

Implementing Information System Innovations to Manage Biosecurity Issues in Australian Food NetChains

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Abstract

Tracking and tracing systems are being demanded by customers such as the major Australian supermarket chains, superior food service chains and globally in export markets such as the European Union and Asia. This includes the ability to track products as they move to downstream customers and to traceback where products have been sourced for feedback and to resolve problems. To continue to access these global premium priced markets Australian food organisations need to ensure they meet changing customer requirements.

Traditionally information communication technologies to provide tracking and tracing systems have been set up for larger businesses and industry sectors that warrant the costs of development. Small business cannot always afford to invest in the infrastructure to establish through chain and industry wide netchain based systems. This problem is compounded where businesses are fragmented and spread over large geographical areas even if they have similar requirements.

An action learning approach was taken to identify what is needed in setting up tracking and tracing systems to address biosecurity issues in three small business based netchains (livestock 'A' and fruits 'B' and 'C'). In the livestock 'A' sector fears of a global pandemic has heightened the need for tracking and traceability processes, combined with preventative actions and rigorous bio-security protocols (e.g. traceability of traffic movements around production areas, contaminants from the wild animals and activities on neighbouring properties). For fruit 'B' and 'C' movements of produce across state and national borders requires phytosanitary certification to provide assurance to minimize or eradicate the spread of diseases and pests. Concerns or delays in tracking and tracing can result in perishable produce becoming unsalable.

A system was identified to suit small businesses and those in niche market industries. The system was based on deployment through the internet. The system had to link in with existing business information systems and business methods, be reliable, able to be tailored to address biosecurity issues and effective in meeting customer requirements.

Results presented compare the use of the tracking and tracing system across the three different sectors (animal and horticultural products) and states of Australia. Findings are presented on what was learnt in the process including: identifying business in chains and networks to work collaboratively with; catalysts needed to get commitment to change; and support systems needed for successful implementation across multiple small businesses linked in netchains.

Introduction

Tracking and tracing systems are demanded by customers such as major Australian supermarket chains, superior food service chains and globally in export markets such as the European Union and Asia. This includes the ability to track products as they move to downstream customers and traceback to where products have been sourced for feedback and to resolve problems (Ra, 'bade, and Alfaro 2006, Smyth and Phillips 2002). Three factors are likely to 'influence the demand for tracability: risk assessment and management; product differentiation ; and productivity gains (Canesis 2006). To continue to access global premium priced markets Australian food organisations need to ensure they meet changing customer requirements.

Traditionally information communication technologies to enable tracking and tracing systems have been established for larger businesses and industry sectors that warrant the costs of development. A recent

Australian Department of Agriculture Forestry and Fisheries (DAFF) study by the researchers (Batt, Noonan and Kenyon 2006) identified that small scale efficient technologies are needed by food industry for food safety systems. Small to medium enterprises (SME's) can't always afford to invest in the infrastructure to establish chain and industry wide netchain (horizontal network links between similar organisations as well as vertical chain links with customers and suppliers) systems. This problem is worse where businesses are fragmented and spread over large geographical areas: even if they have similar requirements.

Australia has a strong record in managing biosecurity and quarantine issues (Nairn, Allen, Inglis and Tanner 1996) and has a multiagency / mutli organization focus on maintaining this status. The ability to track and track via a range of mechanisms – electronic and paper based - has historically been a central component of Australia's capacity to maintain such an enviable position of managing biosecurity issues.

The main aims of the research were to set-up and evaluate the use of emerging technology in track and trace systems for several SME based netchains. The research objectives are specifically to:

1. Identify the issues affecting the uptake of tracking & tracing technologies
2. Trial tracking & tracing systems in several industries
3. Evaluate the systems trialed
4. Determine the problems faced in adopting tracking & tracing technologies
5. Identify possible solutions including support needed initially and on an ongoing basis

Research Methods

Identifying Industries, Organisations and Participants

The first step was to identify organisations to participate in the project. They had to be small to medium sized food organisations where perishability and biosecurity concerns that would provide the motivation to participate. In addition, they needed to be connected in industry netchains. Owners and managers of the business were targeted to participate in the project. Ultimately three netchains have been investigated from three sectors or industries.

In the first industry, livestock 'A' sector, recent fears of a global pandemic heightened the need for tracking and traceability processes, combined with preventative actions and rigid biosecurity protocols. These concerns introduce new areas to trace (beyond normal, through chain considerations), such as traffic movements around production areas (for example, carrying chemicals and stock feeds), contaminants from the wild (e.g. native species and escapees) and activities on neighbouring properties.

In the 'B' and 'C' fruit industries, movement of produce across state and national borders requires phytosanitary certificates to ensure diseases are not spread. Delays in producing phytosanitary certificates to track produce can result in perishable produce like fruit 'B' and 'C' becoming unsalable.

The industries and associated netchains were selected on the basis of advice received from the commissioning research funder, the experience of the research team and contacts within of the netchains.

In addition to the three netchains reported here, honey bee and rambutan netchains were approached for inclusion in the study: due to a range of factors these netchains were not included.

The livestock 'A' netchain is characterized by a group of approximately 20 small, somewhat interconnected and dependent businesses, ranging from breeder and grower operations through to processors and marketers. The direct chain actors form a cluster that operates in concert with a number of infrastructure providers and State and Local Government agencies. There are strong business to business relationships through and within the netchain, with looser arrangements across the netchain. The netchain is primarily based in a temperate Mediterranean type climatic zone in South Central Victoria which is subjected to few major weather related natural events that can compromise biosecurity.

Fruit 'B' is grown in Northern, Central and Southern Queensland (48 identified growers). The sector is characterized by a strong alignment of the growers with a marketing association and its marketer (the principle marketing agent), which is the dominant mechanism by which fruit 'B' is exported interstate and beyond Australia. There appear to be strong symbiotic relationships and cooperation between growers and the

marketing association. It appears that the marketing association and the marketer have a strong interdependent relationship within the netchain. Production is spread across a range of climactic and agro-geographic zones from Tropical to Sub-tropical and has been subjected to more frequent weather related natural events (Tropical Cyclones) that can compromise biosecurity.

Fruit 'C' is grown in Queensland (19 growers) and New South Wales (23 growers) and there are two major market agents. Production is spread across a range of climactic and agro-geographic zones from Sub-tropical to Warm Temperate and has been subjected to less frequent weather related natural events that can compromise biosecurity.

There are some 23 independent wholesalers who service either or both of the 'B' and 'C' fruit industries that were contacted in some way by the project. Business and marketing arrangements are more fragmented and opportunistic in this sector: there appear to be fewer strong inter business relationships in comparison to fruit 'B' and livestock 'A'.

Action Learning to Develop and Evaluate Tracking & Tracing Systems

An action learning research approach was taken where the needs of the industry were identified and systems developed to address these needs at each stage of the research. Industry participants were involved in identifying and evaluating solutions through the research.

Initially, industry members were consulted to determine their requirements for a tracking and tracing system. Part of this stage was the mapping of organisations involved in the chain and how product and information flows between each organisation. The business rules used and biosecurity issues to be addressed were identified as well as the outcomes required. Industry members were then consulted about a proposed tracking and tracing system. During and after implementation feedback was sought with a formal evaluation made after the system had been used.

The netchain management systems deployed for each commercial group had to be customised to the industries requirements and address priority biosecurity issues. The system used needed to fit efficiently into current business methods, as well as be reliable and effective in meeting customer requirements. Technology was found that had been developed by the web based track and trace system provider that suited SME's and those in niche market industries. The system linked existing legacy computer systems across multiple organisations in netchains through the internet. It was able to be developed to address biosecurity issues and link with existing business information systems and business methods.

The specific steps in the system design and evaluation included:

1. Document the chain. Identifying at each point in the chain: all the roles played, interfaces, reporting loops and relationships;
2. Document the physical processes and information flows within the chain;
3. Document the outcomes that are required and the points in the chain that need to have data to make decisions and/or build workflow processes;
4. Prepare a functional specification for the chain - services (data capture by electronic forms and data files, and reports), profile data, roles, business and chain transparency rules (who can see what), data dictionary etc;
5. Netchain to confirm acceptance of proposed system;
6. Build solution;
7. Progressive rollout to each industry netchain - user documentation, training, continuous fine-tuning done as required; and
8. Evaluation

This paper reports on the in-depth interviews conducted with participants in the program after the system installation and the researcher team's interpretations over the period of the project on the implications for implementation in other industries. A total of 29 interviews were conducted - 8 in the livestock 'A' industry; 14 in fruit 'B'; and 7 in the fruit 'C' industry. All businesses were categorised as micro or small business, with an average of 3.4 employees ranging from none to 10 employees for a fruit 'C' grower and 15 for a livestock 'A' meat processor. Employee numbers were stable with only the livestock 'A' growers

increasing staff with increased production and two fruit 'C' growers reducing staff due to poor fruit harvest or removal of trees.

Results

Results presented compare the use of the tracking and tracing system across these different industry sectors (horticultural and animal products) and states of Australia. Findings are presented on what has been learnt in the process including: identifying business in chains and networks to work collaboratively with; catalysts needed to get commitment to change; and support systems needed for successful implementation across multiple small businesses linked in netchains.

The research through the trial and evaluation of tracking and tracing systems across several industry sectors and in several states of Australia provides examples of what is possible for others. Across chain principles can be derived, as well as differences required for horticultural and animal products. It can also facilitate the subsequent adoption by other industry sectors and regions. In addition, the process of businesses working together may facilitate learning in other areas such as joint problem solving.

Livestock 'A' Netchain

In October 2007 a preliminary workshop was conducted with eight industry members representing a breeder, a nursery farmer, growers and processors. A preliminary scoping document outlining the proposed tracking and tracing system was circulated to industry in February 2008. However the scope of the system and participants continued to change until May 2009. The system was developed with pilot roll out and training conducted in August 2009. Only one grower and one processor participated in the training and trialing. Note: it was originally expected to design and trial the prototype system in February 2008 with a revised expanded system trialed in May 2008 and rolled out to others in the industry by August 2008.

Initially the tracking and tracing system was designed for exotic meat animals only. With the sole main stream supplier having concerns about information being shared with customers, it was decided to remove the breeder stage and start the system from the breeders through to customers (retailers or food service). To improve the potential take up by others in the sector, the system was then expanded to add the mainstream grower netchains (finishing meat animals) with potentially 40 growers with three or four facilities each. The expansion however added complexity in trying to link into a larger number of existing systems. Some of the businesses were larger (40 businesses employ 1,412 full time and part time employees) and had well developed systems. There were delays in exchanging details of existing systems with the system developers even when done 'commercial in confidence' (workflow processes, business rules and documentation used). In August 2008 it was suggested the group was not clear on the competitive and collaborative advantages and where competitive information may be passed to others in the industry. In addition, there was not clear target date to get decisions finalised by. Forms and the scope boundaries of the system was not finalised until May 2009.

Concerns were raised by growers that the pilot system did not do all the things they had expected, such as tracking animal growth rates daily and weekly. With the extensive discussion period and changes in system specifications it would seem expectations were not well managed. It is recommended that there needs to be clear communication about compromises made in the final system scoped with details provided of what could potentially be added in the future.

A clear commercial or technical imperative for the system is apparently lacking. It is hypothesised that this may be due to the biosecurity risk of a particularly contagious virulent virus not eventuating as expected. It was suggested this lower perception of risk may be due to the fact that during the same time period humans dealt with the so called 'swine flu' (H1N1) pandemic and the Australian horse industry dealt with equine influenza without the sensational impacts the media had warned of.

The system was narrowed down to focus on the game processor who by the time it was trailed was only operating a day or two per week. As a small business operation that had traditionally operated based on 'memory' the lower volume of production may have meant the system was not seen as necessary.

It is noted that organisations need a clear commercial imperative to set up tracking and tracing systems as well as sufficient volume to make it worth the effort to do so.

Fruit 'B' Netchain

A meeting was held with the fruit 'B' marketer and fruit 'B' growers in November 2007. Training of fruit 'B' growers on how to use the system was then run in North Queensland and then in central Queensland. The training day planned in Southern Queensland did not eventuate. Training was attended by 17 of the 47 growers. With a change in the Board of Directors of the fruit 'B' grower group, support for implementation of the system by most growers was extinguished. The loss of support can in part be attributed to: the role of key influence members in the netchain (gatekeepers – Rogers and Kincaid 1975. and Brown, Malecki and Spector 1976); a desire to protect commercial in confidence information; and information that could be used to extract market intelligence; and the presence of a preexisting information management system.

Fruit 'C' Netchain

After a meeting with the fruit 'C' marketer a prototype system was designed and set up in February 2008. Training was provided to the marketer in March 2008 who provided further training and support for its fruit 'C' grower suppliers. A short time frame was involved to get the system up and working before the season started in March. Some growers had used a similar system for other crops grown in the previous year. Since the roll out in 2008 all growers used the system.

The system provides tracking and tracing of fruit 'C' from growers properties to the marketer and to downstream customers (exporter quality assurance assessors, importers, retailers, food service businesses). In 2009 the system was expanded to generate 'recipient created tax invoices' and payment documents to assist in linkages with financial recording systems. In addition it was expanded to provide reporting of wholesale prices paid to comply with the new Horticulture Code about price communication. In 2010 the system was expanded to provide electronic phytosanitary 'plant health' certificates to give assurances the fruit will not have biosecurity risk such as fruit fly. The electronic plant health certificates ensures there are no delays in accessing other markets such as Victoria, South Australia and Western Australia.

The lessons learnt from the fruit 'C' netchain would be that strong leadership and support by a key customer is needed for successful implementation. There were clear commercial imperatives to participate through system development to solve business problems.

Characteristics of In-depth Interview Respondents

All interviewees had considerable experience working in their current role (average 14 years – fruit 'B' 14 years, fruit 'C' 11 years and livestock 'A' 20 years), in the current organisation (average 16 years – fruit 'B' 17 years, fruit 'C' 14 years and livestock 'A' 20 years) and in the industry more generally (average 15 years – fruit 'B' 14 years, fruit 'C' 10 years and livestock 'A' 24 years). The nature of their experience in the industry was more varied. All had experience as growers although in livestock 'A' they may have been involved in growing breeder animals (3 respondents), conventional growers (5), or game (3). Fewer had experience in marketing (9 respondents), supplying inputs to growers (8), distribution (6), exporting (6), wholesaling (5), processing (4) and retailing (4).

Experience with Quality Assurance, Environmental Management Systems (EMS) and Traceback

Most respondents (22 – 75%) had a quality assurance (QA) system in place although it was more common in the fruit companies (fruit 'C' s 7 – 88%; fruit 'B' 12 – 86%) than in the livestock 'A' companies (3 – 43%). Mostly Freshcare™ for those involved with fruit 'B' and 'C' and Primesafe for those in livestock 'A' - game. In the fruit 'B' organisations three used the marketers QA system, two used ICA13 (EMS), one used SQF2000^{CM} and one used a standalone HACCP certification.

The reasons for using the systems were for customer reassurance or market requirements and traceability. Those that commented on why they did not have QA or EMS said they were setting up their systems in new businesses. The one livestock 'A' organisation that said they were 'too busy' was the owner of a business and had been in working in it 30 years.

QA systems had been operational for an average of 8.3 years but this ranged from two to 20 years. Each industry had organisations with QA systems operational for over ten years (fruit 'B' – 2 for 12 years and 1 for 20 years; livestock 'A' 1 for 10 years and 1 for 13 years; fruit 'C' – 2 for 10 years and 1 for 15 years).

The time to develop QA systems averaged 4.3 months but ranged from 1 to 60 months. The longest time was 12 and 60 months to set up QA systems in the fruit 'B' industry. On the premise that primary producers are often Bayesian (that is accumulators and processors of information over time) (Lindner 1987) in their approach to the acquisition and application of information about new technologies (Noonan and Gordard 1995), that there are a range of factors in the dictate of the time taken to understand and implement new technologies (Marsh 2010), and that there are a number of steps, stages or 'time lags' in the process of adoption of a technology by primary producers (Lindner, Pardey and Jarrett 1982); then the time taken to assess, setup and trial management systems are consistent with a Bayesian model of behavior. The assurance certification approaches used are also consistent with other studies (Batt, Noonan and Kenyon 2006).

Over half (11 – 55%) had experience in setting up information, quality assurance or EMS's with more experience in the fruit 'C' organisations (6 – 75%) than the livestock 'A' organisations (4 – 57%) or fruit 'B' organisations (2 – 14%). Mostly it was Freshcare™ (fruit 'B' and 'C') or HACCP (Hazard Assessment Critical Control Points) with one each involved in setting up Interstate Certification Accreditation (ICA13), ISO9000, export accreditation and livestock 'A' processing licensing systems. All systems were certified against a standard such as State Government and Industry systems like Freshcare™ and Primesafe as well as HACCP (5 organisations), Woolworths QA (4 organisations), SQF2000^{CM} (2 organisations) and ISO 9000 (1 organisation).

While the QA systems in the 'B' and 'C' fruit industries were stable with no changes in the last 12 months, three of the four organisations in the livestock 'A' industry had changed their QA systems. For one a HACCP review resulted in changes in system procedures. For another there was increased customer feedback with a new product. For the other there were new processes to comply with ISO 9001:2008. It would seem that the livestock 'A' industry was undergoing much change in existing QA systems and in the process of setting up QA systems.

Biosecurity Issues

Definitions of term Biosecurity varied depending on the organisation (fruit 'B' organisations were not asked this question). For the livestock 'A' organisations it was mostly about reducing the risk of spreading disease while for fruit 'C' organisations it was more about the control of insects and pest movement and for fewer about the spread of disease. One organisation defined biosecurity in terms of 'biological or chemical hazards to humans and domestic/wild animals' and another as 'disease contamination and interaction with non complying species or environments'. Biosecurity was defined by another as 'chemical and biological safety of food'.

Five organisations said their understanding of the term Biosecurity had changed as a result of involvement in the project. Two changed their understanding due to the 'more in-depth look at inputs' and 'greater observation of the fruit supply chain'. Another saw how 'sensitive certain areas are to foreign insects'. One did not know the meaning before the project.

While two thirds (10 – 67%) had systems in place that complied with biosecurity requirements, there were more biosecurity systems in the fruit 'C' organisations (6 – 75%) compared to the livestock 'A' organisations (3 – 43%). Fruit 'C' biosecurity systems were known as ICA (01, 02, 18 or 21). Livestock 'A' biosecurity systems included the Victorian 'A' code, 'A' bio-security guidelines (Victorian Dept of Primary Industries), Australian Quarantine Inspection Service registered premises and livestock declaration forms.

All fruit organisations had biosecurity systems in place to access interstate markets (Western Australia, Victoria, South Australia, Queensland). Livestock 'A' organisations had biosecurity systems to 'determine where produce originates' and to 'process livestock for export'.

Nearly half the organisations sales (45%) were to interstate markets. Interstate markets were more important for fruit 'B' (62%) and fruit 'C' (52%) than livestock 'A' organisations (10%). The main market for livestock 'A' organisations was local state sales (89%) with it being 100% of sales for some organisations (4/7 livestock 'A', 2/12 fruit 'B' and 2/7 fruit 'C'). International markets were less important (9% – fruit 'B' 17%, fruit 'C' 4%, livestock 'A' 1%).

Attributes Sought by Customers and Consumers

Respondents were asked unprompted what they thought final end consumers and their direct customers were looking for in their products. They thought fruit consumers were looking for taste/ripeness (7/14 fruit 'B' organisation and all 8 fruit 'C' organisations) and appearance (6 fruit 'B' organisation and 4 fruit 'C' organisations) followed by quality more generally (5 fruit 'B' organisation and 4 fruit 'C' organisations). By comparison respondents thought livestock 'A' meat consumers were looking for safe and reliable meat (3/7 livestock 'A' organisations) or quality more generally (2 livestock 'A' organisations) and price/value for money (2 livestock 'A' organisations). Only one fruit 'B' organisation thought consumers wanted quality assured fruit.

Different attributes were sought by direct customers. Fruit 'C' organisations said customers looked for taste/ripeness (3), commitments to supply consistent fruit (3), appearance / presentation (2) and consistent quality (2). Fruit 'B' organisations thought customers looked for appearance, presentation and colour (6 / 8 organisations), quality generally (2) and a long shelf life (2) but there was no mention of taste thought important for consumers. Livestock 'A' organisations thought customers looked for safe / reliable products / clean shed (3 organisations), appearance (2) and general quality (2).

To compare how different issues for customers and consumers were rated, organisations were asked structured questions and rated them on a 1 to 7 scale with 1 not at all important through to 7 very important. The most important issues overall were food safety for final end consumers (mean 6.6) and customers (mean 6.5) followed by company profit margins (6.3), tracking and tracing so customers can manage biosecurity issues (6.1), profit margins for customers (6.0) and the amount of food waste for customers (6.0). Lesser important issues were environmental stewardship for consumers (5.2) and customers (5.4).

There were some differences between the industries, although the small sample size meant statistical significance of differences could not be calculated so care is needed in relying on these results. Compared to organisations in the other industries, fruit 'B' organisations saw food safety being more important for final end consumers (mean 7.0) and customers (6.9) and tracking and tracing so customers can manage biosecurity issues. Livestock 'A' organisations had higher importance ratings on tracking and tracing so consumers can manage biosecurity issues (mean 6.2), competitive prices for consumers (6.1) and environmental stewardship for final end consumers and customers (5.7). The fruit 'C' organisations had higher importance on profit margins for the companies (mean 6.6), amount of chemical or fertiliser run off (6.6) and less importance on tracking and tracing so consumers can manage biosecurity issues (5.0).

When asked how they identified what customer requirements were most got their feedback directly from customers although one livestock 'A' organisation got website statistics, a fruit 'C' organisation got data from industry marketing exercises, a fruit 'B' organisation did research and another fruit 'B' organisation got feedback through quality assurance.

The main organisation influencing product specifications was different for each type of industry. For the fruit 'B' organisations all thought product specifications were influenced by the marketer (13 of the 13 organisations) with one saying there was influence by retailers and another that exporters and their customers were influential. For fruit 'C' organisations there were a range of down stream customers who were influential including the wholesalers (3 of 8 organisations), marketer (2), retailers (2) and other parties (1). For livestock 'A' game meat organisations the most dominant influencer on product specifications was the processor (4 of 7 organisations) as well as the marketer (1), food service (1) and other parties (1).

None of the customers were seen to have changed their product specifications or expectations in the last 12 months with the exception of one livestock 'A' game meat customer wanting higher volumes.

Experience with Tacking and Trace back

All organisations said they could trace their fruit and livestock products back from customers if there was needed with the exception of one fruit 'B' organisation (no response to this question from three fruit 'B' and one livestock 'A' organisation). This was done through identification on cartons, batch codes, serial numbers and delivery documents.

Fewer were able to track all inputs used back to suppliers (18 with two saying no and nine not answering the question). Most not answering the question were in the fruit 'B' organisations (8/9). Tracking of input supplies was done through batch numbers, delivery records, supplier declarations and certification. On average it took fruit 'C' organisations 1.3 hours to track sources of inputs and livestock organisations 35 hours (one organisation said greater than 7 days). The one fruit 'B' organisation who could track sources of inputs said it would take approximately 14 hours and one organisation said they had not been required to do so. There had not been any changes in the systems or time taken in the last 12 months.

One key fruit 'B' respondent was able to cite how at an industry / exporter level a rapid capability to demonstrate compliance with importer country requirements for irradiation of fruit could be demonstrated when live but 'irradiation sterilized' insects were found in a consignment at the receiving port.

Expected Impact of Biosecurity Issues on Business and Industry

Organisations were asked what biosecurity issues they thought may affect their organisation. While few of the fruit 'B' organisations expected any biosecurity issues (4/14 organisations), threats were seen from pests, imports of inferior standard fruit, fruit temperature in transport. One fruit 'C' organisation saw potential biosecurity issues from fruit spotting, bug bites and peach moth grubs. Another was concerned about imported fruit that did not adhere to same systems of pest management and recording/traceability. One livestock 'A' organisation was concerned about introduction of disease from food or new animals. Another was concerned about non-conforming product and being able to prove health history.

When asked to give examples of biosecurity issues that have experienced in the business, only one fruit 'B' and one fruit 'C' organisation could provide an example. They were problems with soft fruit and fruit not arriving in the condition expected. Respondents were able to give more examples of biosecurity issues they had heard of in the industry. One livestock 'A' grower cited a species specific disease closing down production in a region. One fruit 'C' organisation cited poor packing of fruit and another fruit fly in Victoria. Six fruit 'B' organisations had biosecurity examples including: errors in post harvest treatments, heat damage during transport, quality control with imports and issues with exports to China in 2006/07.

Some miss-interpreted the biosecurity issues question thinking it was about the new tracking and tracing system. One fruit 'B' organisation thought the tracking system would make the industry more accountable. One fruit 'C' organisation was concerned about the time taken and duplication of records. A livestock 'A' organisation was concerned about ease of use of the new system.

Organisations were asked what impact the tracking and tracing for biosecurity system may have on their businesses. Most fruit 'B' organisations did not respond to this question (9/14 organisations) and half the fruit 'C' organisations (4/8) did not respond or not able to respond to this question. One fruit 'B' organisation said it would provide a better price due to reliability and another thought it would make growers more accountable for quality assurance of their product. One fruit 'B' organisation thought it would suppress prices and grower returns. Two fruit 'C' organisations thought it would increase costs while another thought it could save time and paper as well as improve record keeping. More livestock 'A' organisations answered this question (6/7) and more positively. Livestock 'A' organisations thought it would provide end user confidence, provide better feedback so problems could be fixed, improve the product so it was safer and there was less risk, secure business continuity and ensure business could continue in the case of biosecurity outbreaks occurred elsewhere. The positive expectations of the livestock 'A' organisations may be due to early stages of QA system implementation.

Organisations were asked what benefits they expected from setting up the new tracking and tracing system. Five fruit 'B' organisations commented on more ease in tracing fruit, getting fruit into China, potentially helping with costing and profit, increased transparency and getting ownership of defects to assist improvements. One organisation only saw data in a digital rather than hard copy format.

Fruit 'B' organisations were further asked what benefits they expected for the industry from setting up the new tracking and tracing system. The seven organisations that saw benefits suggested it would provide better prices, better access to markets, customer satisfaction, helping with marketing estimates and ensuring all growers monitor things like spray programs.

To get a broader picture of the expected reasons for implementing a tracking and tracing biosecurity system organisations were asked to agree or disagree with a range of potential benefits on a scale of 1 to 7 with 1 being strongly disagree to 7 strongly agree (Table 9). There was the strongest agreement that the system would reduce the risk of litigation (mean 6.1), better meet customer needs (6.1), improve performance and profitability (5.9), better understand customers and suppliers (5.9) and to remain competitive (5.9).

Fruit 'B' organisations were then asked what were expected problems and challenges in setting up the new tracking and tracing biosecurity system. Responses varied from poor industry compliance, people not giving all information resulting in missing links, potential conflict with quality assurance systems already in place, computer glitches, lack of broadband internet connections and data entry errors when done by those not doing the task. With only one fruit 'C' grower on a 'dial up' internet connection and everyone else having broadband (ADSL) the internet connection was not expected to be an extensive problem.

Response to the Tracking and Tracing System Trialed

Ten organisations had trialed the new tracking and tracing system – one fruit 'B' organisation, three livestock 'A' organisations and six fruit 'C' organisations. The trial users of the system were asked to agree or disagree their response to the new system on a 1 to 7 scale with 1 being strongly agree to 7 being strongly disagree. There was strongest agreement that the system provided continued access to markets when a biosecurity incident would quarantine other businesses (mean 6.5), enable more equitable sharing of risks and rewards (6.4), reduced the risk of litigation (6.3), enabled secure sharing of confidential information (6.2), reduced time delays (6.1), reduced time to respond to correction action requests (6.1) and improved information flows (5.9). All the negative effects of the system were on the disagree side of the scale including requiring a lot of time to learn (mean 3.8), additional software (3.8), frustration with insufficient training (3.6), distraction from production and marketing activities (3.4), frustration with complicated system (3.2), extra workload (3.1) and additional computer equipment (2.9).

Key Comparisons Between Netchains

The three netchains examined have quite markedly varied adoption and diffusion patterns (Lindner 1987) for the specific tools that they have utilized to enable them to track and trace.

Trial users were asked to assess the future benefits to industry more widely of on-line tracking and tracing systems on biosecurity issue. Livestock 'A' users suggested benefits may include greater security (financial, safe food, well managed), improved information (livestock numbers, areas to start or expand farms) and improved processes (quality, reduced mortality). Fruit 'C' users suggested benefits may include better record keeping, performance pressure, efficiency, uniformity and more reliable product to consumers.

All trial users recommended similar businesses use an on-line track and trace system. Reasons given included benefits already mentioned such as: financial security; improved quality; safer products; risk assessment and easier paperwork; being made to think outside the business; and develop further/better data entry systems. One fruit 'C' organisation commented on getting immediate notification of financial returns on the market and another getting crop analysis data.

The role of gatekeepers (Rogers and Kincaid 1975) in each of the netchains influenced the establishment of working relationships and are key to the success of the adoption and diffusion of track and trace technologies. In one instance a key gatekeeper was instrumental in quickly shifting attitudes of participants away from further participation in the trial.

Conclusions and Recommendations

Across the three networks there is:

- varied ability to respond and provide information to chain partners and stakeholders;
- variable understanding of the need for and role of 'biosecurity'
- a range in capacity and propensity to use electronic systems for track and trace in
- recognition of track and trace capability as critical for ongoing ability to trade at both a domestic and export level and
- recognition that track and trace capability has led to 'biosecurity' 'barriers to trade' being circumvented.

The role of Gatekeepers and the 'Bayesian learning' style of most primary producers must be taken into account when establishing the deployment mechanisms for the roll out of web based integrated information systems. Such systems have the potential to conflict with more conservative approaches of some actors in sharing information and in tightly bound business to business and group relationships.

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