reliant risk management strategies rather than hoping for

access to government assistance. Increasingly, agricultural industries and regions will need to demonstrate how the government funds they receive are generating worthwhile public benefits.

If the mooted changes towards 2025 do unfold, are there also implications for farm management advisers and researchers? The complex nature of farm management in the future may mean that the demand from farmers for specialist and integrative advice will increase. As the variety of crops and animals, methods of enterprise management and market opportunities available to farmers becomes increasingly diverse, many farmers will seek a range of advisory services. Consultancy firms probably will offer an increasing array of client services based on specialists and integrators.

Many advisers will need to invest frequently in updating their knowledge and skills to remain competitive and relevant to their clients' needs. A standard competency for advisers will be skill in the use of information and communication technology.

If the trend of a real decline in public funds for agricultural R,D&E continues (Persley 1998) then public sector farm management advisers and researchers will find reduced job opportunities in the public sector. Increasingly their work agendas may lie in the private sector or be derived from either public benefit tests or from the requirements of non-government funding partners.

Due to the larger portfolio of enterprise and management options available towards 2025 there will not be a shortage of farm management problems and issues to investigate. Rather the problem will be that farm management researchers will not be able to maintain the depth and breadth of skills and knowledge required to promptly address many farm management issues. Increasingly farm management researchers will need collaboration from a range of disciplines to ensure their work is relevant.

In response to the diversity of issues, some farm management researchers may opt for specialisation in niche areas such as biotechnology, price risk management, financial planning, farm taxation or business and management structures. Towards 2025 farm management research will investigate topics currently emerging such as marrying farm and environmental management and incentive systems, or the role of biotechnology in designing new farming systems; and no doubt there will be topics about which none of us here has an inkling!

Cautionary Note

Developing forecasts, particularly medium or long-term forecasts for agricultural industries, is known to be difficult (Godden 1999, Freebairn 1975). Freebairn showed that formal forecasting models of Australian agriculture at the time were no better than naïve forecasts for providing accurate price and quantity predictions.

Technical innovation, pest and disease, policy and market changes are often difficult to predict. For example, Perry *et al* (1980) when speculating about broadacre farming in the 1980s pointed to a bold future of grass-free pastures and grassweed-free crops made possible by herbicides. There was no mention of weeds developing resistance to herbicides. Nelson

(1995) predicted the area of narrow-leaf lupin in Western Australia would further expand to 1.5 million hectares by the year 2000. However, the area actually reduced to be around a million hectares due mostly to the unforeseen introduction of the disease anthracnose in 1996. Another example of forecast error is the failure to anticipate the collapse of wool profitability in the 1990s. Richardson (1989) in a broad review of the wool industry suggested, like many others, that 'The wool industry is presently in a sound phase of growth and could perhaps be said to be one of the main growth industries in Australia.' (p.13); yet collapse in wool profits was under two years away. Few market and country analysts predicted the rapid economic downturn in several Asian economies in the 1990s. Yet this downturn affected the cattle and wool industries in Australia. Disease and pest outbreaks (e.g. cereal rust, Newscastle's disease, anthracnose, locusts, foot and mouth disease) and weather or climate events (frosts, flooding, prolonged drought) are difficult to predict yet can have pronounced effects on agricultural industries and market opportunities.

Hence, strong caution is merited when making judgements about what will be the future of farm management. The comments in this paper are best viewed as a set of possibilities. Just as happened to the folk in Summit County Ohio, history will reveal if I am wide of the mark or closer to the money.

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