Change

Increasing the adoption of technology in the Australian beef industry

A report for

By William Harrington

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Executive Summary

Change is hard. Change is uncomfortable. Change is also necessary for survival in everyday life. Agriculture is no exception. This report examines the process of change in the northern Australian beef industry and provides some context and history to help understand why the beef industry is where it is. The outcomes and recommendations for this report can however be applied more broadly to agriculture in general and even to other industries outside of agriculture.

Resistance to change is a trait that is part of human nature. This was seen throughout this Nuffield Scholarship. It didn't matter if it was a small village in Kenya, a modern dairy farm in Europe or a beef ranch in Texas.

Change is also necessary for the survival of any business. The world does not sit still and things are constantly changing. To be able to deal with change it is important to understand and to manage the process of change.

> *"The definition of insanity is doing the same thing over and over again and expecting a different result." – Albert Einstein* *(Calaprice, 2010)*

There are many ways individuals, businesses, industries and even governments can bring about change in an industry. First and foremost they need to understand the process of change. There are many different models that can be used including the adoption curve and the Satir change model (explored in this report). These models can be used to understand the status quo and lend insight into how to manage groups and change at different times.

It is important to foster and nurture change; this can be done by supporting the early adopters of change and providing trusted advisers they can speak with to help them through the process.

There are several things that can be done to support change in the northern beef industry. These approaches can include emphasising the value of education to the industry, demonstrating the value of training and an improvement in the communications infrastructure in northern Australia to enable better dissemination of ideas. The final and least popular way to bring on change is through the use of regulation. This is unpopular but sometimes required, or can, at least, provide an impetus toward change.

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Foreword

After founding Harrington Systems Electronics in 2005 to develop technology for the beef industry in Australia, it became obvious, despite overwhelming evidence that technology can be used to improve productivity and efficiency on cattle stations (Meat & Livestock Australia Limited, 2011), adoption of this type of technology was still very slow.

So, I asked myself, why is this the case?

In 2016 I was granted the exciting opportunity by Nuffield Australia to research this question as part of a Nuffield Scholarship. My topic originally started with adoption of technology specifically in the beef industry, but I began to realise that some of the reasons there is a slow uptake of technology in the beef industry are the same in the whole of agriculture, and that change is slow in almost every part of life.

This report may at times seem critical of certain attitudes towards change of some farmers. It is important to remember it is the beef industry I know and love, and that you cannot move forward until you know where you are now.

This scholarship has been kindly supported by John Deere Australia.

Acknowledgments

A Nuffield scholarship is a major undertaking, not just for the scholar but for the people around them, especially their family. My scholarship would not have been possible without the support of my wife Hollie and the rest of my family – Carmel (Mum) and Peter (Dad), Emily and Grace.

Gratitude is extended to my investor John Deere and the team behind them (especially Sheryl Friend and Fraser Scott) who made this once in a lifetime opportunity possible.

A thank you to the myriad of other people, who shared their time and thoughts to help this report come to fruition, I also would like to thank the editors of my report, without them it would not be what it is.

Nuffield is an amazing organisation with a long history and it is an honour to be part of it. Keep up the good work!

Abbreviations

CAP	Common Agricultural Policy
EU	European Union
ESCAS	Export Supply Change Assurance System
HSE	Harrington Systems Electronics
NBN	National Broadband Network
NDVI	Normalized Difference Vegetation Index
NLIS	National Livestock Identification System
RLMS	Remote Livestock Management System
UAV	Unmanned Aerial Vehicle
USA	United States of America

Objectives

The objectives of this report are to:

- Gain an understanding of the beef industry around the world and its history.
- Understand some of the technology that is available to the beef industry.
- Learn about the adoption of new ideas and technology and understand the process of change and how it applies to agriculture.
- Discuss how to increase adoption and bring on change in the beef industry.

Chapter 1: Introduction

Cattle were first domesticated approximately 10,500bc in the near east. Domesticated cattle travelled north, reaching Britain approximately 1,000 - 2,000bc. The domestication of cattle occurred in at least two places, resulting in the Bos Indicus and Bos Taurus types. It is fair to say cattle were critically important in the development of humanity as beasts of burden and food.

From these simple beginnings has grown a multi-billion dollar global industry, which produces 60 million metric tons of beef annually around the world, feeding billions of people. In 2016, there were 1.4 billion head of cattle in the world (Beef 2 Live, 2016).

The Australian beef industry

The beef industry in Australia has simple beginnings, starting with a Zebu bull, four cows and a bull calf purchased from Cape Town and transported to Australia on the First Fleet. Several months later, these cattle escaped and were lost, until they were found six years later, multiplying to 61 head! It was not until 1795 when 131 head of cattle arrived from India that numbers were sufficient to start supplying meat to the colony.

The northern grazing industry started in the early 1860s when the newly formed Queensland government set up laws to use the land to allow grazing as a precursor to extensive settlement in the state. Initially, most graziers in Queensland were running sheep, however this quickly moved towards cattle due to problems with sheep pests such as blowfly and predators such as dingoes. Cattle also had the advantage of being able to move over long distances more easily.

These early landholders operated their properties by keeping costs as low as possible. There were high costs of setting up and running these stations in remote areas, and the challenge of a shortage of labour willing to work in such isolated regions - a situation ironically that has not changed greatly over the last 150 years! The northern Australian beef industry has been characterised by cycles of boom and bust, droughts and floods. This is evident in the operating of most beef businesses now. Their businesses are generally conservative, sticking to tried-and-tested methods and avoiding risk, to be able to survive.

Australia is now part of a global industry and competes directly with all the other beef producing countries worldwide. We produce enough beef to feed millions of people every year and are one of the cleanest, most efficient and advanced beef industries in the world.

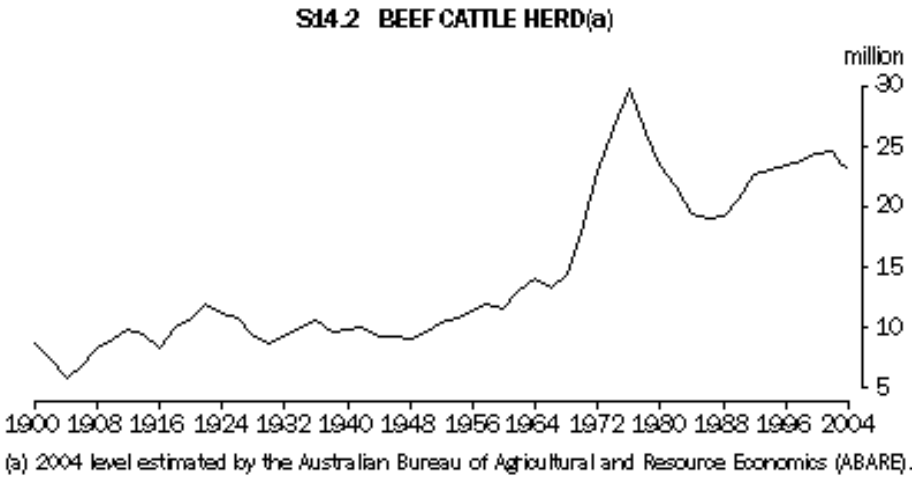

Figure 1: Cattle numbers in Australia over the last 100 years (Source: ABS Agricultural census and Surveys)

The beef industry in Australia is one of the most unsubsidised in the world (Australian Broadcasting Corporation, 2014) and it must be efficient to remain competitive. This lack of government support has a profound impact on the management systems and rate of innovation, and forces farmers to look at ways to improve. This is evident in countries with high levels of government subsidies such as the European Union (EU) where innovation is stifled because it is not needed to receive their subsidies. This constant market force means that the Australian beef industry is one of the most innovative in the world. This has anecdotally led to one of the highest levels of technology adoption in the world, however there have been no studies to accurately measure this. From personal experience beef producers who use technology in daily management to help run their businesses (such as telemetry, remote weighing systems and individual animal identification) are still in the minority.

The introduction of the National Livestock Identification System (NLIS) in 2005 is a good example of the Australian beef industry leading the world in the adoption of technology. NLIS was introduced to help protect the Australian beef industry if there was an outbreak of disease such as foot-and-mouth. In Australia, animals are tracked by recording all livestock movements between properties (where separate property identification codes exist) in a central database. This is typically done using a Radio-frequency identification (RFID) reader that records the electronic number stored inside the animal's ear tag or rumen bolus (similar to the way a pet is microchipped). This data is then downloaded from the reader onto a computer and then uploaded using a website or the computer software that came with the reader.

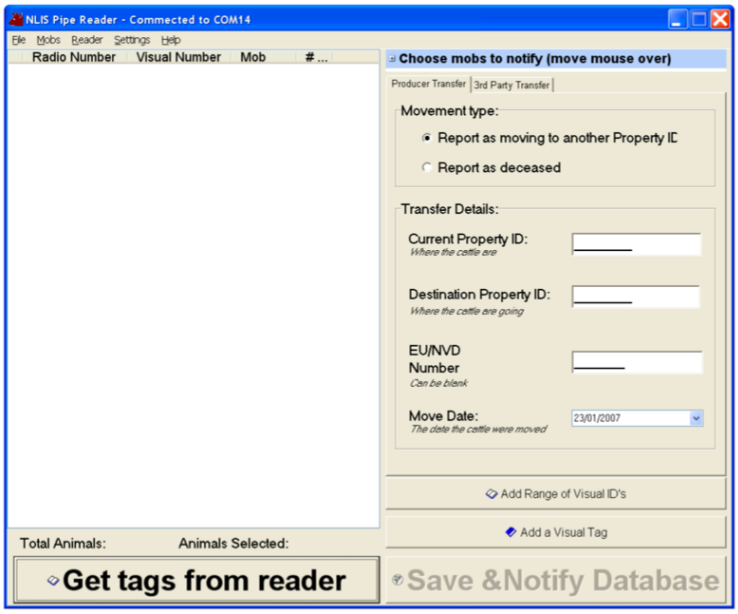

Figure 2: NLIS Pipe Reader software

This obviously requires the use of a computer. From experience, at the time NLIS was introduced in 2005, the use of computers in the beef industry was lower than most other agricultural industries in Australia. The mandating of NLIS forced the industry to invest in tags, RFID readers and computers, devices these farmers may not have purchased had they not been required to do so. Even still, a small percentage of beef producers have found ways to avoid having to use this technology by changing the sale terms to require the other party to read the animals or paying someone else to do this for them. One of the rare government subsidies that have been given to the beef industry was a 50% rebate on the purchase cost of RFID readers. This helped increase the uptake of these readers, however it also artificially affected the reader market with sales dropping to near zero when the subsidy ended.

Beef around the world

Globally, over 60 million metric tons of beef is produced annually, with almost half of this coming from the USA and the EU (Beef 2 Live, 2017).

World Beef Production: Ranking Of Countries			
World		61,583,000	
Rank	Country	2017	% Of World
1	United States	12,086,000	19.63%
2	Brazil	9,500,000	15.43%
3	European Union	7,875,000	12.79%
4	China	7,070,000	11.48%
5	India	4,250,000	6.90%
6	Argentina	2,760,000	4.48%
7	Australia	2,065,000	3.35%
8	Mexico	1,910,000	3.10%
9	Pakistan	1,780,000	2.89%
10	Turkey	1,700,000	2.76%
11	Russia	1,310,000	2.13%
12	Canada	1,160,000	1.88%
13	South Africa	885,000	1.44%
14	Colombia	825,000	1.34%
15	New Zealand	610,000	0.99%
16	Paraguay	610,000	0.99%
17	Uruguay	605,000	0.98%
18	Japan	460,000	0.75%
19	Kazakhstan	435,000	0.71%
20	Ukraine	390,000	0.63%
21	Egypt	360,000	0.58%
22	South Korea	285,000	0.46%
23	Belarus	277,000	0.45%
24	Chile	220,000	0.36%
25	Vietnam	219,000	0.36%
26	Peru	210,000	0.34%
27	Philippines	210,000	0.34%
28	Iran	200,000	0.32%

World Beef Exports: Ranking Of Countries			
World		9,439,000	
Rank	Country	2016	% Of World
1	Brazil	1,850,000	19.60%
2	India	1,850,000	19.60%
3	Australia	1,385,000	14.67%
4	United States	1,120,000	11.87%
5	New Zealand	580,000	6.14%
6	Canada	430,000	4.56%
7	Paraguay	390,000	4.13%
8	Uruguay	385,000	4.08%
9	European Union	330,000	3.50%
10	Mexico	255,000	2.70%
11	Belarus	220,000	2.33%
12	Argentina	210,000	2.22%
13	Nicaragua	140,000	1.48%
14	Pakistan	85,000	0.90%
15	South Africa	60,000	0.64%
16	Ukraine	30,000	0.32%
17	China	22,000	0.23%
18	Costa Rica	20,000	0.21%
19	Colombia	16,000	0.17%
20	Chile	13,000	0.14%
21	Russia	10,000	0.11%
22	Saudi Arabia	10,000	0.11%
23	Bosnia	5,000	0.05%
24	Malaysia	5,000	0.05%

Table 1: Global Cattle production and exports in 2017 (metric tons) Source: (Beef 2 Live, 2017)

As can be seen from Table 1, Australia is the seventh largest beef producer in the world and the third largest exporter. Almost 70% of Australia's beef is exported (Canadian Beef, 2016), most of it being marketed to premium markets and leverages on Australia's clean, green reputation.

Queensland is the largest beef producing state in Australia. Figure three shows the breakdown by state of beef production in Australia.

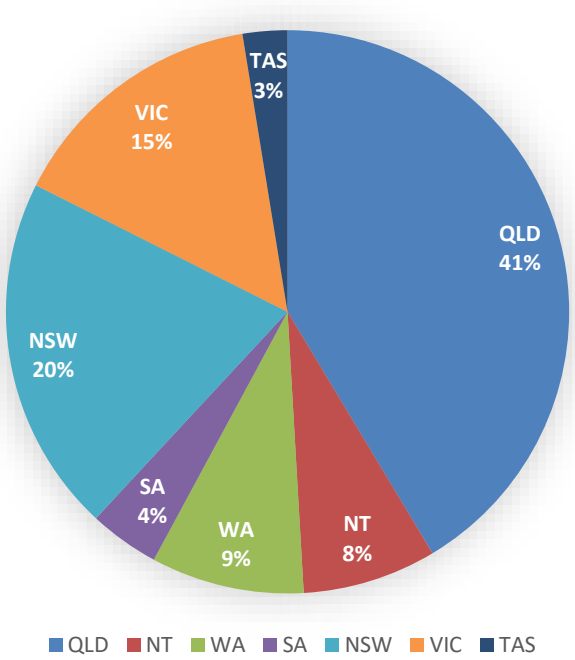

Figure 3: Australian beef production by state (Meat and Livestock Australia, 2017)

Beef production in the Americas

Over half of the world's beef is produced in North and South America. Production systems range from large-scale intensive feedlots to rangeland grazing systems similar to Australia.

Canada

Canada is the 12th largest beef producing country in the world. Over 70% of Canada's beef is exported to the USA (Canadian Beef, 2016). In 2010, Canada introduced an individual animal identification system similar to the NLIS system in Australia (Canadian Cattle Identification Agency, 2009). The majority of the cattle in Canada are produced in the rangelands of Alberta and Saskatchewan. A lot of cattle handling in Canada is still very traditional, with many cattle being roped to be branded. This is very much a social event and is part of the culture of the beef industry. The average size of a ranch in Canada is 320 hectares (800 acres). With Canada's challenging environment, there has been a huge focus on genetics to breed cattle that are better able to handle their climatic extremes, however little other technology specific to the beef industry is in daily use on ranches.

United States of America (USA)

As mentioned previously, the USA is the world's largest producer of beef with over 99% of the beef consumed being fattened in a feedlot, a significantly higher figure than in Australia (National Cattlemans Beef Association, 2008). Up to 50% of the beef consumed in the USA is ground beef (Beef2Live, n.d.). Texas is by far the largest beef producing state in the USA, followed by Nebraska, Kansas and California (Beef USA, 2016).

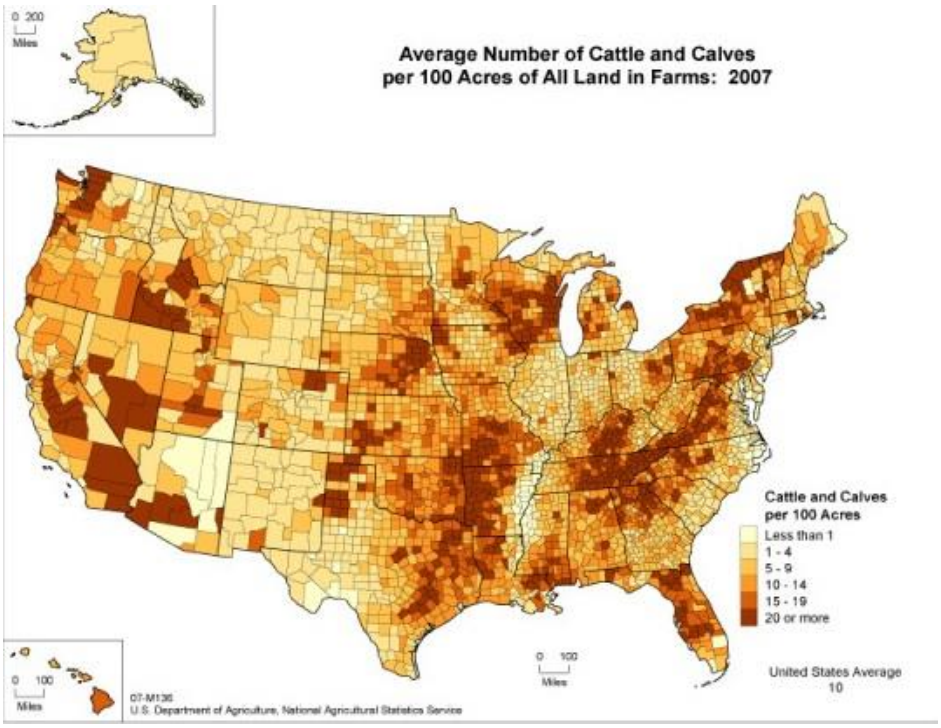

Figure 4: Density of cattle in the USA (US Deparment of Agriculture, n.d.)

The USA has made significant improvements in the efficiency of beef production over the last 50 years. There are approximately 97million head of cattle in the USA and beef production is at the same level as it was in 1970 where there was an estimated 133million

head. (Powell, 2011). These gains have been made through improvements in genetics and production methods. The beef industry in the USA is undergoing a generational change with a significant portion of the farmland in the USA changing hands over the next 30 years as the older ranchers exit the industry (United States Department of Agriculture, 2012). The new incoming ranchers will be younger and in general have more experience with technology. This will lead to a greater uptake of technology in the USA beef industry going forward.

The beef industry in the USA is indirectly subsidised through the availability of quantities of inexpensive corn and this is one of the primary reasons the majority of the beef in the USA is finished at feedlots.

Brazil

The second largest producer of beef after the USA is Brazil, which produces over 15% of the worlds' beef. The Brazilian cattle industry has been growing at a huge rate due to increases in productivity, driven by genetics and improved husbandry. Between 1997 and 2010, the cattle herd in Brazil increased 27%, beef production 38% and exports 731%, all while decreasing the land used for beef in Brazil by 2%. (Brazilian Beef Exporters Association, n.d.) Wages are significantly lower in Brazil than Australia and this lowers the cost of production and reduces the drivers for labour saving technologies such as remote water monitoring (McManus & Otávio, 2016).

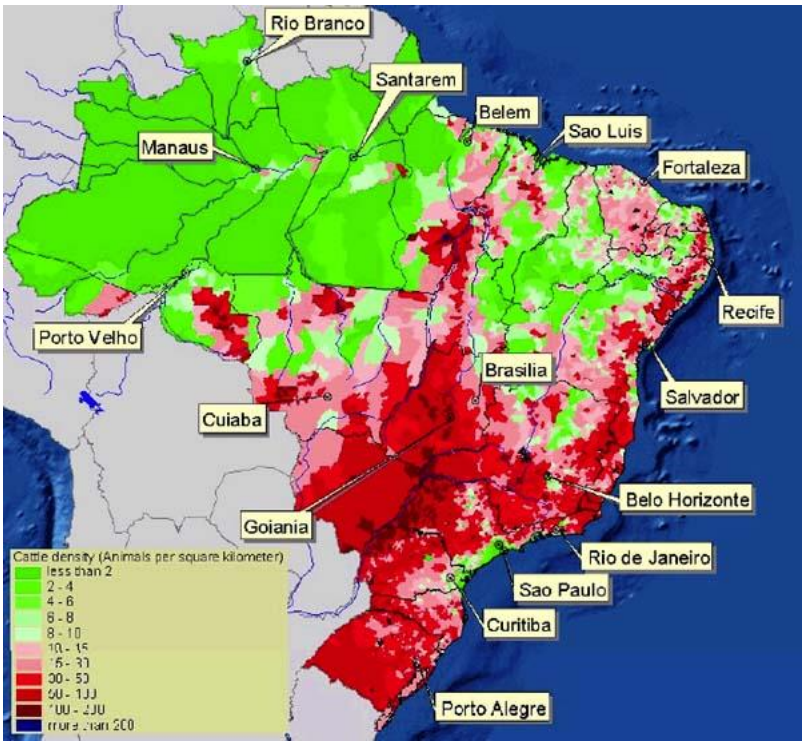

Figure 5: Cattle density in Brazil (Food and Agriculture Organisation of the United Nations)

The majority of beef produced in Brazil is consumed domestically, however the Brazilian beef export industry is growing and will become a significant competitor to Australia. Brazil is facing several challenges including outbreaks of foot-and-mouth disease and an overvalued currency. Expansion of the land used for beef production will also be difficult due to the push for environmental conservation.

Beef production in the EU

The third largest beef producer in the world is the European Union. Consisting of 28 separate countries (soon to be 27 when the UK leaves), the EU generates 27.2% of the worlds GDP and has 7.3% of the world's population. (Wikipedia, 2016). Beef production (and agriculture in general) in the EU is heavily subsidised through the Common Agricultural Policy (CAP).

The Common Agricultural Policy consists of two pillars; Pillar 1 for market and price support and Pillar 2 for rural development policies. The subsidies are linked to meeting environmental, public, plant, and animal health and welfare standards, and the need to keep land in good agricultural and environmental condition. (Wikipedia, Single Payment Scheme, 2016). It is important to note it is not compulsory for farmers to accept any subsidies, however due to the high costs of farming in the EU, very few farms would be viable without them. For this reason, the EU has very tight control of their agricultural sector. If farmers want to remain in business in the EU, they need the subsidies and therefore must meet the requirements.

There has been a huge amount of debate about the Common Agricultural Policy and the artificial affect it has on global markets. For example, in Ireland, before any EU farming subsidies, the average beef farm would lose 103 euros per hectare (Nuffield CSC 2016). This meat is then sold on the international market at market prices, artificially affecting prices. These subsidies also apply to areas of land that are not as productive to help balance production over the whole EU. 39% of the EU budget is spent on the Common Agricultural Policy (DG Agriculture and Rural Development, Agricultural Policy Analysis and Perspectives Unit, European Union, 2016). It is important to remember the vast majority of Europeans expect their farms to appear and operate a certain way and meet certain environmental standards, and are willing to pay for this through their taxes. Figure 6 shows the percentage of the EU budget spent on the Common Agricultural Policy since 1990.

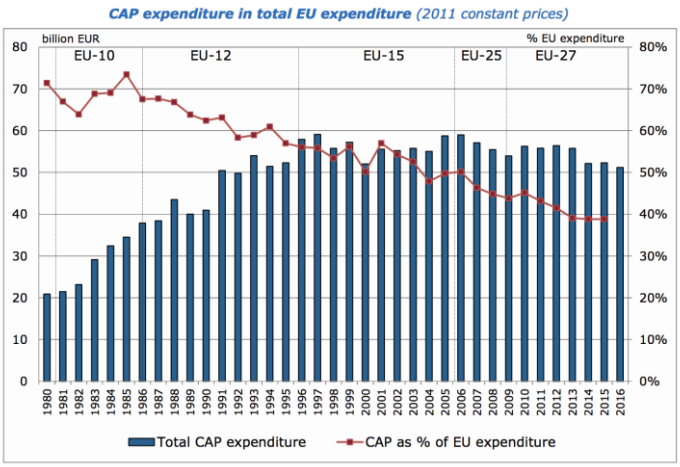

Figure 6: CAP expenditure as percentage of total EU budget (European Commission, 2016)

Due to the level of CAP expenditure in the EU, less emphasis is placed on efficiency and improvements although this expenditure is slowly decreasing (see figure 6). So long as the

farmer complies with the requirements to receive their subsidies, where is the incentive to innovate and improve? The reduction of CAP support to farmers will put pressure on them to improve efficiency

A good example of the disincentive to improve efficiency was seen at Kojetín in the Czech Republic, at a BioGas facility. Due to the subsidies provided by the EU under the CAP, output from the facility was set at a predetermined level. For this reason, the operator would be penalised for any attempt to improve the efficiency or productivity of the facility. This was a difficult concept for the Australians and New Zealanders in our group to comprehend, whose businesses focus on improving efficiencies as a means to improving profitability.

Figure 7: Biogas facility in the Czech Republic (Harrington, 2016)

Beef production in Asia

A huge proportion of the world's population live in Asia and by far the largest beef producer in Asia is China, followed by India. There are also several specialised beef producers such as Japan.

China

The Chinese beef industry is the fourth largest in the world. It is, however, facing several challenges; in particular that domestic consumption of beef is increasing whilst herd numbers are decreasing to the point where the Chinese beef herd has decreased back to the size it was in 1990. Like the USA, beef production in China has been slowly increasing (Waldron, Jimin, Huijie, Xiaoxia, & Mingli) due to increases in productivity and efficiency.

Several challenges still remain for the Chinese beef industry, in part caused by the economic transformation over the last 20 years leading to more people to move into the cities and farmers in rural areas placing more value on their time and to try and increase productivity.

To reduce the decline in the Chinese cattle herd, in 2014 the Chinese government introduced subsidies to encourage farmers to increase breeder numbers (Scott Waldron, 2015). This subsidy aims to increase production by 1.9% per year; however, it does not provide enough money to farmers to significantly affect the beef market in China.

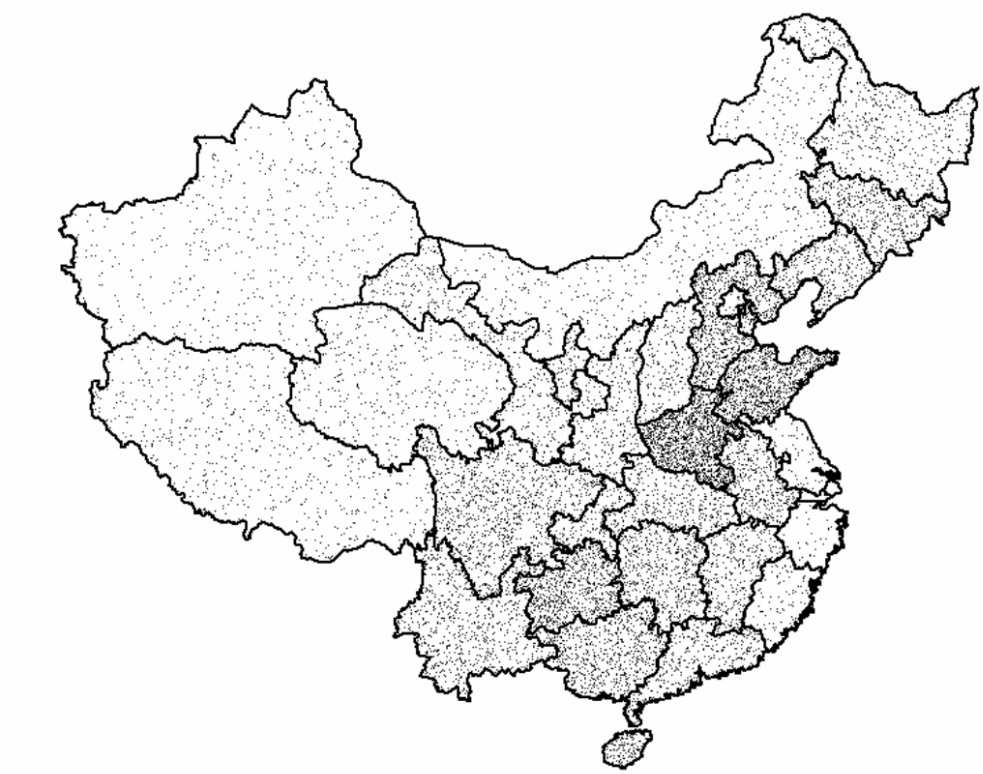

Figure 8: Distribution of Cattle in China in 2005 (Meat & Livestock Australia, 2007) *Darker is a higher density

Artificial Insemination (AI) is used significantly in China by the state to improve the country's herd and is significantly subsidised. Other forms of technology such as electronic animal identification and remote water monitoring are not generally used due to smaller farm sizes and cheap labour.

China is now opening more formal import channels for beef from countries such as Australia, India and Brazil and focusing on shutting down illegal imports of beef into the country (Weekly Times, 2015).

Japan

Japan is one of Australia's biggest and oldest beef customers, even though they have their own beef industry and breed Wagyu. Wagyu is a collective name for several distinct breeds in Japan. The Wagyu industry in Japan is highly regulated and no live Wagyu have been exported from Japan for many decades. Wagyu cattle are almost always fattened on grain for over 400 days to finish and their meat is highly marbled. Wagyu beef has been known to sell for over $1,000AUD per KG, with some calling it the best beef in the world. (Wagyu International, 2013)

Figure 9: Matsuzaka Wagyu Beef (CNN, 2015)

Beef farmers in Japan are heavily subsidised on a per head basis. Despite this, most Wagyu is still beyond the reach of most Japanese people due to its price, and they tend to eat cheaper, imported Australian and American beef.

Japan has very high labour costs, however due to the small farm sizes and climate, very few remote monitoring systems are used on farms. The average age of a farmer in Japan is 66 years old and the younger generation view farming as undesirable. This has caused approximately 10% of the arable land in Japan to lay fallow in 2010. (Japan Times, 2013). This is also holding back the adoption of new technology and farming practices as no young people are entering the industry.

Japan has implemented a traceability system after several outbreaks of Mad Cow disease. High value Wagyu producers have seized on this, going as far as proudly providing a certificate with the details of the animal including its movements and unique nose print with each cut of high value steak.

India

India is the world's second largest exporter of beef (see Table 1) and their export quantities have almost doubled between 2010-2015 (see Figure 10); this is especially interesting as cattle are regarded as a sacred animal in Hinduism, their main religion. Beef has even overtaken rice as India's largest export. It is important to note that Buffalo are included in these statistics and make up almost all of the beef exported. This is possible because India has more than half of the worlds herd of water buffalo, which are free ranged on natural pastures. (The Atlantic, 2016).

Indian beef is starting to be seen more and more in South East Asian countries as they search for low cost sources of protein. All the beef leaving India is normally frozen or chilled as no country will take live animals due to India's cases of foot-and-mouth.

Technology in not generally used in production of beef in India, with similar reasons to China – the low cost of labour and small farms.

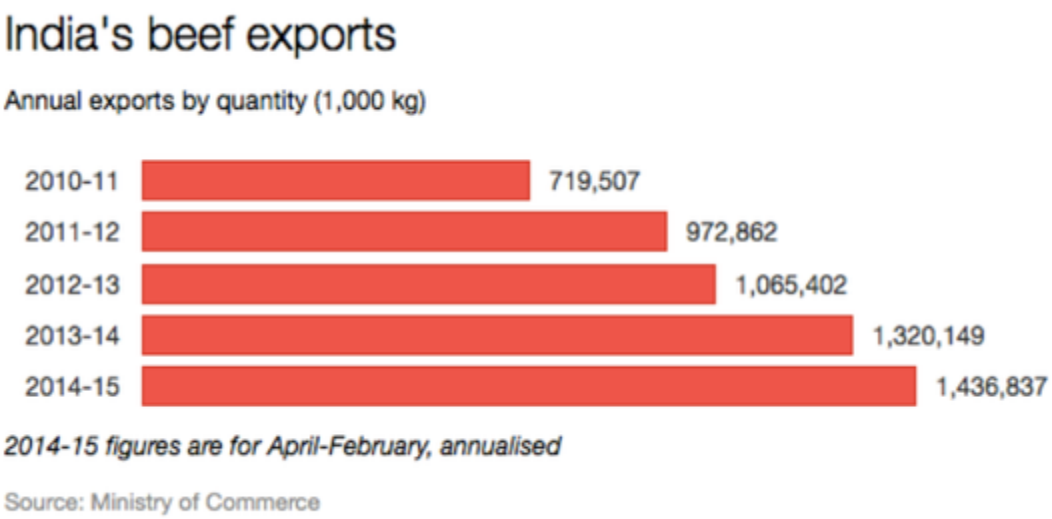

Figure 10: India's beef exports (Chunauti, 2015)

Chapter 2: Technology in Agriculture

The previous chapter detailed the state of the beef industry in many of the largest beef producing countries in the world. For these countries to be able to continue to grow their beef industries, technology will play an important part in increasing their efficiency and productivity.

What is technology in agriculture

For the purposes of this report, technology simply means using newly developed tools and techniques used to improve production and efficiency. It will be focusing on technologies that have been proven but are yet to be widely adopted by the industry. Examples of this include individual animal identification and remote water monitoring.

Why do we need technology in agriculture?

Agriculture is one of the oldest industries in the world and has enabled the human race to thrive. With the world's population estimated to reach almost 10 billion by 2050, technology in agriculture is going to become essential to our survival as we struggle to produce 60% more food (to meet the world's growing population, shown in the graph below) with less arable land and less water (Food and Agriculture Organisation of the United Nations).

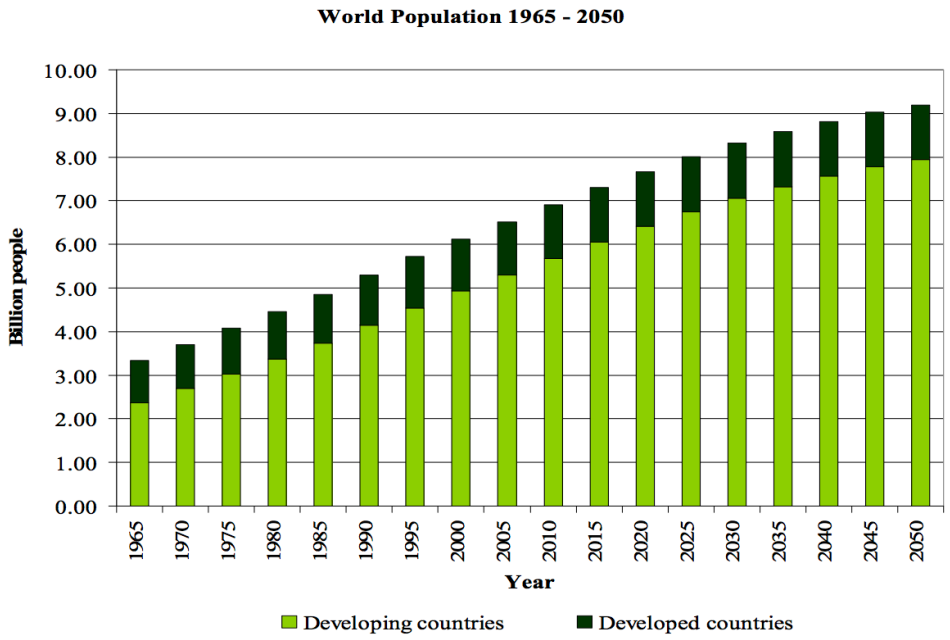

Figure 11: Estimated Population growth to 2050 (Food and Agriculture Organisation of the United Nations)

To be able to produce more food with less, it is necessary to increase efficiency, productivity and reduce losses. We can take a lesson from the cereals industry where improvements in efficiency have been measured (albeit a declining trend) for the last fifty years.

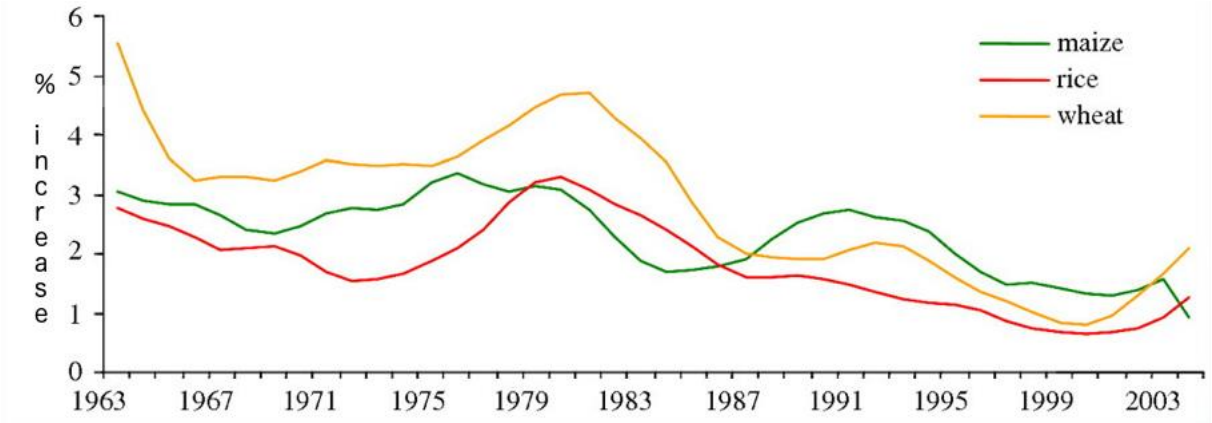

Figure 12: Growth rates in yield (%) for major cereals (Food and Agriculture Organisation of the United Nations)

The gains in yield seen above were only possible through the use of technology such as genetic modification, selective breeding and improved farming methods (Miflin, 1999).

Technology in the beef industry

There are many different types of technology available for use in the beef industry to improve efficiency and productivity. Although the uptake of some of these technologies is low, the beef producers using them are already reaping benefits and enjoying a competitive advantage. Some of the technologies available to beef producers include:

- Genetics
- Individual Animal Identification
- Information technology
- Remote monitoring

Genetics

Perhaps the greatest advancement in productivity for the beef industry around the world is through genetics. By selectively breeding cattle for various traits, it is possible to produce a more suitable, efficient animal that is better able to handle the environment it is living in.

Some traits commonly selected for are:

- Birth weight
- Weight gain
- Temperament
- Suitability for their environment
- Poll (if the animal has horns)
- Meat quality

Selective breeding has been going on ever since cattle were first domesticated. As a result, there are well over 800 different breeds of cattle with various different traits. There are

animals that can survive conditions ranging from the freezing winters of Canada to the tropical climate of India (Wikipedia, 2016).

Many new techniques have been developed to help improve genetics and these include Artificial Insemination and DNA testing. Several countries such as China and Japan are proactively using genetics to improve their whole country's herd by controlling what bulls are available to be used to breed from.

Individual Animal Identification

Another technology being used to revolutionise the cattle industry, particularly in larger herds, is individual animal identification. By using electronic, plastic ear tags, rumen boluses or individual numbered brands, information can be collected about each animal that can be used to make better, more informed management decisions. Some of the information that can be recorded includes pregnancy status (perhaps the most important thing for northern Australian beef herds), how many calves a cow has had, what immunisations the animal has received and its pedigree.

There are many tools that can be used to store this information including various software packages that can run on laptops or tablet computers for use in the field.

Figure 13: KoolCollect by Sapien software in action (Koolmurt Pastoral Pty Ltd; Koolmurt Pastoral Pty Ltd)

The decisions made using this information can totally transform a business through improved productivity of the animals.

Information technology

Another important technology making a huge difference to beef producers is information technology. Beef producers (particularly in northern Australia) are generally isolated and have to travel large distances to most professional and social activities. Internet access (as poor as it is in regional and remote areas of Australia), social media and phones allow graziers to communicate more easily, with social media allowing new ideas to spread and isolation to be reduced. Other things such as email, internet banking and computer accounting packages allow businesses to be run on cattle stations where otherwise it would

be much more difficult. The author's case is a good example of this. 46km of wireless link had to be built to the station to run the remote monitoring business, something that would not have been possible without the technology.

There are still many challenges with the adoption of more information technology in many parts of the world. In Australia Internet services in remote and regional areas are generally only available over satellite, and performance of this Internet connection is typically very poor. This is being referred to as the data drought.

One of the more surprising places where the data drought problem has been solved is in Kenya. Kenya has excellent mobile phone coverage over a large proportion of the country, allowing good communication and dissemination of information. Applications such as WhatsApp are also extremely popular. Most Kenyans did not have access to landlines, and infrastructure spending went directly to providing mobile phone coverage rather than trying to repurpose old infrastructure such as copper landlines like the National Broadband Network (NBN) is doing in Australia.

Remote monitoring

Another technology with great potential to improve the productivity and efficiency of beef production (particularly in Northern Australia) is remote monitoring. Using systems such as remote water monitoring and remote weighing can significantly reduce the operating costs on a cattle station. Technologies like this have been available for many years, however adoption is still low, despite lots of evidence of the benefits.

Remote water monitoring

Keeping an eye on watering points on large cattle stations is a hugely time-consuming and expensive exercise. To ensure animal health, watering points should be checked at least once a week in winter to almost every day in summer. Some of these water runs are several hundreds of kilometres long. This is traditionally done using motor vehicles or in some cases aircraft regardless of whether all the water points are okay.

By installing remote monitoring cameras, flow meters or tank monitoring systems these trips can be reduced (not eliminated) and planned. Managers can get up in the morning, perform the water run using their mobile phone or computer and then plan accordingly. Instead of performing a water run when everything is ok, their time can be spent performing other more important tasks.

An example of a commercially available product is the *uSee remote monitoring system** (www.usee.com). By installing a uSee camera at a trough as shown in Figure 14, the manager can use the uSee app or website to check that the trough is full, that there is nothing stuck in it and that it is not overflowing.

Figure 14: uSee Camera monitoring a trough on "Olga Downs" station (uese.com website, 2016)

Note: The uSee remote monitoring system is a product with which the author has a professional/commercial interest and is presented as one example of a range of products available to farmers.

Remote livestock weighing and drafting

Another huge operating cost is actual handling of cattle. From moving cattle between paddocks to weighing cattle to send to market, handing cattle costs money. On larger stations, this involves many staff and typically a helicopter. By handling the cattle, they also lose weight due to stress, interrupted grazing time and being walked large distances.

Remote livestock weighing and drafting systems have the potential to totally revolutionize the beef industry in countries with high costs of labour such as Australia. By being able to remotely measure animals' performance or if a cow has calved, management decisions can be made by simply clicking a button. Using these tools, cattle can be drafted automatically into a small holding paddock where they can be loaded onto a truck and sent to market or slaughter without the labour or mustering expenses. Cattle can also be moved around the station by opening and closing gates remotely.

Precision Pastoral is an Australian company that has developed such a system called the Remote livestock monitoring system (RLMS) – pictured in Figure 15.

Figure 15: Precision Pastoral RLMS

The RLMS is an automated remote weighing and drafting system that uses satellite communication and solar power to operate in remote locations. Users of the RLMS can automatically weigh and draft cattle with the click of a button. Precision Pastoral has been able to demonstrate the significant benefits of such a system and have installed many systems throughout Australia.

Up and coming technologies

There are many up and coming technologies that have the potential to transform the beef industry.

UAVs

Another emerging technology that has sparked huge interest in the beef industry is the use of Unmanned Aerial Vehicles (UAV). UAVs take many forms, including helicopters, fixed wing and multi-rotor. UAVs have already transformed the cropping industry and have the potential to do the same for the beef industry.

Applications for UAVs in the beef industry include mustering, fence inspections and water monitoring.

Figure 16: Rob Cook – Mustering with Drone

There are still many challenges before UAVs can be in common use in the beef industry. Some of these challenges include maintenance and regulatory issues. It is still illegal in most of the world, including Australia, for a drone to be operated beyond line of sight and for them to fly autonomously.

Satellite imagery

Satellite imagery has many applications for the beef industry, from monitoring pasture to water monitoring. Commercial products have already been developed that are able to take the advancements made in the cropping industry in Normalized Difference Vegetation Index (NDVI) and apply it to larger pastures. Combined with walk over weighing, this provides the manager with quantitative information about the condition of the paddock and animals.

Going forward, near real-time satellite imagery will start to become available, allowing beef producers to monitor most of their property at extremely low cost and minimal capital investment.

Why we need change in the beef industry

The industry is at an unprecedented point in the Australian beef industry. We are now part of a global market, with beef available from many sources from all around the world. Beef can be shipped between continents in days at low cost, reaching markets, even 20 years, ago were hard to imagine.

Compounding this, cost of inputs are significantly increasing, for example, a brand new Toyota Landcruiser work vehicle used to cost the equivalent of eight bullocks. Now, that same vehicle costs closer to 50! This puts huge pressure on margins, which are lower than they have ever been.

At the same time, cost and availability of labour are causing big problems. Beef producers are no longer able to afford to just hire more staff to do the work. These issues have compounded, resulting in one of the toughest times in the Australian beef industry's history. Australian beef producers are already among the most efficient in the world (Price Waterhouse Coopers, 2011), however without constant improvements in efficiency and widespread adoption of labour saving technology, the industry will be in trouble.

Chapter 3: Understanding Change

> ***"The only constant is change"***
> Heraclitus

Change is a really difficult concept to define. It comes in many forms and we experience it in every part of daily lives. It broadly refers to an act or process through which something becomes different. We experience change and humans, as a race, would not be as successful as they are if we were not able to adapt. Change happens on many levels – from the toaster being moved to a different spot to totally changing how a business runs by implementing technology into your management system. In agriculture this can take the form of taking on new technologies, establishing new practises or policies, or modifying systems and processes on-farm.

It is fair to say that change can be uncomfortable, but change is inevitable. It is possible, however, to determine what impact change has; there is the opportunity to turn the need to change into a positive.

The Satir Change Model

The Satir Change Model (Smith, 2005) demonstrates there are several parts in the process of change, which is shown below.

- The late status quo
- Foreign element
- Chaos
- Integration
- New status quo

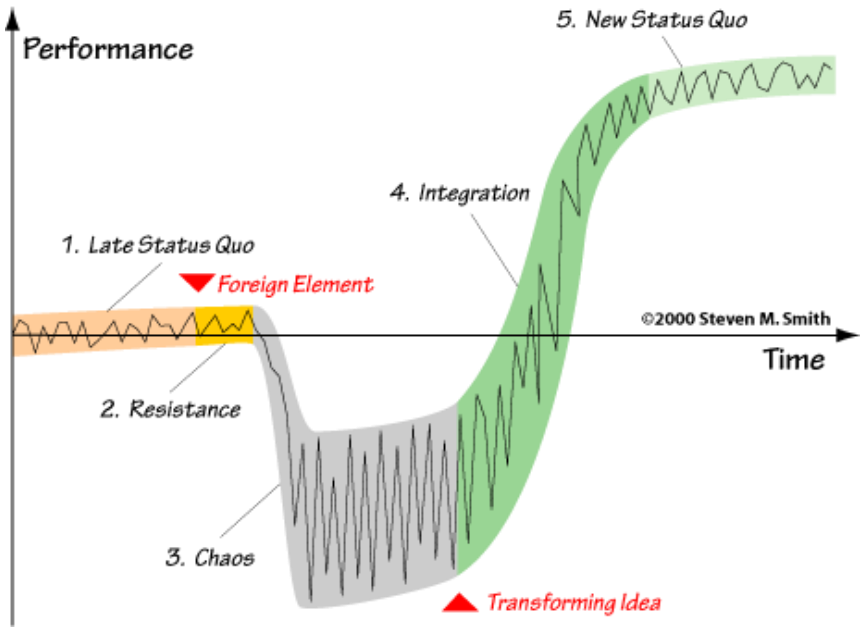

Figure 17: The Satir Change Model (SMITH, n.d.)

This process can easily be applied to adoption of technology in the beef industry.

The late status quo

The late status quo is defined by the Satir model as a familiar place where performance is constant and members of the group have a sense of belonging and identity. There are implicit and explicit rules that define behaviour and how things work. In beef farming it may include things like:

- *I market my animals using tradition methods*,
- *I check my water points once a week*,
- *I can tell the weight and supplement requirements of animals at an acceptable level using only my eyes* and
- *This worked for my father, and therefore will work for me*.

Members of this group know and understand what it is to be part of this group.

Resistance

When the group encounters a foreign element such as new way of doing something that challenges the way things are done, (for example, using a remote water monitoring system), it is met by resistance. This foreign element is normally introduced by a small minority who recognise the benefits of the change (for example, new technology) and seek change.

This resistance by most members of the group takes the form of denial of the idea's validity, avoiding the issue altogether or attributing blame to whoever brought about the change. This was seen in many cases where beef producers might say, "That is nice." and then instantly dismiss the idea.

This resistance can reduce awareness and cloud the benefits of the new technology.

Chaos

As the new idea starts to gain some traction (such as more people installing remote monitoring systems), the group descends into chaos. Old ideas and assumptions start to become less valid, and some of the traditional ways of doing things are no longer possible. This causes anxiety and a common effect is resorting to survival mode and no longer looking forward. This can cause a productivity loss as people start to look for efficient and beneficial ways to use this new technology. It can be a time of great creativity as problem solving occurs and adjustments are made in the workplace.

This chaos is critical to bringing on change. (Smith, 2005)

Integration

Once the critical mass of the group discovers and recognises the benefits to them of the new technology, a sense of opportunity and excitement is felt. It becomes acceptable by the group to use the technology and there are more people within the group to provide the support needed for this transformation to the new technology.

The new Status Quo

It is only after going through the discomfort of implementing the change can the benefits become clear. A perfect example of this in the Australian beef industry is the introduction of NLIS. NLIS was mandated nationally in 2005 and was a cause of great anxiety in the beef industry. There were, however some groups within the industry that recognised the benefits. Now, in 2016 eleven years after the introduction, more and more people are turning the cost of NLIS ear tags into a benefit by improving herd records. NLIS is now no longer seen a cost to these producers.

Application of the Satir change model

An excellent example of the Satir change model is the implementation of the Export Supply Change Assurance System (ESCAS) in Vietnam. Australia exports large volumes of live cattle to Vietnam and Australian beef has become an important source of cheap protein for the Vietnamese people who are not fully self sufficient in beef.

The ESCAS system was implemented in 2011 after changes in Australian law that required a tractability system for all live animal exports and required that any live Australian animals be fully traceable from the moment they leave Australia until they are slaughtered. This is now done through the use of a combination for RFID tags and video surveillance.

In July 2011 when ESCAS was mandated (the foreign element), it immediately forced change on the supply chain. This was met with resistance as would be expected when change is imposed on a group, however as the change was mandated the industry was forced to implement systems to meet the requirements of regulation.

Once implementation systems were developed (the transforming idea), and through the integration of these, a traceability system that met all the requirements of the regulators was deployed through the supply chain.

The end result of the introduction of the ESCAS system is excellent traceability for all Australian animals that are live exported, ensuring their animal welfare and guaranteeing the social licence for live cattle exports.

The benefits of this were seen first-hand with the excellent cattle handling facilities and methods that are now used for Australian cattle in Vietnam.

Figure 18: Cattle handling facility in Vietnam

The adoption curve

Many people have studied the concept of adoption. Understanding how to implement new ideas increases the uptake and success of innovations. Adoption of technology in the beef industry is no different.

In his book, *Diffusion of Innovation (1962), Everett Rogers described the Adoption Curve.* (Wikipedia, 2016). Rogers created the idea of the Innovation Adoption Lifecycle, represented as a bell curve in Figure 19.

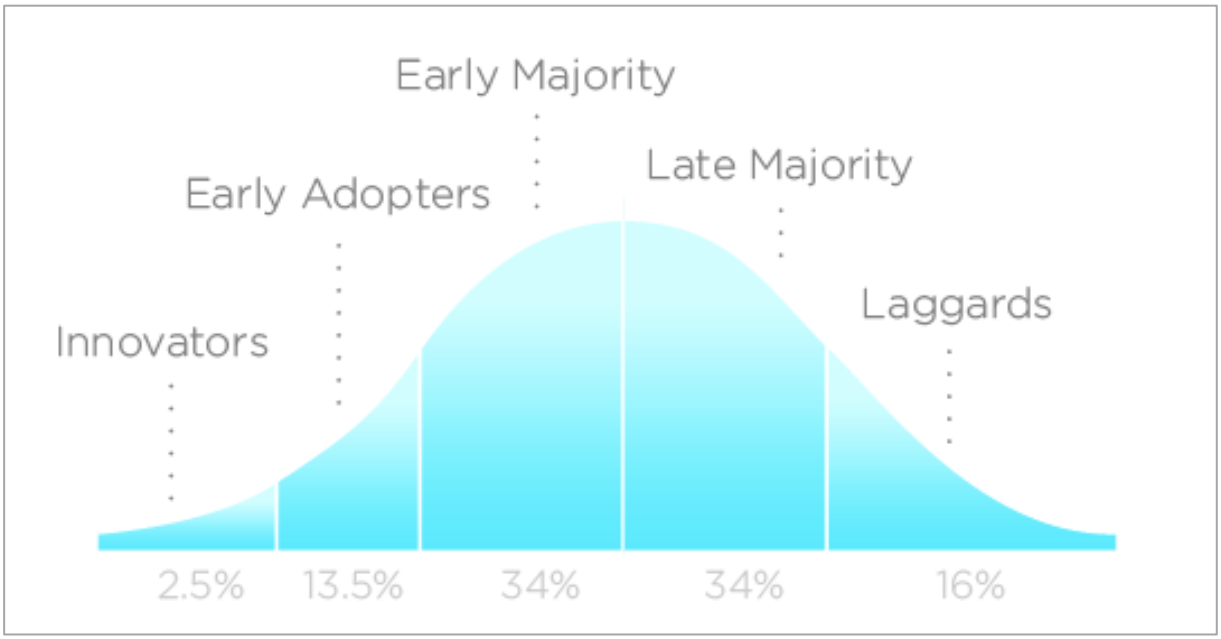

Figure 19: The Innovation Adoption Lifecycle (Wikipedia, n.d.)

The innovation adoption lifecycle represents people's approaches to adopting change; it is presented as a bell curve that splits people up into five groups.

- Innovators

- Early adopters
- Early majority
- Late majority
- Laggards

The challenge of adoption of technology has been an issue for a long time, so much so that the North Central Rural Sociology Committee, Subcommittee for the Study of the Diffusion of Farm Practices in the USA developed similar methods in 1957, to try to understand what needs to be done to increase technology in agriculture.

Innovators

The innovators are the first group to adopt any technology. For example, they were the first people to try a watering monitoring system before the benefits were even demonstrated, the first to use computers and all other new types of technology. They are prepared to take the risk that the technology they are adopting does not work or perform as expected. These are the people who buy a new gadget to be the first to have one.

Early adopters

The early adopters are generally younger and community leaders, who, after seeing what the innovators are doing with their new technology realise that it can help them improve what they are doing. This group is perhaps the most important group in the adoption curve, as the early majority look at the early adopters for the way forward.

Early majority

The early majority are open to new ideas but are generally more conservative. They are normally active in the community and often have contact with early adopters. They discuss ideas about how to improve what they do but are slower to act on them.

Late majority

The late majority are generally sceptical about change and innovation. They are often older and generally more conservative but will implement change after most people do so; when they see that they are some of the last to have not done so.

Laggards

The Laggards are change averse and tend to be focused on tradition and are the last group to adopt any change – if at all (On Digital Marketing, 2017). They also tend to be more advanced in age.

By using this adoption curve, it is possible to understand the different groups making up the market for the beef industry, and then to target the innovators and early adopters to bring about change and improve adoption.

Change in the beef industry

Both the adoption curve and the Satir change model can be applied to gain an understanding of how farmers view and adopt change.

The move towards globalisation has forced the northern beef industry into a position where the "status quo" is no longer enough. The world is changing and the traditional lifestyle view of running a northern beef enterprise is being challenged by a pressing need for efficient grazing practises. External factors such as financial pressures, global markets and droughts are placing a burden on beef producers, and this "foreign element" is going to force unprecedented change to the industry.

There is always going to be push back from these external impetuses for change, and this push back takes many forms.

Excuses for not adopting technology

As part of the Nuffield research, the author was given the opportunity to speak to many beef producers throughout the world to understand their insights into why they produce beef, the way that they do, and what they think about implementing technology on their properties. Of particular interest was understanding why farmers did not want to implement technology. Some of the reasons are discussed below.

Tradition

One of the major reasons adoption of technology is slow in the beef industry is tradition. 'My grandfather did it this way, my father did it this way so I will do it this way', but doing something for a long time it does not always make it right.

Beef production is an extremely old industry and has an amazing history especially in the EU. One of the 2016 Irish Nuffield Scholar's family had been on the same farm for over 700 years! This is almost three times longer than Australia has been settled.

I don't have the money to invest in that

This is commonly known as the investment paradox. When times are good and there is enough money to invest back into the business, the benefits for this investment are not needed as everything is going well. When times start to get a bit tougher and the benefits from such an investment would really start to help the business, the money isn't there to be able to do so.

Technology is a silver bullet

A common problem with adopters of technology is the expectation that technology is a silver bullet. For example, installing a water monitoring system and expecting to not have to do any more water runs. This is obviously not the case; it can be fitted into your management plan. Technology will not solve all farmers' problems, but it is part of the solution, not the whole solution itself.

Blame versus 'How to make this work'

Another common excuse for not adopting technology is the claim that it doesn't work. This comes down to the right attitude towards technology. Most people who use this excuse have tried implementing some sort of technology in their business and during implementation have had problems and given up. Most beef producers are not tech savvy and do not understand that technology, like their tractors, needs maintenance and will occasionally break down. By sticking with it and spending the time learning how it works and how to look after it, they will have a better experience.

'It's a lifestyle'

Experience in the beef industry suggests one of the biggest barriers to adoption of technology is the idea that producing beef is a lifestyle. Before proceeding any further, it needs to be pointed out that many beef producers are in the enviable position to be able to do what they love and generate enough money to have a comfortable living.

Beef producers who regard their business as a lifestyle will make fundamentally different decisions to a beef producer who is solely after a return on their investment. Those who are driven by passion to work in the beef industry and who enjoy the lifestyle afforded by it will employ different decision-making strategies compared to those driven by a purely economic imperative. They are more likely to stick with what they know, this will be totally different to if they are focusing on making money. Where a farm is run as a business, there will be greater focus on improving efficiency and lowering costs of production, which may include investing in technology to help them do so.

'I want to fit in'

Another reason for the reluctance to take up new technology is people's desire to fit in. This is not unique in the beef industry; it is part of human nature. The need to fit in is ingrained. People do not want to be different from everyone else. Following this line of thought, people who use this excuse need to see other people implementing technology before they will.

'I do everything to minimise risk'

Beef producers are in it for the long haul and are generally risk averse. They do not want to risk their livelihood. Beef producers who use this excuse need to see others using the technology and for there to be no perceived risk involved. Typically these people will fit into the late adopters category on the adoption curve.

'I don't have time to look at that'

Too often farmers are so busy focusing on what they are doing they do not take the time to stop, sit back and look at the big picture. Producers need to take the time to look at the big picture and work on the business, not for the business.

External challenges

Regardless of the attitudes of beef producers to technology, there are several external challenges that play a part in the poor adoption of technology in beef production.

Internet access

One of the biggest challenges in remote Australia is access to a decent Internet connection. The vast majority of Australian cattle stations only have access to satellite connectivity. Until recently, the average connection speed was well below 5mb, and the service so over subscribed it was impossible to even check email unless it was very early in the morning.

Things have improved somewhat with the NBN satellite, however it is still well below what the average city dweller can access. The poor Internet connectivity significantly limits the type of services available to use. Things like Dropbox, Xero, and YouTube are unusable. This also applies to many of the cloud-based systems that are used for most new technology products.

Lack of integration standards

Another challenge to the adoption of technology is a lack of integration standards. Almost all agricultural technology providers (with the exception of a few companies) do their best to lock their customers in so that they are not able to move to other providers easily. This, combined with a lack of open standards available for technology providers to implement is slowing the creation of the technology the industry so desperately needs.

Lack of government support

In the Australian beef industry, there is a significant lack of support for the government on education and support services. A good example of this is for the whole of North West Queensland there are only two beef extension officers whose role it is to support the beef industry and help educate producers. These extension officers are not provided with a car to be able to travel to the graziers!

Gone are the days when the beef extension officers would travel to properties to discuss what can be done to improve the grazier's properties and practises, and help spread new methods and technology becoming available.

The only significant government support that has been offered to the beef industry in Australia for adoption of technology was in 2005 when the government mandated the introduction of NLIS and provided subsidies for the purchase of RFID readers.

Isolation

One of the main social factors in the beef industry (particularly in Northern Australia) that can make it difficult for new ideas to spread is isolation. Australian beef producers are used to working alone. This isolation is the nature of the job and makes it extremely difficult for people to engage with their communities to discuss new ideas.

Unique Australian challenges

Australia has its own unique challenges, like most countries, and this includes things like tall poppy syndrome. This can take many forms but it does have an impact on adoption of technology in the beef industry. By adopting technology on your station or challenging the status quo, you run a risk of being different. That being said, some people just like being old fashioned!

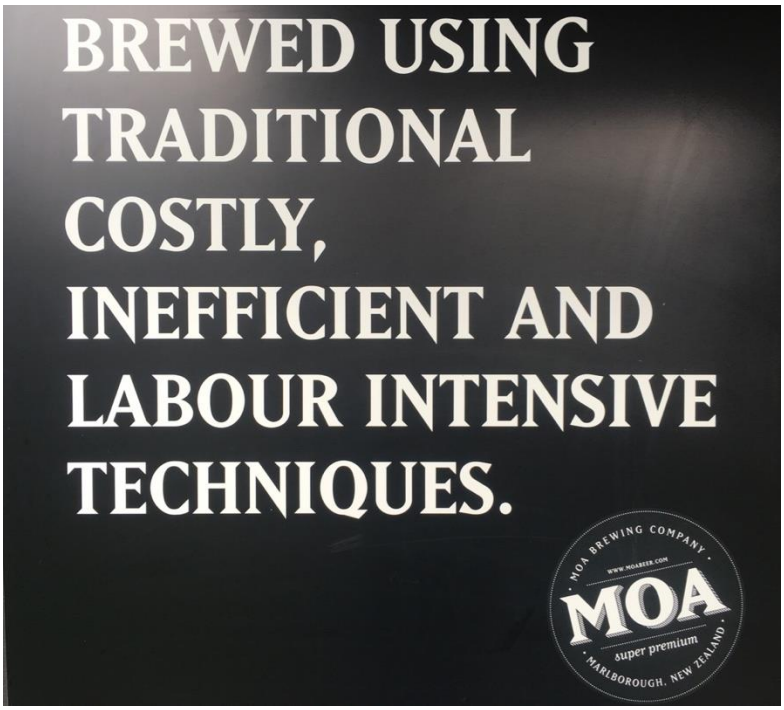

Figure 20: Moa Brewing company - Challenging the status quo in New Zealand

Conclusion

Resistance to change is not uncommon but there are ways to nurture change and make the transition to new methods, ways of thinking and problem solving, and new systems more effective. After being given the opportunity to study technology in the beef industry around the world, there were several things that really stuck out in the success stories.

Firstly, the countries with access to good communications and support networks were able to disseminate new ideas a lot quicker than those that did not. This did not stop overriding factors such as subsidies and other market controls reducing the incentive to change but these features were absolutely critical to encouraging to any uptake of new ideas.

Secondly, it is to really important to understand that resistance to change is a very human thing. We can understand the process of change through the Satir change model and the Adoption Curve; applying theses understandings can be used to overcome and manage barriers to adopting new technology. This, along with increased education and technical literacy are key to moving agriculture into the 21st century.

With the world's population on the way to ten billion people by 2050 and Australia's geographical advantage places its beef industry in a prime position. Global beef consumption is only going to go up. To capitalise on this, the industry needs to address labour and efficiency challenges through the use of technology, learning from similar experiences overseas.

There are several things that can be done to support change in the northern beef industry. These approaches can include emphasising the value of education to the industry, demonstrating the value of training and an improvement in the communications infrastructure in northern Australia to enable better dissemination of ideas, and if necessary regulation.

To continue to succeed, the beef industry needs to embrace technology and take advantage of the benefits it can provide. It needs to work smarter, not harder to keep its place in the world. By understanding the process of change the industry can begin to increase the adoption of technology.

Change can be managed through:

- An increased understanding of the chaos experienced by people throughout the change process.
- Providing guidance throughout this phase (and supporting the people guiding this change).
- Ongoing support for the establishment new ways of working to become the new status quo.

- Harnessing the early adopters, and actively target and support others in the industry to take up new technologies.
- Using regulation where necessary but only as a last resort.

This change will better place the Australian beef industry for any future challenges. With support from government and other industry bodies, beef production in Australia has a bright future and technology will be a key part of that going forward.

Recommendations

1. Support early adopters

The early adopters are critical to getting any technology implemented. They are the first group in the Adoption Curve that are truly taking a risk by giving it a go. They are also the group that the early majority looks to before they start adopting any technology. The early adopters must be identified and well supported if new technology is to succeed. Key is to understand people and where they fit on the adoption curve; minimal effort should be put into supporting the laggards as they will only adopt new technology after every other group, energy is best invested in those most likely to take up new technologies and ideas.

2. Better dissemination of information

One of the challenges of increasing adoption of technology in the beef industry is getting people to understand the benefits of different technologies. To do this, time, effort and resources must be set aside specifically. A good example is the obvious and immediate benefits to remote water monitoring. Working with individuals, or small groups of beef producers and demonstrate the benefits to them, often the producer will be able to see the benefits, and will not instantly dismiss the technology.

This information needs to be provided in a simple, easy-to-use form, as the industry does not typically have the analytical skills or technological understanding to read datasheets and other technical information. It is important to prepare responses to common pretexts for avoiding change and preconceptions that are used to detract against change. This does not normally work if it is a direct sales push, it needs to come from a trusted adviser who the producers know and have confidence in, and who they believe to be acting in good faith. Producers of technology must also understand the intricacies of the market to ensure their products are easy to understand and use.

3. Trusted advisers

Trusted advisers are people the beef producer has confidence and trust in. Beef extension officers and paid advisers are an example of this. At the moment, there are not many advisers devoted to the northern beef industry and, although this is changing, the lack of beef extension officers is a major concern. There should be more support and training for these trusted advisors and a focus on helping the industry overcome the stigma of asking for help. The government must also actively support it beef extension officers and understand their importance to the industry.

4. Support networks

A support network that lets the farmer mix and socialise with their peers is an excellent tool that is used in many countries. Some examples of these include:

- Young Farmers in NZ.
- 4H in the USA and Canada.

- Discussion groups in Ireland.

These groups should be supported and encouraged as they get young people to learn and share ideas.

5. Better communications infrastructure

Modern communications infrastructure such as high-speed Internet connectivity is critical to the dissemination of information. Access to a high-speed internet connection is an enabler for many of the components of a modern business including email, social networking, video conferencing and webinars and cloud services. There should be a focus on supporting regional internet providers and an understanding that the current NBN satellite solution may not be enough in the future

6. Education

Education is another critical component needed to increase the adoption of technology. There is no point trying to sell something if the people who buy it are not able to understand its purpose or how it works. Education can be achieved through field days, webinars and other social events. This also gives beef producers an opportunity to discuss the idea socially. It is also critical to communicate the value of training to the industry as a whole.

7. Government

Another way to bring on change is to mandate it. By forcing change through legislation beef producers have no choice and must change. Obviously, this is a very unpopular way of making change, however sometimes; it can be the only way. This was seen in the EU dairy industry when it was deregulated in 2015. Another good example of this is NLIS. NLIS was introduced in Australia in 2005 and caused huge turmoil in the industry. It also artificially inflated markets such as the NLIS readers through government subsidies, however it also forced the level of computer literacy in the industry to increase, which is a good thing.

Mandating change must be a last resort however is extremely effective at bringing a change that is needed. Australia now has one of the best traceability systems in the world and is better prepared than most for any outbreaks of infectious diseases. NLIS has also been used to gain access to international markets that our major competitors are not able to.

The industry needs to understand that a government mandate can be a usefully way for force change on the industry and to work with the government to mandate changes that the industry deems necessary. This will prevent parts of industry being left behind.

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Plain English Compendium Summary

Project Title:	Change: Increasing adoption of technology in the Australian beef industry

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Objectives

This study explored:

- The adoption of technology in the Australian beef industry
- How other countries have adopted technology in their beef industries
- Several models that can be applied to understand the state of adoption of technology in the beef industry

Background

The Australian beef industry is experiencing ever increasing cost of production and increasing global competition, it is, however, is slow to adopt new technologies that reduce operating costs to allow it to remain commercially viable.

Research

Extensive literature review along with many interviews and meetings in many countries including the USA, Canada, Ireland, Poland, Kenya, South Africa, Japan, New Zealand and Australia.

Outcomes

Several recommendations were identified that would help increase adoption of technology in the Australian beef industry. These included:

- Formation of support networks.
- More support for early adopters.
- Improving communication infrastructure.
- Supporting and increasing the number of trusted advisors.

Implications

By understanding and managing the process of change the Australian beef industry will increase its adoption of new technologies that can be used to reduce costs and allow it to continue to remain one of the most efficient producers of beef in the world.

Publications

Verbal presentation at the 2017 Nuffield Australia National Conference, held in Darwin, Northern Territory, September 2017.