# Assessing the costs and benefits of computers and internet use by landholders in Central Queensland

John Rolfe *
Shirley Gregor**
Don Menzies#

**Paper presented at the 46th Annual Conference of the Australian Agricultural and Resource Economics Society**

**13th – 15th February 2002**
**Rydges Lakeside Hotel**
**Canberra, Australian Capital Territory**

* Faculty of Business and Law, Central Queensland University, Emerald QLD 4720
** School of Business and Information Management, Australian National University, Canberra, 0200.
# Capgrains Cooperative, Rockhampton, 4700.

Abstract.

Landholders in rural Australia are increasing their use of computers and the internet. In part, this is because of the increased availability of hardware, software and communications infrastructure at reasonable cost. However, it is unclear what all the costs and benefits of adopting a new technology are. It may be that the primary benefits are simply cost reduction; for example the time saved in financial bookkeeping. Other reasons might include potential gains to production, keeping pace with regulatory and other external changes, or improved marketing opportunities. It is also unclear whether landholders adopt the technology for short-term returns or view it more as a longer term investment. These issues are explored in relation to the grains and beef industries of the Central Queensland region.

Keywords: computing, internet, agriculture

## 1. Introduction.

The growth in the United States economy over the past decade can be partly explained through the contribution of information technology (Oliner vand Sichel 2000, Jorgenson 2001, Baily and Lawrence 2001). Advances have occurred through improved productivity (particularly in the services sector), and changes in the labour and capital markets. These advances occur in part because of the integration of computing hardware and software into production processes, (allowing greater productivity and better use of labour and capital), the development of new services and products (including the internet), and the improved linkages between businesses and consumers (including ecommerce).

While there is good evidence to claim that the United States economy can be classified as an e-economy (Baily and Lawrence 2001), it is much harder to predict the continued rate of change and growth (Oliner and Sichel 2000, Litan and Rivin 2001). The internet stocks bubble, and the following Dot.Com bust show that expectations about the contributions and growth of the IT sector became unrealistic. However, the underlying contribution of information technology remains.

Market forces, global trading patterns and open economies mean that economic development in Australia follows a similar path to the United States. It would be expected that information technology has made a significant contribution to the Australian economy, and help to explain continued high levels of growth over the past decade. There are many indicators which suggest that the level of penetration of information technology is broadly similar between Australia and the United States (NOIE 2000).

Agriculture is a forgotten sector in the debate about the contribution of information technology to economic growth. For example, most studies of productivity changes in an economy focus on the non-farm sector (Oliner and Sichel 2000, Brynjolfsson and Hitt 2000). Because information technology applications allow not just direct productivity changes, but also organisational changes, marketing and consumer relationship changes, and better control over supply chain management, the greatest benefits from adoption of information technology have tended to be at the manufacturing and service industry levels (Brynjolfsson and Hitt 2000). Agriculture, firmly in the primary industry sector, is generally assumed to have fewer gains to make from information technology.

However, the use of information technology by agriculture is rapidly expanding. In the United States, Just and Just (2001) report that the proportion of farmers who had access to the internet had risen from 13% in 1997 to 29% in 1999. By June 2000, 58% of Australian farms had computer access and 34% had internet access (ABS 1999-2000). However, not all farmers use the access for productive purposes. Mueller (2001) reports that in Germany, 78% of commercial farmers with internet access use it for electronic banking, while 28% use it to purchase goods, and 19% use it for selling goods.

Farmers are notoriously conservative and cautious with new technology. The high rates of takeup indicate that a much larger group than the advanced innovators is coming to grips with the new technology. This suggests that farmers are gaining real benefits from using information technology, and they judge the benefits to be greater than the costs of time, money and frustration involved in getting to grips with a new technology. However, there has been little work to identify and quantify these benefits and costs.

Identifying why farmers in Australia takeup information technology is important for two reasons. The first is that if productivity can be improved from using information technology, this might be an important way of achieving further growth in agriculture. Determining where opportunities lie for productivity gains, how they might be achieved, and what are the barriers and triggers for takeup of information technology are important questions related to this issue.

The second issue is about the net benefits that might be expected from adopting information technology. There is a large political debate in Australia about the provision of appropriate information technology services to rural and regional areas, and the appropriate level of public funding (Government expenditure), quasi-public funding (community service obligations by telecommunications providers) and private funding. Estimates of the level of benefits and costs will be important to help provide information about the likely demand for information technology services, and the efficient use of public funding.

These goals are not easily achievable. First, measurement of e-commerce and e-business activities and information technology contributions are very difficult (Fraumeni 2001). Most national statistics are collected on an industry basis, and do not identify the contribution of particular components. It is difficult to identify transactions that occurred electronically, or to apportion actions and transactions that have an electronic component.

Second, many of the benefits and costs relating to information technology are not priced in markets. Non-priced benefits range from many free products available on the internet to the social benefits in isolated areas of gaining email access. Non-priced costs include the additional time spent on solving problems, and the potential for harmful events like virus infections or data loss.

These issues are explored in this paper in relation to the benefits and costs that agricultural producers in Central Queensland are gaining from information technology. The paper is organised in the following way. In the next section, some evidence of the takeup of information technology in rural areas is presented, and an overview of the expected benefits and costs of using information technology is given in section three. The outline and application of a survey of Central Queensland farmers and graziers is given in section four, and survey results and discussion follows in section five. Final conclusions are drawn in section six.

## 2. The takeup of information technology in rural areas.

Australia is one of the leading nations in the world in terms of number of people accessing the internet, and the rate of takeup remains very high. In May 2000, it was estimated that 41% of its population had access to the internet, with usage rates among males (55%) being higher than females (45%) (NOIE 2000). In *The Current State of Play*, which provides a snapshot of internet related activity in the country (NOIE 2000), it is reported that the percentage of small businesses online increased from 48% to 60% between February 1999 and February 2000. Internet banking and online bill payment increased by 810% between May 1998 and May 2000.

While rates of computer and internet penetration are highest in urban areas, there have also been significant rates of growth in rural and regional areas. By February 2000, it was estimated that all medium sized businesses and 84% of small businesses owned at least one computer. When that data is broken up between city and regional areas, the rates of ownership are 87% and 80% respectively. In comparison, specific rural industries have much lower rates of computer ownership. By March 1999, approximately 12% of beef properties and 18% of grain properties across the nation used a computer (NOIE 2000).

The proportion of farms in Australia with computers rose from 40% to 58% between March 1998 and June 2000 (see Table 1). Internet access rose from 11% to 34% over the same time period, with a 91% increase in access between March 1999 and June 2000 (see Table 2). Queensland was third lowest in terms of proportion of farms with a computer, and second lowest in terms of proportion of farms with access to the internet. While these rates of takeup are very high, rates of computer ownership and internet access still lag behind small business (NOIE 2000, Rolfe 2001).

The grains, sheep and beef sector reported both the lowest proportion of computer use (55%), and the lowest proportion of farms using the internet (31%) (ABS 1999-2000). There was a strong relationship between farm size (as measured by value of turnoff), and the use of the computer and internet (ABS 1999-2000). Groves and Da Rin (1999) report claims that farm users of the Internet actually use it for longer periods than do the general population. One estimate reported was that Farmwide participants used online services for 10 hours per month, compared to approximately 6 hours per month for metropolitan users[1].

The adoption of the internet in agriculture appears to have occurred slightly faster in the United States. Just and Just (2001) report that only 13% of farmers had access in 1997, rising to 29% in 1999. Computer access rose from 38% to 47% over the same time period, indicating that Australian farmers may have been slightly ahead in takeup in this area. Like Australia, computer ownership and internet access in the United States is closely related to the value of farm production. Larger farms in the United States with gross sales of more than $100,000 had approximately double the computer use and internet access of farms with incomes between $10,000 and $100,000 (Just and Just 2001).

**Table 1 Farms using a computer, by State/Territory**

| | March 1998 | | March 1999 | | June 2000 | |
|---|---|---|---|---|---|---|
| | Farms using a computer | | Farms using a computer | | Farms using a computer | |
| | No. | % | No. | % | No. | % |
| New South Wales | 16,934 | 40 | 21,545 | 49 | 23,028 | 53 |
| Victoria | 13,538 | 37 | 18,075 | 49 | 21,549 | 58 |
| Queensland | 11,311 | 37 | 13,870 | 45 | 17,841 | 58 |
| South Australia | 6,795 | 43 | 8,361 | 53 | 10,180 | 64 |
| Western Australia | 6,850 | 49 | 8,270 | 59 | 9,466 | 68 |
| Tasmania | 1,608 | 36 | 2,186 | 49 | 2,507 | 57 |
| Northern Territory | 196 | 52 | 241 | 65 | 260 | 71 |
| Australian Capital T. | 58 | 55 | 66 | 64 | 67 | 70 |
| **Australia** | **57,290** | **40** | **72,615** | **49** | **84,898** | **58** |

Source: ABS (1999-2000).

[1] See http://farmwide.com.au/community/AboutUS/Progress/update3.html

**Table 2. Farms using the internet, by State/Territory**

| | March 1998 | | March 1999 | | June 2000 | |
|---|---|---|---|---|---|---|
| | Farms using the internet | | Farms using the internet | | Farms using the internet | |
| | No. | % | No. | % | No. | % |
| New South Wales | 5,006 | 12 | 8,231 | 19 | 13,596 | 31 |
| Victoria | 3,621 | 10 | 6,174 | 17 | 12,270 | 33 |
| Queensland | 3,075 | 10 | 4,830 | 16 | 9,811 | 32 |
| South Australia | 1,896 | 12 | 3,030 | 19 | 6,442 | 40 |
| Western Australia | 1,428 | 10 | 2,548 | 18 | 5,621 | 40 |
| Tasmania | 552 | 12 | 973 | 22 | 1,539 | 35 |
| Northern Territory | 81 | 22 | 114 | 31 | 180 | 49 |
| Australian Capital T. | 21 | 20 | 27 | 26 | 40 | 42 |
| **Australia** | **15,680** | **11** | **25,927** | **18** | **49,499** | **34** |

Source: ABS (1999-2000).

Research summarised by Groves and Da Rin (1999) indicates that Australian farmers use the internet more for business purposes than do the general population of internet users.

> *While 68% of general household Internet use is mainly for "personal" purposes, with only 26% for "work" purposes, 90% of respondents to an online survey conducted for the* ***Demand for and Supply of Internet Content for Australian Farm Businesses*** *claimed that they used the Internet for farm business purposes "frequently", compared with 50% for social purposes, 34% for recreational/cultural purposes, and 47% for education and training purposes* (Groves and Da Rin 1999:4).

The results are partially explained by combining recreational and business activities at the one location, while metropolitan users tend to also access the internet from their educational or business workplace. However, it still appears that for rural people, the primary reason for accessing the internet is work rather than pleasure (Groves and Da Rin 1994).

Many users of the internet appear to be accessing it to gain information, and only a small proportion are using it to purchase goods and services. Groves and Da Rin (1994) estimate that internet commerce was responsible for less than 0.0002% of all expenditure by rural and regional residents in 1996, and could potentially rise to be 0.2% by 2000. Other important activities include education and training activities, access to services (such as electronic banking), and social and recreational activities. Using the internet for selling or teleworking appear less important at this stage for rural industries.

The rate of computer and internet takeup indicate that farmers perceive real benefits in adopting information technology. Yet as a primary industry, agriculture appears to have limited possibilities to use information technology to increase economic outputs. This raises questions about whether the benefits of information technology adoption will be small in this sector, with corresponding implications for the rate and extent of the takeup. To explore these issues, the potential benefits and costs of adopting information technology are explored next.

## 3. The benefits and costs of adopting information technology

There are a number of benefits that farmers and graziers can expect to gain from access to information technology. For convenience, these can be separated into two main areas. The first reflects a focus on cost reduction, where computers and internet access are used to automate tasks and reduce operating costs. In this case, the key benefits of adopting information technology

flow from cost savings. The second area relates to benefits that farmers and graziers might gain from encouraging innovation. Under this scenario, information technology allows and encourages new ways of doing things, stimulating additional productivity. In this case, the benefits of adoption come from increased productivity, rather than from cost reduction. Here, the case for each of these possibilities is examined in more detail.

*Information technology and cost reduction in agriculture*

The initial focus of using computer hardware and software in agricultural enterprises is usually in the field of accountancy and budgeting. This was the dominant application for computers in the beef industry in the late 1990s (Martin et al 1998). Some benefits here come in the form of reduced inputs, as computing resources are used to replace labour and accountancy fees. Computers are also replacing manual processes for data entry and storage (Frisvold 2000), as the retrieval process is much more efficient when mechanised. Word processing is also an important use, and fax machines are now commonplace.

These uses represent slightly more efficient ways of carrying out previous functions. In the same way, weather forecasts and commodity prices are easily accessible on the internet, but this simply represents another way of getting information that is already widely available. While these improvements in information technology may be welcomed by the agricultural sector because of convenience and time saving, they will do little to generate production increases by themselves.

Improved communication technology is reducing transaction costs in areas such banking, stockbroking, and supply chain management. There are many examples, such as electronic banking, where primary producers now have better and cheaper communication services, with improved efficiencies as a result. There have also been suggestions that improved communication would improve the marketing of products by cutting out middle marketers and reducing costs (Mueller 2001). Here, the benefits of e-commerce are that more direct links can be established between producers and consumers, and the producers can pick up the gains from the reduced marketing costs. However, these potential gains from direct marketing remain largely unfulfilled, mostly because intermediate links in the marketing chain provide very real services that are difficult to replicate (Mueller 2001, Williams 2001).

*Information technology and direct productivity gains in agriculture*

Adoption of information technology impacts may lead to direct production gains, as opposed to reductions in operating costs. There are several areas where this might happen, including:

- Better retrieval and evaluation of available data for management purposes,
- Development of management decisions support systems,
- Development of processes for quality assurance and external regulatory requirements,
- Better links to remote sensing and geographic information systems (GIS) data,
- Better links to technical and other information,
- Better links to agricultural suppliers,
- More direct feedback from customers and consumers,
- Improved supply chain management,
- Opportunities for marketing and other networks to emerge.

Frisvold (2000) suggests that the next decade will see the growing use of GIS data, increasingly detailed farm-level record keeping, and increased reporting requirements for items like chemical use. Satellite and GIS applications are already emerging in Australia. Pyper (2001) describes a

pilot study in Western Australia where satellite images are used by woolgrowers to predict pasture biomass and pasture growth rates. This information can assist management decisions such as grazing rotations, feed budgeting, fertiliser applications and other 'precision farming' techniques.

There are already many examples where improved data sets are being used to improve management in areas such as fertiliser application and water use efficiency. In many cases, such as the development of Breed Plan, the availability of data is coupled with decision support systems to improve cattle selection on specific traits. Other decision support systems that have been developed involve climate predictions and rainfall probabilities.

A key benefit of access to the internet is the increased supply of information to farmers. Information takes many forms, including those relating to production, farm inputs and machinery, and identification of buyers, sellers and favourable contracts (Just and Just 2001). It is likely that the internet will transform the farm input supply sector in particular, and the output marketing sector as well. Farmers will have the possibility to use the internet to learn about and buy about a wide range of inputs, to search for lower costs, and to order directly from manufacturers. In these cases, use of the internet will reduce spending through local and regional suppliers, but should make rural producers more profitable.

Information by itself quickly results in overload. It is the decision support systems to make use of the information that is important. In some cases these are achieved through people development, eg training staff to make the best use of available data. The real gains are to be made in the development of improved decision support software. Just and Just (2001) hypothesise that the learning and investment involved in using such software explains why computer and internet usage is so much higher on larger farms. As decision support software becomes more available and successful in micro management, it may offer even greater economies of scale to larger farms, and allow further amalgamation of farms and development of corporate farming.

Better links to agricultural suppliers is likely to occur through reverse flows of information (Just and Just 2001). This is when suppliers are able to track farmers who explore their sites, and by building up profiles of their customers, target products and advertising directly. There are economies of scale in profiling customers this way, suggesting that it is the larger suppliers that will be dominant.

The internet may also help farmers to market their produce more effectively. Better information will allow some producers to diversify and market niche products directly to customers. Information will help producers of bulk commodities like grains to match supply with demand better, and to insure against fluctuations in commodity prices. Information technology allows growers to form alliances more easily for marketing their product. It also allows for closer integration of supply chains through the improved flow of information, establishment of quality assurance programs, and closer links between market players (Salin 2000, Kinsey 2000).

Agrifood supply chains are expected to undergo further structural changes as information technology and electronic commerce advances impact (Buhr 2000). Particular benefits are likely to occur with electronic identification and information systems, which allow identification and traceback to occur across vertical levels. Some of the key issues relating to this are the role of standardisation in improving market efficiency, the lowering of barriers to entry, and the potential uses of standardised information for cooperative planning, forecasting and replenishment in the supply line (Kinsey 2000). However, the fragmented nature of cattle-beef supply chains, and the

inexperience of players with information technology led Salin (2000) to conclude that full efficiencies of information systems are unlikely to be immediately available in that sector.

*Information technology and indirect productivity gains*

While computers are useful in replacing labour for mechanical calculations, these are not the primary purpose of computers in most business applications in the non-farm sector. Computers, when aligned with other elements of information technology, can be broadly applied to reduce the costs of coordination, communication, and information processing (Brynjolfsson and Hitt 2000). Because these are such integral parts of business production systems in a modern economy, improvements here stimulate wider economic restructuring. Here the arguments about information technology driving gains in innovation in the non-farm sector are analysed. These are then related to potential gains in agriculture.

From an innovation perspective, the real gains with information technology come from business managers finding new processes and organisational structures that employ the new technology in different ways. These encompass changes in the way that firms communicate within the organisation (hence the opportunities to change structure), between other businesses (changes in the way that supplies are sourced), and between customers. Just as the steam engine, the electric motor and the telegraph each transformed economies by changing the form, location, and pattern of production, so does information technology allow innovation to be the key to productivity gains (Brynjolfsson and Hitt 2000). Business investments in information technology do not simply generate normal rates of return, but allow much greater productivity gains to be made.

The search for empirical relationships between adoption of information technology and changes in productivity took some time to produce results. Up to the 1990s, it was difficult to identify relationships between takeup of information technology and productivity. After that point though, much more concrete evidence has been found that information technology is generating real gains (Oliner and Sichel 2000). One explanation for this long lead time is that investment in information technology entails corresponding investment in some intangible items such as staff training, building up a database, software development, organisational restructure and designing new processes (Byrnjolfsson and Hitt 2000). It is only when these have been completed that the net productivity gains and profits will emerge.

Another explanation of the delays in productivity gains is that it takes business managers some time to find innovative ways of using the new technology within their business and market setting. A further explanation is that there is some threshhold level of investment in information technology before enough capital stock and expertise develops within a firm to generate productivity gains.

Some lessons for agriculture can be drawn from this brief overview. First, the real gains from information technology may not be in automating existing mundane tasks, but in encouraging innovation to occur.

Where agricultural businesses involve coordination, communication, and information processing tasks, the opportunities for using information technology will be high. Second, there is often a considerable lead time between investment in information technology and real productivity gains. The size of the investment in computing, the extent to which it is integrated into operations, and the ability of managers to create new production and management opportunities are all indications of potential productivity gains.

It is not always apparent how applicable these lessons are for agriculture. Most operations are run as family farms, so communication needs are simple. The complexities come from variabilities in weather and natural processes, rather than from trying to coordinate complex inputs and outputs. Much of the information that is used in farming is an amalgam of personal observation, inherited knowledge, advice from peers and technical advice, rather than information that has been collected scientifically. In addition, coordination, communication and information needs are probably a much smaller proportion of effort in agricultural enterprises than for businesses involved in the secondary and tertiary sectors. It is with these ambiguities in mind that we turn to identifying the costs and benefits of using information technology in agriculture.

## 4. The design and application of the survey instrument.

The purpose of the research was to identify what the key benefits and costs of adopting information technology were for beef and grain growers in the Central Queensland region. These are the dominant land uses in that region. Other primary industries such as irrigation, mining and forestry, and other land uses such as national parks, occupy only a small proportion of the land mass. In line with the national data (ABS 1999-2000, NOIE 2000) the beef and grain producers of the region would be expected to have low takeup rates of information technology relative to other agricultural sectors.

The key hypothesis to address was whether adoption of computers and internet use was providing more benefits in the form of reduced operating costs (including non-financial ones), or in the form of increasing productivity. The latter might occur in several ways, through items such as better management, improved application of technology, or new opportunities for marketing. To test the hypothesis, producers were asked to rank, in turn, how important computers and internet usage were to their business. These rankings could then be tested against other variables collected in order to determine whether it was the cost reduction or the productivity enhancing activities that were significant in explaining the rankings.

The background information reviewed above was used to identify key variables that might explain choices about takeup and adoption of information technology and predict the net benefits that landholders perceived. Data was collected through a survey designed by the researchers with help from other participants in the research project[2]. Respondents were generally asked to indicate their answers in Likert scale type of responses. Respondents rated their use or the usefulness of an item in five categories, ranging from "very low" to "very high". There were also opt-out options reflecting "don't use" and "don't know" alternatives. For the dependant variables, where respondents were asked to rate the value of computer use/Internet use to their business, the response scale varied from "very low" to "very high".

This ordinal data is more difficult to use and analyse than is corresponding metric data. However, it was important to frame the questions in ratings or general response ways because respondents typically have no precise information about the benefits and costs of information technology usage. Forcing respondents to make choices in terms of the 'value of activity 1 versus the value of activity 2' would have been unrealistic, difficult to comprehend, and likely to produce biased results. In order to encourage participation and minimise the cognitive burden on respondents, most questions were framed with these Likert scale intervals, where respondents could tick the category that best suited their operation.

[2] A copy of the survey is available on request from the researchers.

In the survey, respondents were asked a series of questions about their use of computers and the internet, as well for information about their enterprise, and some demographic information. The key questions were about how they rated the value of computer use and internet use in their business according to a number of factors such as use of accountancy records and use of online banking. They were also asked questions about what influenced their decision to gain access to the internet, what were some of their security concerns, what support they accessed, and some attitudinal questions. Respondents were asked to quantify if possible the ways in which the internet helped their business (eg dollars saved in purchases). A list of the key variables for which responses were collected is summarised in Table 1.

**Table 1. Key variables collected in survey**

| Variable | Description | Coded |
|---|---|---|
| Electronic equipment | Links to computer for production | 0,1 |
| Use per week | No of days used each week | 1,2,4,7 |
| Time spent on computer | Increase in use over past 5 years | 1 – 4 |
| Accountancy records | Value of computer use | 1 – 5 |
| Production/property records | Value of computer use | 1 – 5 |
| Budgeting | Value of computer use | 1 – 5 |
| Forward planning | Value of computer use | 1 – 5 |
| Word processing | Value of computer use | 1 – 5 |
| Value of computer use | Value to organisation | 1 – 5 |
| Use of the internet | | 0, 1 |
| Email | Value of internet use | 1 – 5 |
| Weather | Value of internet use | 1 – 5 |
| Technical notes | Value of internet use | 1 – 5 |
| Market information | Value of internet use | 1 – 5 |
| Education and training | Value of internet use | 1 – 5 |
| On-line banking | Value of internet use | 1 – 5 |
| Social and recreation | Value of internet use | 1 – 5 |
| Buying goods | Value of internet use | 1 – 5 |
| Selling goods | Value of internet use | 1 – 5 |
| Own website | Value of internet use | 1 – 5 |
| Teleworking | Value of internet use | 1 – 5 |
| Feedback on product | Value of internet use | 1 – 5 |
| Shares and investments | Value of internet use | 1 – 5 |
| Value of internet | Value to organisation | 1 – 5 |
| Better information | Reasons for using the internet | 1 - 5 |
| Reduced paperwork | Reasons for using the internet | 1 - 5 |
| Improved customer service | Reasons for using the internet | 1 - 5 |
| Faster for goods in | Reasons for using the internet | 1 - 5 |
| Better inventory control | Reasons for using the internet | 1 - 5 |
| Reduced costs of operation | Reasons for using the internet | 1 - 5 |
| Differentiation of services | Reasons for using the internet | 1 - 5 |
| Improved competitive advantage | Reasons for using the internet | 1 - 5 |
| Help from software suppliers | Support for computer and internet use | 1 - 5 |
| Help from internet service provider | Support for computer and internet use | 1 - 5 |
| Govt funding for training | Support for computer and internet use | 1 - 5 |
| Significance of financial costs | Cost of computer, internet access and other resources for business | 1 - 5 |

The list of potential respondents in central Queensland was compiled from several sources. These comprised lists of members of a grains cooperative (Capgrains Co-operative) and a beef marketing cooperative (Bluegum Beef), and lists of grains and beef producers supplied by the Department of Primary Industries (DPI). The DPI beef producers were taken from the Qld Tail Tag directory using the region of Central Queensland and could include any producer with greater than 11 head.

The DPI grains producers were supplied by a DPI grain Extension Officer and were sourced from a list of producers subscribing to a DPI grains newsletter.

Potential respondents were selected at random from the lists, once duplicate entries had been removed. The following break-up reflects the source of the 197 respondents selected for the survey.

- DPI Beef List – 58 producers used (~50% of original list)
- DPI Grains List – 53 producers used (~75% of original list)
- Bluegum List – 40 producers used (~80% of original list)
- Capgrains List – 46 producers used (~66% of original list).

The survey was collected through a mail-out/telephone response format. All surveys were mailed out in batches of 20 per week from October to December 2001. Respondents were contacted by telephone in the following week and asked if they would like to participate. Respondents could either complete the forms in their own time and return them by post, or could give the answers to the interviewer over the telephone. One of the researcher (Menzies) and a research assistant performed the mailout and the telephone interviews.

By January 2002, 75 responses had been received from 197 surveys issued. There were another 8% of respondents who indicated that they did not own a computer and that the survey was not relevant to them, giving an overall response rate of 46%.

## 5. Results and analysis

The responses to the survey indicated generally that computer usage and internet access was important for business purposes. The involvement of respondents in the different sectors is summarised in the table below. The off-farm income relates to the use of property assets for other purposes (eg farm tourism), while Other income usually refers to people working part-time or full-time off the farm or property.

Fifteen respondents indicated that their time spent on a computer had increased slightly over the past five years, while 47 respondents (64%) indicated that their time commitment had increased significantly. Only 5 respondents indicated that their time commitment had stayed the same or declined. 21 respondents (28%) indicated that they were linking their computer to other technology, such as water scheduling equipment.

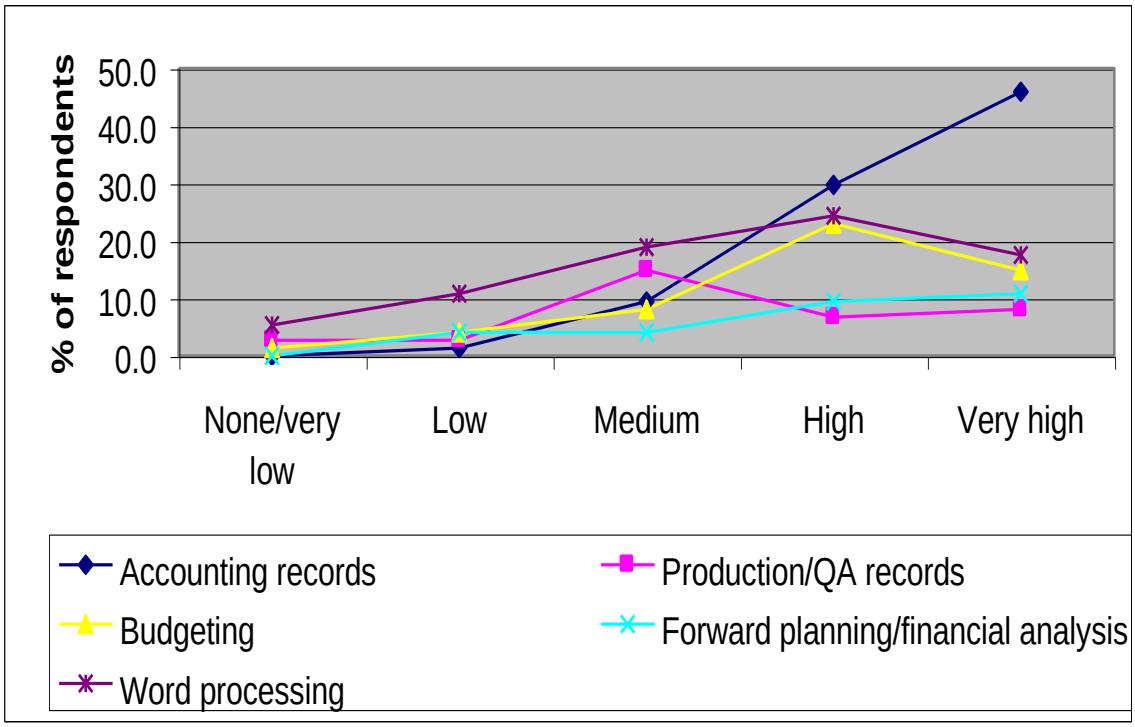
**Table 2. Responses by enterprise type.**

| Involvement with enterprise | Number of respondents | % of respondents |
|---|---|---|
| Cattle | 58 | 78.4 |
| Grains | 35 | 47.3 |
| Sheep | 0 | 0 |
| Cotton | 7 | 9.5 |
| Off – farm | 5 | 6.8 |
| Other income | 18 | 24.3 |

Respondents were asked to rate some of the software that they might be using for certain functions. The results, summarised in Figure 1, show that accountancy packages receive very high ratings. It is clear that almost all computer users are using their computer for some form of

record keeping. There is also widespread involvement with budgeting and word processing, and much more limited involvement with production records and scenario planning.

**Figure 1. Ratings given for value of different categories of computer use**




Respondents to the survey were asked to rate the value of both computer use and internet use to their organisation. The number of responses given to each rating category are summarised below in Table 3. It is clear that the majority of respondents rate the value of computer use highly in their business. This suggests that computer usage generates real value, either in the cost savings or productivity gains area. Value for internet usage also rated highly, but not to the same extent of computer usage. This suggests that internet usage does not generate nearly as much value as computer usage[3].

**Table 3. Ratings given for value of computer and internet usage.**

| | Very low | Low | Medium | High | Very high |
|---|---|---|---|---|---|
| Value of computer use | 1 | 5 | 9 | 24 | 30 |
| Value of internet use | 9 | 5 | 16 | 23 | 9 |

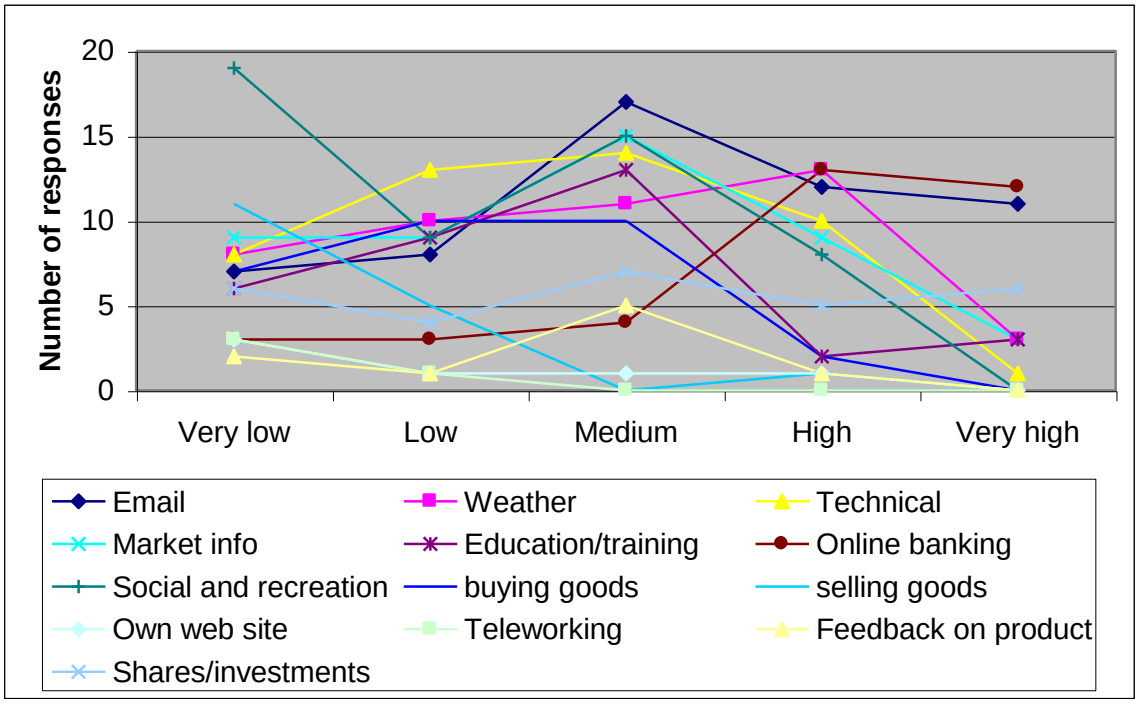
Respondents were also asked to rate the value of internet usage for different purposes. The responses are summarised in Figure 2 and Table 4. The use of email and electronic banking rated highly in value, followed by weather information, technical information, market information and social and recreational uses.

[3] Respondents to the value of computer usage question may have also incorporated their values for internet usage within their response.

**Table 4. Ratings given for value of different categories of internet use.**

| | Very low | Low | Medium | High | Very high |
|---|---|---|---|---|---|
| Email | 7 | 8 | 17 | 12 | 11 |
| Weather | 8 | 10 | 11 | 13 | 3 |
| Technical | 8 | 13 | 14 | 10 | 1 |
| Market info | 9 | 9 | 15 | 9 | 3 |
| Education/training | 6 | 9 | 13 | 2 | 3 |
| Online banking | 3 | 3 | 4 | 13 | 12 |
| Social and recreation | 19 | 9 | 15 | 8 | 0 |
| buying goods | 7 | 10 | 10 | 2 | 0 |
| selling goods | 11 | 5 | 0 | 1 | 0 |
| Own web site | 3 | 1 | 1 | 1 | 0 |
| Teleworking | 3 | 1 | 0 | 0 | 0 |
| Feedback on product | 2 | 1 | 5 | 1 | 0 |
| Shares/investments | 6 | 4 | 7 | 5 | 6 |

**Figure 2. Ratings given for value of different categories of internet use**

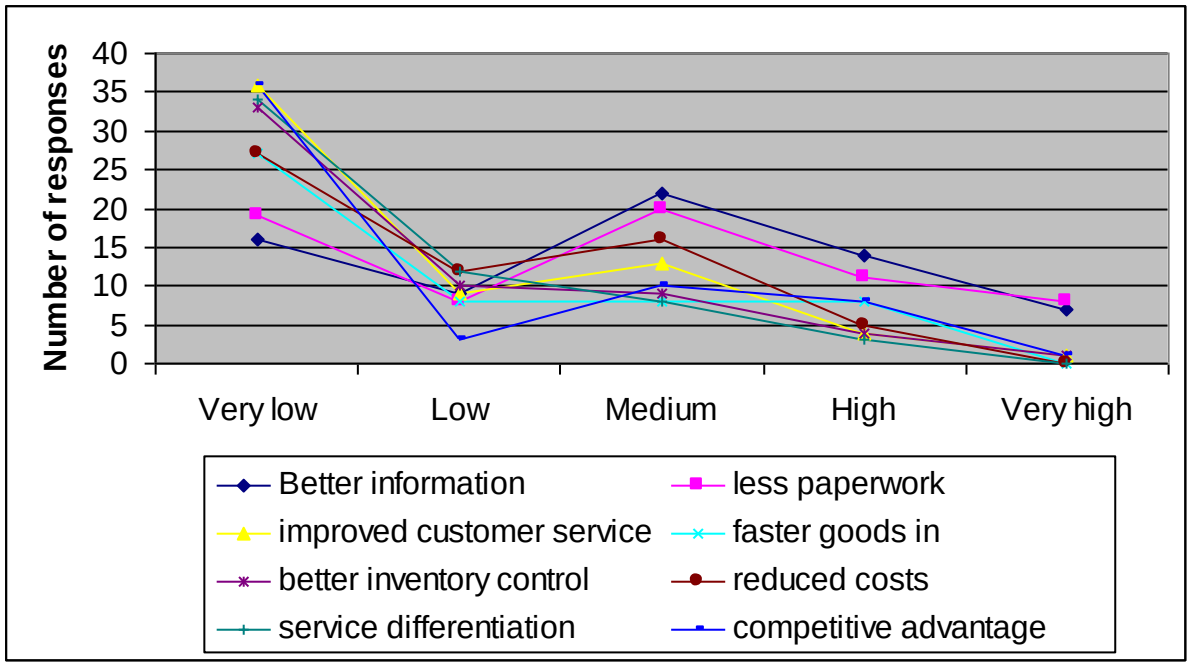



Respondents were also asked to rate their perceptions about different reasons for using the internet. The results (see Table 6 and Figure 3) show that the majority of respondents viewed the internet as achieving low value for them. Reasons for use that achieved the highest values were *more timely and better information for decision making*, and *greater clerical efficiency (less paperwork*). There was little support for the internet helping to improve service, control inventories, reduce costs, or differentiate services, and only modest support for the internet helping to improve response time for goods ordered, or to improve competitive advantage.

**Table 6. Ratings given for value of different purposes of internet use**

| | Very low | Low | Medium | High | Very high |
|---|---|---|---|---|---|
| better information | 16 | 9 | 22 | 14 | 7 |
| less paperwork | 19 | 8 | 20 | 11 | 8 |
| improved customer service | 36 | 9 | 13 | 4 | 1 |
| faster goods in | 27 | 8 | 8 | 8 | 0 |
| better inventory control | 33 | 10 | 9 | 4 | 1 |
| reduced costs | 27 | 12 | 16 | 5 | 0 |
| service differentiation | 34 | 12 | 8 | 3 | 0 |
| competitive advantage | 36 | 3 | 10 | 8 | 1 |

**Figure 3. Ratings given for value of different purposes of internet use**




In another section of the survey, respondents were asked about the time and dollar savings that might have been gained from access to the internet. Two respondents indicated that they had saved money making purchases over the internet, while one respondent indicated that they had improved their sales results (selling lucerne hay). Eight respondents indicated that they had saved time through internet use, and 14 respondents indicated that they had improved management decisions. By contrast, 35 respondents (47%) indicated that the internet allowed them better information access, especially in relation to weather and market information.

The results allow some general conclusions about computer and internet usage to be drawn. The respondents have generally viewed computers as creating real benefits for their businesses, especially in the areas of financial management, budgeting and word processing. The value of internet usage is not ranked nearly so highly, perhaps because it has simply tended to replace other forms of gaining information about items such as weather forecasts and market prices. The use of the internet and electronic communication for personal and social reasons does not appear

to rank very highly, suggesting that the reasons for investing in information technology generally relate to business purposes.

*Do the benefits of computer usage relate more to cost savings or increased productivity?*

Some information about whether the benefits of computer usage relate more to cost savings than to increases in productivity can be gained from the survey results. It is clear that the time spent on computer use has increased for almost all respondents, with 67% of respondents indicating that their time spent had increased significantly. In comments, many respondents indicated that there were significant time losses in learning to use the computer, and that there were low benefits to be gained. However, it appears likely that in some areas, such as financial accounting, that there is a net savings in time. The use of computers and financial accounting software (principally Quicken and Phoenix packages) would also be expected to save accountancy and other professional fees.

There appears to be a significant group of respondents who are using computers to achieve productivity gains, with 21 respondents indicating that they utilised electronic equipment (such as liveweight scales and water scheduling equipment) in conjunction with their computer. A number of respondents indicated that they were using software (eg Cattle Plus) to track property production, and software (eg Phoenix) to engage in budgeting and forward planning. This information suggests that for these respondents, the value of computer use may come through improved production opportunities.

The survey data generated mostly nominal and ordinal data. For the purpose of hypothesis testing and statistical analysis, the variables of interest, including the dependant variables, were ordinal. This restricts the pool of statistical techniques that may be used to construct relationships between the variables. The key options for determining relationships (apart from non-parametric correlation techniques), are canonical correlation analysis, probit models, and logit models[4]. Canonical correlation analysis is generally seen as a weaker (or last resort) statistical technique than probit or logit models (Hair et al 1998). The size of the data set made it difficult to fit logit models because of the number of categorical variables. This left probit models as the preferred technique for testing the hypothesis.

The probit model was established by creating binary dependent variables for respondent perceptions about the value of computer usage and internet usage to their businesses. Two options were created for each dependent variable. Under the first option, all the 'high' and 'very high' responses were combined into one response ('high value'), and the 'medium', 'low' and 'very low' responses were combined into the other response ('low value'). Under the second option, only the 'very high' responses formed the first value, ('very high"), while the other responses formed the second value ('other').

Under the probit model, choices between one of the two options available are described in terms of significant independent variables. Results of a probit analysis generate a variate of coefficients similar to a multiple regression exercise. A least squares regression exercise is used to generate starting values, and then a bootstrapping procedure used to generate the probit model. Log-likelihood and chi-square statistics (for testing model significance) are also generated.

Two probit models for predicting values for computer use are reported below. In the first model (Table 7), the 'high value' of computer use was significantly related to three variables. If

[4] The latter can be used by identifying the independent variables as categorical.

respondents were generating off-farm income (through activities such as contract harvesting), they were less likely to rate computers as being of high value to their business. Respondents that had high levels of computer use, and used computers for farm budgeting were more likely to rank computers as being of high value.

**Table 7. Probit model modelling 'high value' and 'low value' computer use**

| | Coefficient | Standard Error. | Probability value |
|---|---|---|---|
| Farm generates off-farm income | -1.759 | 0.8212 | 0.032 |
| Days of computer use each week | 0.723 | 0.1609 | 7.03E-06 |
| Using computer for farm budgeting | 0.001 | 0.0004 | 0.001 |
| | | | |
| Restricted Log-likelihood | -36.13 | | |
| Chi-square (degrees of freedom = 2) | 29.46 | | |

In the second model (Table 8), respondents who rated computers as having a 'very high value' for their business were more likely to be doing farm budgeting, value internet usage highly, and source help from software suppliers. They were also less likely to source help from internet service providers (suggesting perhaps that they did not have many access problems).

**Table 8. Probit model modelling 'very high value' and 'other value' computer use**

| | Coefficient | Standard Error. | Probability value |
|---|---|---|---|
| Using computer for farm budgeting | 0.001 | 0.0003 | 0.001 |
| Value of internet usage to farm | 0.129 | 0.0528 | 0.015 |
| Help from software suppliers | 0.128 | 0.0527 | 0.016 |
| Help from internet service provider | -0.128 | 0.0527 | 0.015 |
| | | | |
| Restricted log-likelihood | -47.24 | | |
| Chi-square (degrees of freedom = 3) | 19.45 | | |

It is notable that use of computers for accountancy and financial records purposes does not emerge as an explanatory variable, while budgeting does. Budgeting may be a traditional activity that primary producers have automated with computer use. It may also be a newer management tool that has been more recently adopted with the aid of information technology. Both explanations have some validity, making it difficult to test the hypothesis. However, to the extent that budgeting activities can be associated with new and improved management, it would appear that the benefits of computer use are moving from the cost minimisation phase towards improved management and production phases.

*Do the benefits of internet usage relate more to cost savings or increased productivity?*

Information about whether the benefits of internet usage relate more to cost savings or increased productivity can also be drawn from the survey results. It is clear from the responses to the survey that very few respondents had achieved either reduced costs from purchases in, or increased revenue from sales out as a result of internet use. As well, only a small proportion of respondents indicated that they were achieving time savings through internet use. However, there did appear to be some benefits in terms of improved access to information (which may be related to better management decisions), and access to electronic banking services (which relate to both

management and financial accountancy needs). The latter would also be important in terms of time saving and convenience, as the trips would reduce the number of trips to town and other centers.

**Table 9. Probit model modelling 'high value' and 'low value' internet access**

| | Coeff. | Std.Err. | P-value |
|---|---|---|---|
| Intercept | -7.999 | 3.016 | 0.008 |
| Cattle producer | -2.972 | 1.479 | 0.044 |
| Job off-farm | -3.452 | 1.387 | 0.013 |
| Days/week access internet | 0.725 | 0.291 | 0.013 |
| Value of email usage | 2.414 | 0.875 | 0.006 |
| Value of weather information | -1.521 | 0.566 | 0.007 |
| Value of market information | -0.754 | 0.329 | 0.022 |
| Value information from internet | 1.656 | 0.612 | 0.007 |
| Value less paperwork | 1.060 | 0.465 | 0.023 |
| Faster response time for goods in | 1.953 | 0.699 | 0.005 |
| | | | |
| Restricted log-likelihood | -42.94 | | |
| Chi-square (degrees of freedom = 12) | 61.85 | | |

The results of the 'high value/low value' model indicate that the groups most likely to put a low value on internet use are cattle producers, those with jobs off-farm, and those who want weather and market information. The groups that are most likely to put a high value on internet use are those who access the internet more frequently each week, those who rate email highly, value information services highly, want less paperwork, and want a faster response time for ordering goods in[5].

**Table 10. Probit model modelling 'very high value' and 'other value' internet access**

| | Coeff. | Std.Err. | P-value |
|---|---|---|---|
| Intercept | -15.1794 | 5.11708 | 0.003013 |
| Days/week access internet | 1.33608 | 0.499439 | 0.007469 |
| Value of weather information | -2.90725 | 1.06043 | 0.006114 |
| Value of technical information | 2.81311 | 1.00087 | 0.004944 |
| Value of electronic banking | 1.63008 | 0.64171 | 0.011079 |
| Value of social and recreational use | 0.649792 | 0.373337 | 0.081772 |
| | | | |
| Restricted log-likelihood | -25.68 | | |
| Chi-square (degrees of freedom = 5) | 36.35 | | |

The results of the 'very high/other value' model indicate that respondents with a high value for weather information are less likely to put a high value on internet use. The groups most likely to put a high value on internet use are those with higher rates of access, and those who put a high value on technical information, electronic banking, and social and recreational uses.

[5] There may be some interaction between the *Valuing information from the internet* and the *Weather* and *Market* attributes, which would explain the negative coefficients for the latter.

It appears from these results that the respondents who value internet use highly are those that can be classified as those that wish to improve their efficiency. It is unlikely that high value simply comes from accessing information more easily, such as information about the weather or markets. Actions that save time and effort, such as electronic banking or ordering goods to speed up delivery time, appear to be key components in providing value. The significance of technical information (Table 10) may suggest the importance of internet access in increasing productivity in some businesses, while the importance of social and recreational uses (Table 10) highlight that these values are also important.

## 6.0 Conclusions.

Information technology (including computers and internet access) have helped to transform the non-agricultural sectors of western economies and drive real productivity gains. In recent years, agricultural enterprises have adopted information technology at a high rate, suggesting that agricultural producers are gaining real benefits from employing information technology in their businesses. However, these benefits have been difficult to identify and quantify.

In this paper, survey information from primary producers in central Queensland has been analysed with probit models to identify factors that are associated with perceptions of value for computer use and internet access. The key goal was to identify whether benefits could be associated mainly with the reduction of costs or increases in productivity in agricultural enterprises.

While most enterprises surveyed use computers for financial accounting purposes, this did not emerge as a key explanator of perceptions of value about computer usage. (If it had been a key explanator, it would have suggested that the primary value of computers was in minimising costs). Other factors that were significant in explaining value were the use of budgeting programs, and help from software suppliers. To the extent that budgeting activities can be associated with new and improved management, it would appear that the benefits of computer use are moving from the cost minimisation phase towards improved management and production phases. This will lead to computers being used to achieve production gains.

With regard to internet usage, respondents to the survey were not generally able to identify either cost (or time) savings or production gains resulting from access. However, the statistical analysis did identify that high value ratings for internet access did appear to be associated with the use of technical information, electronic banking, and social and recreational uses. It appears that the value of the internet is not necessarily in replacing other means for sourcing information, such as about the weather. Some value comes from making processes more efficient, as in the use of electronic banking services or ordering goods on-line. Some value comes from providing better access to information (especially technical information).

These results hide a great deal of detail about farm-level benefits that would be identified in specific case studies. There are examples of individual producers who are using information technology in innovative ways to reduce costs, increase production and market their goods more effectively. However, for the group of primary producers surveyed, it remains difficult to quantify accurately the amount of benefit that they gain from using information technology. This research has answered some questions about the types of benefits that are being gained, but many more questions remain.

**Acknowledgements.**

The research reported in this paper has been supported by the Australian Research Council, the Capgrains Cooperative, the Queensland Department of Primary Industries, and the Queensland Department of Innovation and Information Economy.

**References.**

Australian Bureau of Statistics (ABS) 1999-2000 *Use of Information Technology on Farms, Australia,* (Cat. No. 8150.0), Canberra.

Baily, M.N. and Lawrence, R.Z. 2001 "Do we have a new E-conomy", *American Economic Review*, 91(2): 308-312.

Brynjolfsson, E. and Hitt, L.M. 2000 "Beyond computation: Information technology, organizational transformation and business performance", *Journal of Economic Perspectives*, 14(4):23-48.

Buhr, B.L. 2000 "Information technology and changing supply change behaviour: Discussion", *American Journal of Agricultural Economics*, 82(5):1130-1132.

Frisvold, G.B. 2000 "Data, information, and rural environmental policy: What will the next ten years bring?", *Review of Agricultural Economics*, 22(1):237-244.

Fraumeni, B. 2001 "E-commerce: Measurement and measurement issues", *American Economic Review*, 91(2): 318-322.

Groves, J. and Da Rin, J. 1999 *Economic and Social Impacts of Farm Internet Use*, Rural Industries Research and Development Corporation Publication No 99/35, Canberra.

Hair, J.F., Anderson, R.E., Tatham, R.L. and Black, W.C. 1998 *Multivariate Data Analysis (5th ed.)*, Prentice-Hall International, New Jersey.

Jorgenson, D.W. 2001 "Information technology and the U.S. economy", *American Economic Review*, 91(1):1-32.

Just, D.R. and Just, R.E. 2001 "Harnessing the internet for farmers", *Choices*, second quarter 2001: 36-40.

Kinsey, J. 2000 "A faster, leaner, supply chain: New uses of information technology", *American Journal of Agricultural Economics*, 82(5):1123-1129.

Litan, R.E. and Rivlin, A.M. 2001 "Projecting the economic impact of the internet", *American Economic Review*, 91(2): 313-317

Martin, P., Riley, D., Jennings, J., O'Rourke, C. and Toyne, C. 1998 *The Australian Beef Industry 1998*, ABARE Research Report 98.7, Canberra.

National Office for the Information Economy (NOIE) 2000 *The Current State of Play: November 2000*, Canberra.

Mueller, R.A.E. 2001 "E-Commerce and Entrepreneurship in Agricultural Markets", *American Journal of Agricultural Economics*, 83(5):1243-1249.

Oliner, S.D. and Sichel, D.E. 2000 "The resurgence of growth in the late 1990s: Is information technology the story?", *Journal of Economic Perspectives*, 14(4):3-22.

Pyper, W. 2001 "Space-age farming", *Ecos*, 109:20-23.

Rolfe, J.C. 2001 "The Uptake of Information Technology by Businesses in the Central Highlands region of Queensland", in S. Marshall, W. Taylor and X. Yu (eds), *Proceedings of the IT in Regional Areas Conference*, Central Queensland University, Rockhampton.

Salin, V. 2000 "Information technology and cattle-beef supply chains", *American Journal of Agricultural Economics*, 82(5):1105-1111.

Williams, J. 2001 "E-Commerce and the lessons from nineteenth century exchanges", *American Journal of Agricultural Economics*, 85(5):1250-1257.