A Nuffield Farming Scholarships Trust Report

Award sponsored by

The Royal Highland and Agricultural Society of Scotland

Electronic Identification (EID) in the cattle industry

Robert Neill

October 2014

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A Nuffield (UK) Farming Scholarships Trust Report

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Date of report: July 2014

Title	Electronic Identification (EID) in the cattle industry
Scholar	Robert Neill
Sponsor	The Royal Highland and Agricultural Society of Scotland
Objectives of Study Tour	➢ To investigate how technology is being implemented in the beef industry ➢ How to find a system of electronic identification that is workable and measurable ➢ How to maintain a profitable beef industry in the United Kingdom
Countries Visited	Canada Argentina Australia New Zealand United Kingdom
Findings	➢ Electronic identification in the beef industry needs to be made compulsory in order for progress to be made ➢ A national database needs to be developed to be used for benchmarking and analysis ➢ For the beef industry to survive in an ever changing world farmers need to be using the information that can be collected to make more informed decisions about their business ➢ All parts of the supply chain should be working together in order to produce a product that matches consumer needs

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DISCLAIMER

The opinions expressed in this report are my own and not necessarily those of the Nuffield Farming Scholarships Trust, or of my sponsor, or of any other sponsoring body.

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1.0. Introduction

My name is Robert Neill and I was born in 1967, the oldest of four children, into a dairy farming family in north Northumberland. From a very early age I knew that I wanted to follow in the footsteps of my father and become a farmer. My father's family had moved to north Northumberland in 1954 from a dairy farm in Ayrshire in the West of Scotland. At the age of 16 I left school with a bare minimum of qualifications. At this time my father had just taken over the tenancy of an upland farm in the Scottish Borders. Rather than going to study at college I was offered the opportunity to take over the running of this upland farm. During this time I started to build a herd of beef cows to run alongside the sheep enterprise. We held the tenancy on the farm for sixteen years but during this time we had three landlords. By this time I had built up a herd of 200 beef cows and had invested in the facilities on the farm, but when an opportunity arose to take on the tenancy on a farm 30 miles away I jumped at the chance. I had recently married Jac and our first son, Andrew, had been born. With a fifteen year tenancy on offer it was a much more secure position for my new family. Our second son, Harry, was born shortly after moving to Upper Nisbet.

Figure 1 : Me, Robert Neill

We moved to Upper Nisbet in 2000 and since then we have grown the business. With considerable investment being made again in the facilities, the arable land and increasing the beef cow herd, we have now reached 300 cows.

In 1997 I purchased our first weigh bars and weigh head and started weighing and recording daily live weight gains in our cattle herd. The missing link at this time was using electronic identification to streamline and automate the weighing process. In 2006 I was delighted to win the Farmers Weekly Beef Farmer of the Year award. Shortly after winning the award we were approached by a tag manufacturing company to ask if we would be interested in trialling RFID tags in our herd. I saw this as a great opportunity for our business. From this point on we have continued to trial a number of different types of tags and equipment.

I have always been interested in monitoring the performance of our cattle herd and in order to do this I have been adopting new technology before it has become compulsory. I believe that new ideas and technology have to be embraced, and although not every new idea can practically be implemented, or will benefit my business, we have to move forward with an open, optimistic mind in order to tackle the difficulties facing the world-wide cattle industry.

My other main focus has been safety of both staff and animals on my farm. In order to achieve this I have spent a considerable amount of time designing and creating safe and efficient handling facilities for our animals. *(see picture below)*

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Figure 2 : Handling facilities at Upper Nisbet Farm

2.0. Electronic Identification (EID)

What is EID and how can it be used to benefit livestock farmers, processors and consumers?

EID is a means to tag a live animal. Around the world most EID tags currently being used are low frequency, either full duplex (FDX) or half duplex (HDX) transponders. These are all manufactured to an ISO11784/ISO11785 standard (standards are specified by ICAR: See Appendix 2: International Committee for Animal Recording (ICAR). These transponders are a 64-bit chip which can only store a certain amount of numbers, and can only store numeric data. Sheep EID tags are What You See Is What You Get (WYSIWYG) which means the number on the chip is the same as the number printed on the ear tag and these tags are read in decimal format.

Cattle tags are mostly Low Frequency (LF) but are not WYSIWYG which means the number printed on the outside of the tag is not the same as the number on the chip. This means that when you order cattle EID tags you also get what is called a tag bucket. A tag bucket is a computer text file which you have to import into your livestock management software on your computer or reader hardware which will then create a link between the two different numbers. From this point on you will only see the number that is printed on the ear tag in both the computer software and on the tag readers. This system is currently too complicated and must be simplified for more producers to want to use this technology. There needs to be a push to make cattle tags WYSIWYG.

This system is currently too complicated and must be simplified for more producers to want to use this technology. There needs to be a push to make cattle tags WYSIWYG.

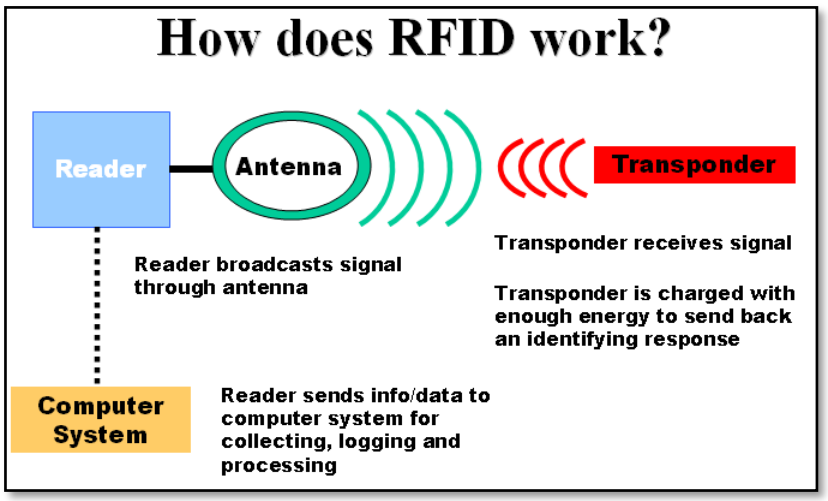
The huge benefit of using EID in livestock production is being able to have a traceable product from birth to plate. If there are outbreaks of disease it should be possible to trace the movements of any animal affected and to follow back through the family tree of any particular animal to identify possible origins.

The other benefits include not having to manually read tags which can at times be difficult and result in human error. As well as the possible mistakes that can be made by manually reading tags there are issues of safety for both the people reading the tags and the animal being restrained. Being able to read tags automatically and keeping a safe distance from the animal allows the animals in most instances to remain calmer and the risk to staff being injured is also reduced.

2.1. Radio Frequency Identification (RFID)

Radio-frequency identification (RFID) is the wireless use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. The tags contain electronically stored information. Some tags are powered by electromagnetic induction from magnetic fields produced near the reader. Some types collect energy from the interrogating radio waves and act as a passive transponder. Other types have a local power source such as a battery and

may operate at hundreds of meters from the reader. Unlike a barcode, the tag does not necessarily need to be within line of sight of the reader, and may be embedded in the tracked object. Radio frequency identification (RFID) is one method for Automatic Identification and Data Capture (AIDC).



2.2. RFID Frequencies

RFID tags can use different frequency bands: low frequency (LF), high frequency (HF) and ultra-high frequency (UHF). There are also two other types of systems, which are passive or active.

The low frequency band covers frequencies from 30 KHz to 300 KHz although typically they operate at 125 KHz. This band provides a short read range and a slower read speed than the other frequencies, but the advantage is that LF is less sensitive to interference. This is the frequency used most widely in livestock tracking at the moment.

The high frequency band covers frequencies from 3 to 30 MHz although typically operate at 13.56 MHz. Read ranges are usually between 10 cm and 1 metre.

The ultra-high frequency band covers frequencies from 300 MHz to 3 GHz although typically operate between 900 and 915 MHz. The read range of passive UHF systems can be up to 12 metres. They have a faster data transfer rate than either of the two bands but are most sensitive to interference. Passive UHF tags are the easiest and cheapest to manufacture and this is the fastest growing area of the RFID market.

2.3. Active or Passive

Tags can be either Active or Passive.

Active tags are larger and have their own power source, usually a battery. The active tags broadcast their own signal and are usually used with UHF frequency bands. These tags will have a range up to 100 metres.

Passive tags do not have their own power source and rely on the antenna sending a signal to "wake up" the tag to send its information back to the antenna. These tags are smaller and cheaper and can be used with LF, HF and UHF but have a range of less than 10 metres.

2.4. RFID and the cattle industry

Low frequency (LF) tags contain 64-bit chips and have very limited storage. High frequency (HF) tags contain a much larger chip and can store much more information. For example, these chips could record all the information currently being held on cattle passports, as well as movement data and any drug administrations. The data on high frequency tags can be read and written to, unlike the low frequency tags that simply hold the tag number which can only be read to identify the animal.

There is a possibility that if high frequency technology were to be embraced for the cattle industry then there is the potential for paper copies of cattle passports not to be needed. In my opinion there are huge savings to be made within the industry if this technology were to be adopted. The cost of operating the current system of issuing cattle passports is surely a catalyst to attempt to adopt a more cost effective system. With the database technology currently available a new paperless system is surely possible. If some farmers still wanted to have a paper copy of any passports there should be a facility to allow them to print one off at their own cost.

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One of the problems with UHF technology is that LF hardware will not read the UHF tags. Sheep farmers who have invested a lot of money in hardware to work with sheep RFID tags cannot be expected to re-invest more money to be able to use UHF. Dairy units around the world are all also using LF technology in their milking systems.

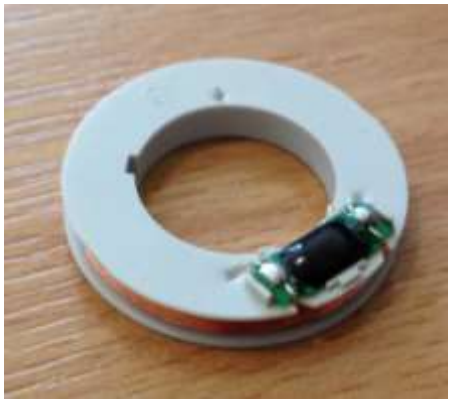

Figure 3: Low frequency Half Duplex chip used in cattle ear tags

Figure 4: Ultra High Frequency chip used in cattle ear tags

2.5. Tag Retention

In every country I visited there was a problem with tag retention. Some people I spoke to during my travels reported a 66% tag loss rate. This very high loss rate was mainly due to the difficult terrain these cattle were grazing, which consisted of mainly rough bush and scrub.

In the United Kingdom we have an annual tag loss of 10% in cattle. As of December 2013 the UK cattle population was 9.68 million. With replacement tags costing, on average, £2 per tag this amounts to an additional cost of £1.94 million to the cattle industry.

In the United Kingdom we have an annual tag loss of 10% in cattle. … this amounts to an additional cost of £1.94 million to the cattle industry.

In some countries the problems with tag retention were exacerbated by extreme weather conditions. It has been proven that tags that are inserted during extremely cold conditions are much weaker than tags inserted in warmer weather. In warmer conditions there is an increased risk of infection in the tag site.

Tag placement is another problem and tags not inserted properly in the middle part of the ear will be more likely to get caught on fences etc. and will be pulled out. Perhaps there needs to be more advice available on the correct placement of ear tags.

Figure 5 Tag inserted too close to the end of the ear

Figure 6: Tag inserted correctly in the middle part of the ear

3.0. Canada

I travelled to the state of Alberta, Canada in July, 2013. During my first day there I had meetings arranged with the Canadian Angus Association; the Canadian Beef Breeds Council; Alberta Beef Producers; Canadian Cattlemen's Association; Alberta Beef Producers and the Canadian Cattle Identification Agency (CCIA).

Visiting all these organisations during the first day of my study tour gave me a good insight into beef cattle production within Canada. As of July, 2013, there were approximately 11 million bovines in Canada with 4.87 million in Alberta, which is 44% of the total. This overall figure, however, is 20% lower than it was in 2008. This seems to be following the trend of falling cattle numbers in all the countries I visited. The declining profitability of the industry as well as climatic pressures such as drought and flooding all seem to be contributing to the fall in numbers.

3.1. Canadian Cattle Identification Agency (CCIA)

The Canadian Cattle Identification Agency (CCIA) was established in 1998 and currently has 68,000 registered cattle producers throughout the country. The average cattle herd size in Canada is 40 animals. All cattle owners must be registered with the CCIA and have a Premises Identification (PID) number which is the equivalent of the holding numbers used in the United Kingdom.

Since 2006 it has been compulsory for all cattle to be identified with a Canadian Cattle Identification Agency (CCIA) approved RFID tag before the age of 10 months, or before leaving the farm of origin – whichever occurs first.

RFID tags are bought from local tag dealers. When a beef producer purchases RFID tags, the numbers associated with each tag are assigned to that individual's PID and these tags can only be used on the owner's premises. The tag dealer must register the purchase of tags within 24 hours to the CCIA's database.

RFID tags must be approved by the CCIA to be used within Canada. There are currently six approved tags:

- Allflex FDX
- Allflex HDX
- Destron
- Y-Tex
- Ketchum
- Zee-tags

These tags all have a three quarter maple leaf and a unique 17 digit identification number both printed on them, as well as being electronically pre-programmed onto each one, and are all low frequency.

Age verification is linking an individual animal's birth date to an RFID tag number on the Canadian Livestock Tracking System (CLTS) database. Either individual dates or batches can be recorded. For example, all calves born in the months of March and April can have the same date of birth (a batch).

Figure 7: Canadian Angus Rancher Endorsed RFID Tags

3.2. Aberdeen Angus Association

In Canada there are currently 140,000 pedigree registered Angus female cattle. 60% of the Angus herd is black Angus and 40% is red Angus. In 2012 Angus genetics accounted for 50% of the bovine herd.

In 1999 the Angus Association started electronically tagging with Canadian Angus Rancher Endorsed RFID Tags. The Association decided to launch these tags to promote the Angus breed. They are currently supplying 300,000 tags a year. For animals to qualify to use these tags all the calves must be from a registered Angus sire.

3.3. The Canadian Livestock Tracking System (CLTS)

The Canadian Livestock Tracking System (CLTS) was established in 1998 and is run by the CCIA. This is a trace-back system designed for the containment and eradication of animal disease. The CCIA has developed the only mandatory, national cattle identification programme for the cattle industry and works with the Canadian Food Inspection Agency to ensure the food safety of the Canadian beef industry.

They have now developed a mobile app, called CLTS MOBD, to be used on a smartphone. The app can be used to access information such as:

- Tag numbers
- Transaction numbers
- Animal information
- Premises information
- Birth certificates

3.4. Ranchers

The big ranchers are operating with large numbers of cows on vast areas of land. Most large ranchers see tagging calves at birth, or later in their life, as a waste of time. The terrain that their cattle are grazing makes the retention of any type of ear tag problematic.

Most ranchers think that hot branding is still the best method of identification. Their view was that a brand never falls out and also that you can see a brand from a distance. Every ranch has its own unique brand, registered on a database.

Figure 8: Hot branded Canadian cattle

I visited one ranch that was tagging all calves at birth with Angus RFID tags and recording dates of birth. They were also using computer software to record all breeding data, movement data and sales. This operation was running 900 cows over an area of 10,000 acres at an altitude of 5,000 feet. This rancher also retained ownership of all progeny until slaughter. The calves were weaned and put into a feedlot under different ownership.

3.4.i. Feedlots

I visited four feedlots of different sizes holding from between 10,000 and 45,000 head of cattle. They were all very impressive units and well managed. The feedlot operators commented that RFID tags had made a big difference to their job enabling them to more easily record data such as movements, weights and drug administration.

The feedlots I visited all used computer software to record and track animals. Their handling systems were the best systems that I have seen anywhere in the world. They were all using hydraulic squeeze crushes. Some had built-in RFID readers and some were using hand-held RFID readers. They had all adapted the Temple Grandin template to design the handling facilities.

The Temple Grandin design template was designed by Dr. Temple Grandin who is a designer of livestock handling facilities and a Professor of Animal Science at Colorado State University. Curved chute and race systems she has designed for cattle are used worldwide and her writings on animal behaviour have helped many people to reduce stress on their animals

during handling. Curved cattle chutes are more efficient for handling cattle because they take advantage of the natural behaviour of cattle. Cattle move through curved races more easily because they have a natural tendency to go back to where they came from.

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"*During twenty five years of work on livestock handling and design of restraining devices for animals, I have observed that many people attempt to restrain animals with sheer force instead of using behavioural principles. Improvements in the design of restraining devices enhance animal welfare and will reduce stress and injuries. Quiet handling of cattle will reduce stress and injuries in squeeze chutes. Excited animals are more difficult to handle. It takes up to 30 minutes for an excited animal to calm down. To keep animals calm in a restraint device they must be calm when they enter it. Cattle should walk into a squeeze chute and walk out of it. Feedlot operators have found that calm handling of cattle in squeeze chutes will enable cattle to go back on feed more quickly." Prof. Temple Grandin*

Figure 9: An Example of Temple Grandin Handling Facilities

All the handling facilities were inside; insulated and heated due to the extremely cold conditions in which they are work during the winter.

Figure 10: Handling facilities in a Canadian Feedlot

3.4.ii. Auction Companies

I visited several auction yards, both large and small, during my time in Canada. The auction companies held mixed opinions on the use of RFID tags. Some said it was the way forward but other companies did not use them at all. The most pro-active company that I visited used both a cattle race with a row of linked panel readers and also a long pole stick reader, but they were simply using these devices to check the tags and weren't doing anything else with the data.

3.4.iii. Abattoirs

The large abattoirs in Canada have embraced the use of RFID tags and said it was helping with the throughput of animals through their facilities. There is now no manual reading of tags, which removes the risk of read error. Abattoirs are reporting a 98% read rate over all tags. As a result of using this technology they are able to record kill data against each individual animal and report this back to the producers.

By automating their systems they have been able to reduce their labour requirement which has been particularly important in the light of the changes to employment law in the country. Most of the employees were immigrant workers but now companies can only employ a maximum of 10 per cent of their workforce from outwith the country and the time that immigrant workers can stay in Canada has been reduced.

3.5. On-Farm trial

One of my last visits in Canada was to a farmer in British Columbia. He farmed 1,650 acres of owned land and a further 5,000 acres of rented land. He had 400 cows plus followers. The farm was located 3,000 feet above sea level with 12 to 18 inches of rain per annum.

This farm was doing an on-farm trial with Ultra High Frequency (UHF) tags. He had cows in batches of 25 animals in each trial group. In the corner of each field he had placed an antenna and was getting approximately 3,500 reads in any 24-hour period. The antennae have a read range of 2 kilometres. He was monitoring movement: how far cows were travelling and how many times they came to drink water. He could also monitor when the cows were in season by the level of activity of the cows.

Figure 11: Antenna used for UHF trial

This UHF technology is very much in its infancy. The biggest problem that he was encountering was tag retention. The reason for this problem was that he was using active tags that are heavier and larger than normal tags because the active tags must contain a battery that is used to transmit the information back to the antenna.

The biggest problem that he was encountering was tag retention.

Figure12: Antenna placed in the corner of the field to record cattle activity

Figure 13: Active RFID tags being used for UHF trial

Figure 14: Tag retention issues when using active RFID tags

4.0. Argentina

I arrived in Buenos Aires on Sunday 8th December, 2013. This visit was the most challenging of all of my overseas travel. I didn't speak the language and Nuffield Farming is not a well-known organisation in the country.

I visited one of the biggest livestock auction markets in the world. They can sell and hold up to 35,000 cattle for a single sale. Cattle are brought into the market from a radius of 500 km in the Buenos Aires province. The cattle arrive at the market through the night from 6.00 pm until 6.00 am and are then sold from 7.30 am each day. There are thirty auction companies working within the site.

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Cattle are weighed on arrival to give the buyers a guide weight. The cattle are then weighed when they leave the site. The leaving weight is the weight that the purchaser pays on. The weight and price are displayed on a real-time website so current auction prices are used throughout Argentina as the base price for beef.

Figure 15: Cattle Market in Buenos Aires

The day I was at the auction was only a small sale with 10,000 prime cattle being sold. The average live weight that day was 380kg and the average price was 13 pesos per kilogram. The exchange rate at that time was £1 = 10 Argentinian pesos.

Argentina has a cattle-breeding herd of approximately 22 million cows producing 18 million calves every year.

In 2006 rules were brought into place for EU export so that all cattle have to be double tagged with a large primary tag and a small button tag. If an animal loses a tag then a blue replacement tag is fitted and at that point EU accreditation is lost. There are currently no RFID tags at all being used in any livestock in Argentina.

I attended a meeting of the CRE, which is the Argentinian equivalent of the National Farmers Union in the United Kingdom. The main topics they were discussing were cattle identification and traceability. I had taken copies of cattle passports and cattle tags that I use back in Scotland. This organisation wants to progress the beef industry in Argentina in terms of tagging and traceability. The farmers were reporting tag losses of up to 66% due to the difficult terrain, extreme heat and also infection in newly fitted tags. Some producers hand over the tags to the haulage contractors in a plastic bag, rather than tagging their animals, because of the problems described.

The farmers were reporting tag losses of up to 66% due to the difficult terrain, extreme heat and also infection in newly fitted tags.

Their aim is to be able to export beef to the EU, which in turn, they predict, will increase the beef price in Argentina. In 2005, 720,000 tonnes of beef was exported; however, by 2013 only 2,000 tonnes were being exported. On average each Argentinian will consume 60kg of beef per year which is one of the highest consumption rates per capita in the world. By comparison, in the United Kingdom the average consumption in 2012 was 18.1kg per capita.

On average each Argentinian will consume 60kg of beef per year which is one of the highest consumption rates per capita in the world.

At present all records are carried out manually and on paper. The Argentinian government would like to change to a computerised system and introduce RFID tags.

All the farmers that I visited had very low production costs. The cattle were kept outside all year round and labour was very cheap.

5.0. Australia

I arrived in Brisbane, Australia, on 27th January, 2014, and travelled extensively throughout Queensland, New South Wales, South Australia and Victoria until 14th February, 2014. During this time I visited sale yards, abattoirs, feedlots and farms.

The use of RFID tags in Australia has been compulsory since 1999. All livestock producers in Australia have a Property Identification Code (PIC) similar to herd numbers in the United Kingdom.

The use of RFID tags in Australia has been compulsory since 1999.

Australia has a total cattle population of approximately 24 million animals. They have in place a National Livestock Identification System (NLIS). NLIS is a government-run system with a national database to record all cattle registrations and movements. This database aims to provide whole-of-life traceability for cattle in Australia. The cattle NLIS was established in New South Wales on 1st July, 2004. In the event of any disease outbreak it would be possible to trace back any animal movements to find the source of any outbreak. It is mandatory for all cattle producers to report information to the NLIS.

All cattle movements have to be notified to the NLIS database.

- Movements between properties have to be notified by the producer;
- The agent notifies sale yard movements; and
- The abattoir notifies the movement of animals when they arrive at the abattoir.

5.1. Gracemere Sale Yards

I visited Gracemere Sale Yards where, during one day's sale, 4,500 cattle were being sold. The local authority owns Gracemere.

There were 14 agents (auctioneers) who all rented sale space. This is a brand new sale yard facility and the most sophisticated system that I saw throughout my travels. A team of people employed by the local authority handled all the cattle. This team also read all the ear tags and entered all the cattle movements on-line. The electronic ear tags were read with a long pole reader. Once the tag had been read the information went straight onto a "tough book" (a robust laptop designed for outdoor use).

(this was) the most sophisticated system that I saw throughout my travels

All the cattle were weighed after they were sold and were sorted into buyers' lots. All this was done automatically with air or hydraulic operated gates. They also had a weighbridge with RFID readers over the top of it.

Figure 16: "Tough book" used at Gracemere sale yard

Figure 17: Weigh-bridge with RFID reader panels above the animals

Figure 18: RFID pole reader

5.1.i. Haulage

I met with one haulage company that scanned all cattle into their lorries. This is relatively easy because they are all loaded up a single file chute into the side of the lorry. If a tag does not read, or if the animal has lost its tag, it cannot be transported. Once the animals are loaded the driver prints off a document with all the tag numbers listed. The driver then leaves a copy at the point of collection, has a copy for the receiving customer, and has a final copy to go with the invoice. The driver can also email this movement directly to the NLIS database.

5.1.ii. Abattoirs

The abattoirs that I visited all read the RFID tags on entry to the abattoir premises. The RFID tags were then read at the point of slaughter when a label was also printed with the animal's identification number that was attached to the carcase.

Trials have been carried out in Australia and other parts of the world to test other means of RFID which included rumen boluses and microchip implants. Rumen boluses are applied using an oral applicator and are approximately 74 grams in weight. Rumen boluses have very good retention rates and work well with panel readers. Rumen boluses cannot be inserted into a new-born calf and therefore there would still be a requirement for ear tags. They consist of a glass microchip in a ceramic case. The microchip implants are injected under the skin of the cattle and are more widely used for the identification of domestic pets. The chips are about the size of a large grain of rice and use passive RFID technology.

The abattoirs did not like rumen boluses as a form of identification for two principal reasons:

- They could not see them and so, if the boluses did not read, they did not know if they were actually present in the animal.
- They caused problems when cleaning out the animal's stomach – boluses could be rolling around the floor.

The also did not like to use microchip implants for the following reasons:

- The microchips implants migrated around the body so could not always be found and if they were not read they could not determine whether they were actually present.
- They were concerned about contamination of the meat.

Figure 19: RFID tag being read upon entering the Abattoir

5.1.iii. Farms/Ranches

Farmers were starting to adopt the technology made available to them and could see the benefits to be gained from using RFID tags as a means of recording and measuring. The technology can be used to weigh finishing stock and carry out routine drug administration.

6.0. New Zealand

During my visit to New Zealand in February 2014 I visited farms, feedlots, abattoirs, tag manufacturers, hardware manufacturers, government officials and cattle crush manufacturers.

6.2. National Animal Identification and Tracing Scheme (NAIT)

The National Animal Identification and Tracing Scheme's mission is to protect New Zealand's agricultural export market by linking people, property and livestock. Under the scheme, animals are traced using NAIT-approved RFID tags. Once tagged, the animals (cattle and deer) are registered in a national database. The details being recorded are:

- The animal's location
- All movements each animal makes
- Contact details for the person in charge of the animal

65,000 people in charge of animals have been registered with NAIT.

NAIT is currently funded by producers of deer and cattle in New Zealand. There is a levy on every RFID tag that is purchased, which is approximately 90c per tag. If registrations and movements are carried out on-line there is no charge; however, there is a charge of NZ$1 for every cattle registration, and NZ$1 for every movement that uses the paper-based system. There is also a slaughter levy of 50c per animal giving a total of NZ$1.40 per animal to cover the operating costs of the database. There are approximately 10 million cattle in New Zealand. Thirty full-time staff operates the NAIT database.

The National Animal Identification and Tracing Scheme's mission is to protect New Zealand's agricultural export market by linking people, property and livestock.

For notifying movements there is a double entry system: off-movement and on-movement.

Internet notifications: 90% dairy

80% beef

85% deer

There is a limit of 48 hours to register movements.

NAIT are interested in investigating automatic movement notifications by the transport sector using smart phones.

6.2. Electronic tagging equipment manufacturers

When using RFID tags you need all the hardware and software to communicate with each other.

- RFID tags must be made to the ISO standard
- Hardware required to read the RFID tag and store the data e.g. RFID number and animal weight
- Software to be able to download data from the hardware device and allocate it to animals stored in a database

6.2.i. Hardware

Tru-Test and Gallagher, who are the two main manufacturers of weighing and RFID equipment, have various hardware options available that can be used with RFID tags.

- Stick reader
- Panel readers that can be used on the side of a crush or race
- Weigh heads to weigh and record
- EID ear tags

There are a number of different combinations available to suit every budget. The diagram below shows how hardware can be used in a cattle handling situation:

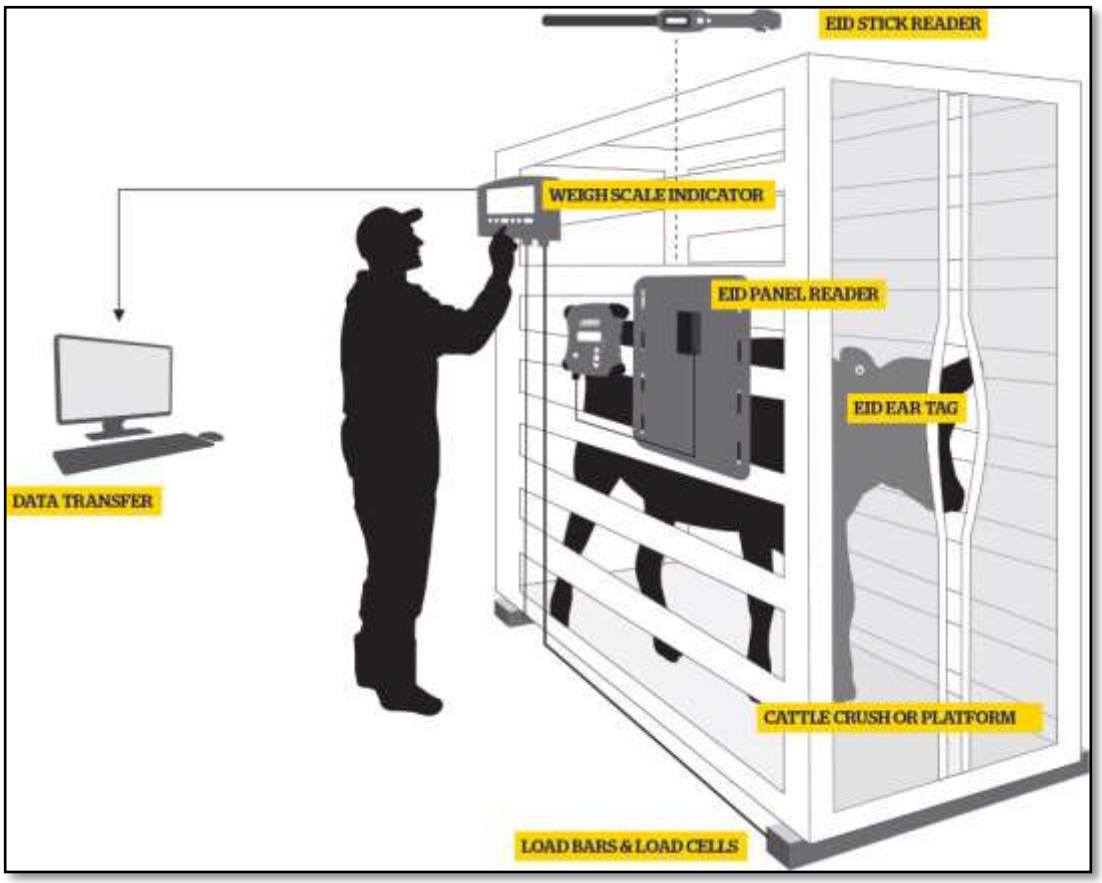


Figure 20 : Using hardware in a cattle handling situation

6.2.ii. Hardware Costs

There are a number of combinations that can be used to work with RFID tags. Costs can vary greatly but the following gives average costs for the main equipment that might be required:

Hardware Item	Approximate Cost
RFID tag (pair)	£2.50
Stick Reader	£550 - £750
Handheld reader	£1,000
Load bars to be used in cattle crush or weigh platform	£720 - £1,000
Weigh head[1]	£359 - £1,800
Bar code scanner	£100 - £200
Bar code printer	£460
Bluetooth printer	£380
Computer software package[2]	£500 - £1,000

Figure 21: A selection of hardware used to work with RFID tags

6.2.iii. The Animal Data Interface

Tru-Test and Gallagher, who are two of the largest manufacturers of electronic identification hardware, are launching an animal interface standard.

"The Animal Data Interface aims to simplify the exchange of livestock-related information between disparate devices and systems. The primary goal is to allow data interchange between devices, software applications and central servers regardless of the manufacturer, vendor or organisation respectively. Some possible scenarios are summarised as follows:

[1] Basic weigh head will simply display weights. More expensive weigh head will communicate with panel readers, stick readers and computer software to match the weights of the animals to the animal record.

[2] Variation in the price of the computer software depends on the number of additional features such as the ability to communicate with EID equipment.

- Transfer data collected in the field on your data collection device to a computer software application for additional processing.
- Update your data collection device with information from your computer software application.
- Synchronise information between desktop management applications and a centralised management server.
- Synchronise data between data collection devices.
- Computer software application setting up the device with definitions of data types."

This new standard means that any hardware being developed and launched by these manufacturers will "speak" the same language and this will mean that software developers will not have to re-programme their software every time new equipment is launched.

6.2.iv. Cattle crush manufacturers

A number of manufacturers of cattle crushes are starting to produce equipment that incorporates reading equipment into the crush.

Figure 22: Antenna to read RFID tags incorporated during the manufacture of the cattle crush

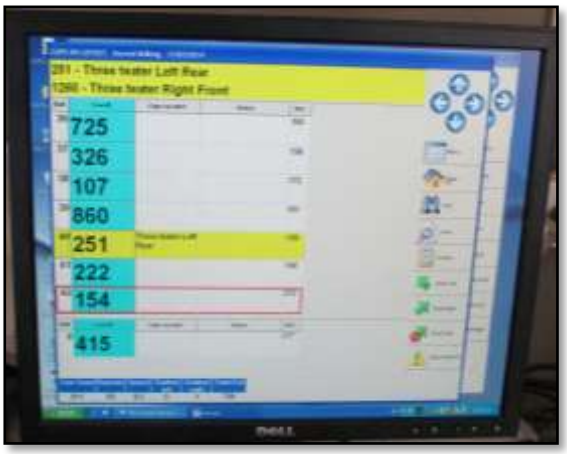
6.3. New Zealand's dairy industry

Relative to EID, the New Zealand dairy industry at farm level was the most sophisticated that I have seen. The large dairy herds that I visited were all milking cows in rotary parlours. All dairy farms are

using LF RFID technology which has been compulsory since 2006. They are taking full advantage of the technology available.

A working example of how the technology is being used:

- When the cow enters the parlour and stands on the milking platform the RFID tag is read.
- At that point the animal is fed according to the amount of milk she is producing
- If this cow had been treated with antibiotics this would have been entered in the computer software programme so that when the RFID tag was read a message is relayed through a speaker system to alert the person milking that the cow's milk is to be discarded.
- If a cow only milks on three teats instead of four this could also be entered into the computer software programme so that this information is also given to the person putting the clusters on the cow (see below).



- When exiting the milking platform each cow is weighed and the weight recorded (see below)

- At the exit there is a shedding system so that the person milking can shed off any cows that perhaps needed attention; for example, lame cows or cows in season to be artificially inseminated.

A computer on the milking platform running the livestock management software can be used to input and view data relating to all the animals on the farm.

On one farm that I visited all this information was held in cloud storage on a real-time information database. The whole farm was linked using Wi-Fi from the milking platform to the herd manager's house and then to the farmer's house. After every milking all the data could be accessed by everyone.

The ability to store and share all this information is only possible through the use of RFID and these farmers are using it to make their businesses more efficient.

Figure 23: Dairy Cow in New Zealand wearing an active RFID tag on a neck collar

7.0. United Kingdom

The UK and Europe's current policy is that it is not compulsory to electronically tag any bovine. However, the electronic tagging of sheep throughout Europe has been compulsory with low frequency WYSYWIG tags since January 2010. There is an option to use electronic tags cattle on a voluntary basis using low frequency, non-WYSYWIG tags.

there is the potential to get much more out of the database. For example, it should be possible for abattoirs to directly input kill data into the database as animals are slaughtered.

At the moment, like Canada, Australia and New Zealand, the UK has a database to record all births, deaths and movement data of cattle for every holding within the UK. The database was setup and is operated by the British Cattle Movement Service (BCMS).

The database follows the life of every bovine from birth to slaughter. I think there is the potential to get much more out of the database. For example, it should be possible for abattoirs to directly input kill data into the database as animals are slaughtered. Animals can then be bench-marked against each other. What producers should be able to do is to compare all this information in order to use this to improve the quality of their produce which in turn will enable them to become more profitable.

BCMS rules include:

- Dairy farmers must fit one ear tag within 36 hours of birth, the second tag must then be fitted by the time the animal is 20 days old.
- Beef farmers have up to 20 days from birth to fit two tags.
- If an animal is to be moved off the holding of birth then both tags must be fitted, even if this movement takes place before the animal is 20 days old.
- All calves have to be registered with the BCMS by the time the animal is 27 days old.
- Movements must be notified within three days of the movement taking place
- Passports must be returned to the BCMS within seven days for any animals that die on the farm.

7.1. BCMS Key Statistics

I contacted the Rural Payments Agency to request statistics on the running costs involved in operating the BCMS database.

Year	Number of cattle passport applications received by BCMS annually between 2010 – present day
2010	2,641,532
2011	2,691,605
2012	2,706,836
2013	2,654,643

BCMS estimated cost of administering passports (i.e. per passport) annually between 2010 and present day are shown below:

01/01/2011	£8,645,145		
01/04/2011	£8,548,415		
01/07/2011	£8,747,075		
01/10/2011	£8,666,816	Total for 2011	£34,607,451
01/01/2012	£8,434,481		
01/04/2012	£8,479,507		
01/07/2012	£8,722,307		
01/10/2012	£8,671,170	Total for 2012	£34,307,465
01/01/2013	£8,449,727		
01/04/2013	£8,436,412		
01/07/2013	£8,634,080		
01/10/2013	£8,623,279	Total for 2013	£34,143,498
01/01/2014	£8,114,316		
01/04/2014	£8,091,922		
01/07/2014	£8,339,890		

Other costs that are associated with the operation of the database have not been included in the figures above and therefore it is not possible to work out an actual cost for every passport.

It is fair to say, however, that the costs involved are considerable and there is the potential to save vast sums of money if a database and tracing system could be developed doing away with the need for paper passports.

there is the potential to save vast sums of money if a database and tracing system could be developed doing away with the need for paper passports.

On 1 October, 2014, the Driver and Vehicle Licensing Agency (DVLA) in the United Kingdom introduced a system for electronically paying car tax. The previous system had been to issue every car owner with a paper car tax disc upon payment of the car tax, and it had to be displayed on the windscreen of every vehicle. It is estimated that the change in the system will offer a saving of £10 million a year to the UK tax payer.

Surely there must be an argument that if a paper system of registration is no longer needed for every *vehicle* in the country, then it should be possible to have a similarly paperless system for the *cattle* industry, which would similarly result in huge cost savings.

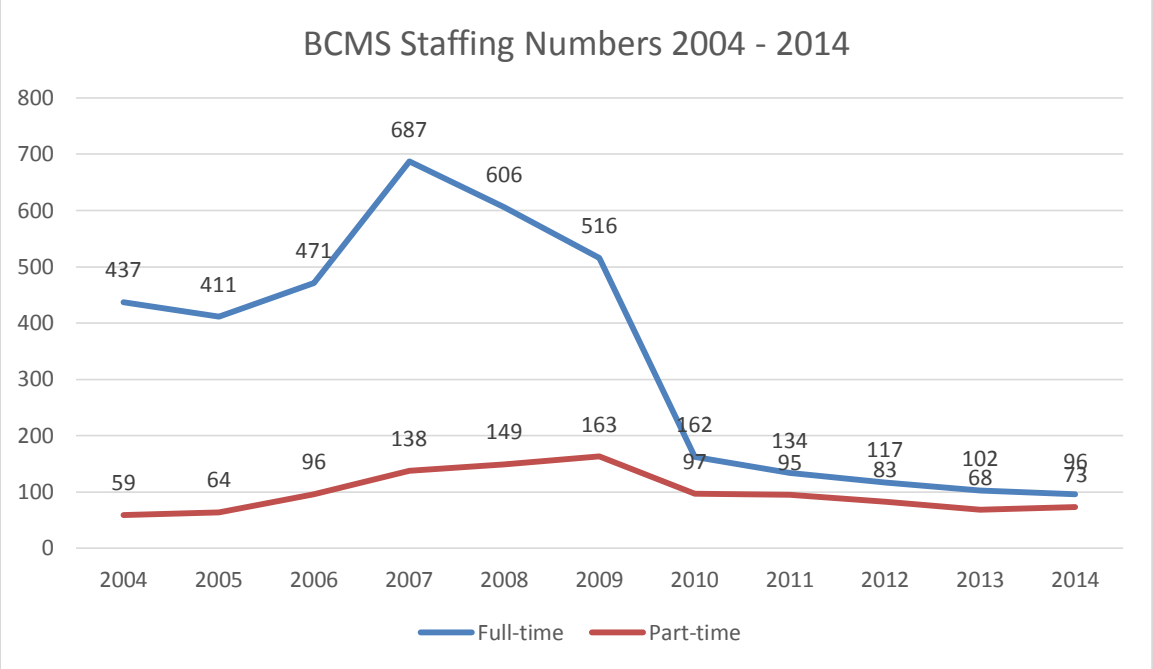


Figure 24: BCMS Staffing Numbers

8.0. Scotland

ScotEID was set up to create and manage a database for sheep when, under EU regulations, compulsory electronic identification in sheep came into force in January 2010. The database has now been expanded to handle pig, deer and cattle data.

Currently the cattle part of the database is being used to record Bovine Viral Diarrhoea (BVD) statistics. This means that anyone can search the database and look up the BVD status of any cattle or holding in Scotland. Testing for BVD in Scotland has been made compulsory in an attempt to gain BVD-free status for the whole of Scotland.

anyone can search the database and look up the BVD status of any cattle or holding in Scotland.

8.1. Research Project

ScotEID have been commissioned by the Scottish Government to run a research project to look at an EID system for the cattle industry. They have been mainly looking into the use of ultra-high frequency (UHF) technology.

This project has now reached farm level with trials on the hybrid tags taking place on 5 farms throughout Scotland. The farms that are involved have had to remove any previous tags and re-tag animals with the hybrid tags. Farmers have been provided with readers. The main focus at this stage is looking at the readability and longevity of the tags.

8.1.i. ScotEID Ultra High Frequency Tags

ScotEID has come up with a hybrid tag which incorporates UHF and LF all in one.

Due to the variability in the preferences and technical capabilities of different members of the supply chain it is important to retain flexibility. Some examples of the requirements of different groups might be as follows:

- A smaller farmer might want to read tags visually, which requires the numbers written on the front of the tags to be WYSIWYG.
- Larger farmers might want to use existing sheep LF RFID equipment that they have already purchased to be used to read cattle electronic tags to maximise their investment in various items of hardware.
- A livestock market might want to use multiple UHF readers for handling batches of cattle simultaneously.
- Abattoirs might want to use LF to reduce electromagnetic inference with their equipment.

9.0. Upper Nisbet Farm – my farm

In October 2006 I was given the Farmers Weekly Beef Farmer of the Year award. As a result of my success in the Farmers Weekly competition, in the spring of the following year I was approached by a tag company to ask if I would be interested in trialling electronic tags in my cattle herd. I decided this would be a great opportunity to move our business forward and to try out the new technology. That spring every calf born was fitted with an electronic identification button tag and we started using an analog reader to read the tags.

In the autumn of 2007 the first calves were weaned and at that point we weighed every calf using a Tru-Test XR2000 weigh head and a stick reader to scan all the calves electronic tags as they stood in the cattle crush. This was my first experience of how electronic tagging could benefit my business and I was immediately impressed. Previously every tag would have been manually read and typed into the weigh head; this was both time-consuming and prone to human error when reading or entering the tag numbers.

In 2008 we upgraded our weigh head to the Tru-Test XR3000 and we continued to tag all new-born calves with electronic tags. In the summer of 2008 the first calves that had been electronically tagged the previous year were being finished at fourteen months of age and we started weighing them at thirty day intervals to look at growth rates. Every animal was weighed and scanned automatically and recorded onto the new XR3000 weigh head.

We use Farmplan Cattle Manager Software to look after the day to day management of our cattle enterprise. It allows us to record all births, sales, movements and deaths. All this is reported electronically to the BCMS database. The programme also imports all the weighing data from the weigh head which in turn allows us to view statistical reports to enable us to make decisions on

Figure 25 : RFID tags being read with a hand-held stick reader

weight performance. This data can also be traced back to the animal's dam and sire in order to make breeding herd decisions.

In 2009 we fitted a panel RFID reader onto the side of the cattle crush so we no longer had to scan each tag with a stick reader. This once again streamlined the whole process and now the tags were read automatically as soon as the animal entered the cattle crush. A batch of 40 cattle could now be weight recorded in ten minutes.

Figure 26: Panel Reader attached to cattle crush

In 2010 we started moving away from the button tags to using a new style of RFID tag which had a management tag so that we could write management numbers on the tag; for example the dam and sire information. We also decided to invest in a new cattle crush so we upgraded to a new hydraulic squeeze crush which was imported from New Zealand. This crush also had the panel RFID reader fitted to the side of it. We now had a system that was completely hands-free weighing and recording.

In 2011 our handling pens had another upgrade in the form of air-operated shedding gates. Whilst weighing or sorting cattle this now enables us to draft animals into three different pens as they leave the cattle crush and the gates can be operated from the same area from whence the crush is opened and closed.

In 2012 Upper Nisbet Farm was awarded the Scotch Beef Farm of the year which was run by AgriScot and Quality Meat Scotland (QMS). As a result of winning this competition and after winning the Farmers Weekly Award we have had numerous groups visiting the farm and one of the main points of interest has been how we use electronic identification to record data plus the design of our cattle handling facilities.

In 2013, I won the Future Farming Award. Along with using RFID tags we were asked to try out new DNA tissue sample tags. As the new-born calves are tagged with these new tags, a sample of tissue

from the ear is stored in a small pre-printed sealed test tube which is then sent to a laboratory and tested for BVD.

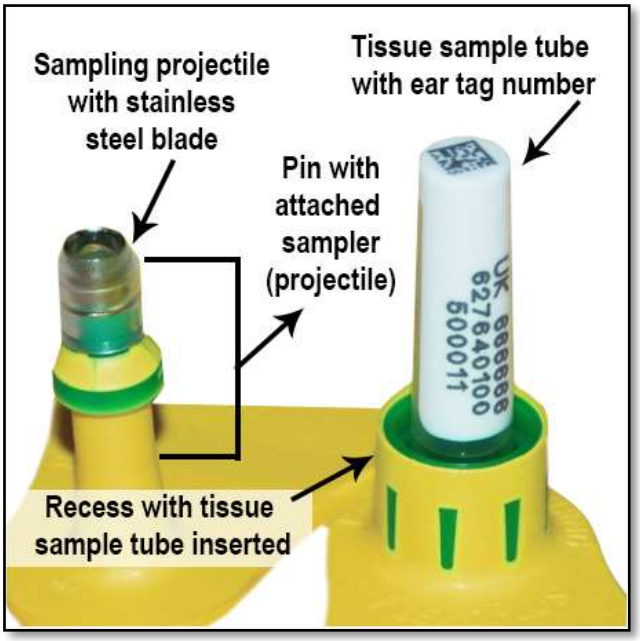


Figure 27: Tissue Sampling Tags

In 2014 we started to work with ScotEID as part of their UHF trial and have fitted UHF/LF hybrid tags to all breeding stock and all calves born in 2014. We also started using Farmplan's Psion Workabout Pro which is a handheld device that can scan RFID tags and has all of our herd information stored on it. As well as being able to read tags this device allows births, movements and drug administrations to be recorded, as well as any other observations that might need to be recorded whilst out in the field. This information can then be synchronised with the data held on the farm computer.

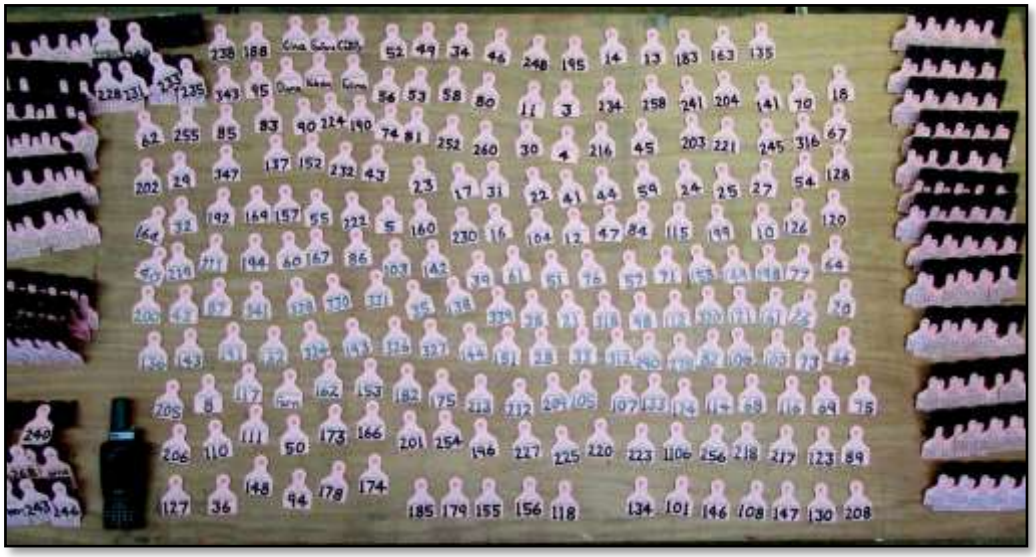


Figure 28 : UHF tags for ScotEID trial

In the autumn of 2014 we are going to upgrade to Tru-Test's new XR5000 weigh head. This weigh head has a number of new features including more data transfer options including being able to transfer information using a smart phone. It will also be possible to track performance through a range of features to calculate and visualise the performance of individual animals or groups.

Figure 29: Tru-Test XR5000 Weigh Head

In dairy herds there is a regular supply of information on a daily basis in terms of output but many beef farmers are unaware of how productive their animals are because performance information is not being recorded or analysed. The only way to monitor and record beef production is to weigh cattle on a regular basis and monitor daily live weight gains.

10.0. Conclusions

1 There was sporadic use of RFID technology in the countries that I visited but where the technology was used to gather and analyse information; for example the dairy industry in New Zealand, farmers were making decisions about the performance of their animals to increase production and meet customer demands.

2 Although in the countries that I visited where RFID was compulsory there were databases tracking births, movements and deaths of animals, there was no performance information being recorded for beef production by processors once the animal has gone to slaughter. This information could potentially be captured and fed back to the producers in order for them to ascertain which animals are producing the product that best matches their target market.

3 The use of RFID tags has many advantages during the handling of cattle to increase the ability to read tags efficiently, quickly and accurately. Tags can be read using various items of hardware which remove the requirement for people to be in close proximity to animals whilst they are being handled, and which also greatly reduces the risk of injury to both animal and human.

4 Tag retention continues to be a problem with RFID tags and is a contributing factor to cattle producers not realising the potential benefits of using the technology. In many places that I visited tags were simply not being fitted correctly to the animals which was perhaps due to a lack of understanding of how to best fit and maintain the tags. Climatic conditions such as extreme temperatures can greatly affect the strength of the tags.

5 Around the countries that I visited the handling facilities varied greatly. Where the facilities allowed safe and efficient movement and restraint of cattle the introduction of RFID technology and the ability to collect information was much easier to implement than in some places where there was poor infrastructure. In order to gain real benefit from fitting RFID tags the handling facilities for cattle need to enable easy movement and throughput of animals.

11.0. Recommendations

1 Electronic identification in cattle throughout the European Union should be made compulsory. Further investment and utilisation will not take place until everyone is using the technology. There should be a minimum transitional period of five years to allow producers to investigate how the technology will integrate with their individual systems.

2 All cattle RFID tags should be WYSIWYG (what you see is what you get) so that even if producers do not want to invest in electronic readers to use themselves, they will still be able to read the tag numbers manually.

3 The cattle database in the United Kingdom should be developed to enable all parties throughout the cattle supply chain to notify all births, movements and deaths directly and in real-time which will remove the requirement for animals to have paper passports. This would reduce costs and ensure that the database is always current and can be used to trace every animal in the event of a disease outbreak.

4 There is the potential for the central cattle database to be further developed to capture information from processors regarding the performance of different animals that are being produced. This data should then be available for all parties throughout the beef supply chain to produce a product that matches the needs of the consumer.

5 Through the use of RFID tags in cattle there is an ability to capture vast amounts of information relating to the growth and performance of each and every animal. Producers should then be able to use this information to make informed decisions about their herds in order to improve productivity.

12.0. After My Study Tour

As a result of the work I have done as part of my Nuffield Farming Scholarship, in the spring of 2014 we teamed up with ScotEID and re-tagged every breeding animal on our farm with hybrid tags. We also tagged every calf born in 2014 with the hybrid tags. We started tagging with LF RFID tags in 2007 so this trial is giving us the opportunity to assess how this new technology will fit in with our cattle enterprise. I am interested to find out how we can develop the use of the hybrid tags to find out just how well the UHF tags will work in a herd situation and whether the ability to read and write information to the tags will be a workable solution for the future of the cattle industry.

Figure 30 : Stick reader and printer to print bar code labels

During my travels in New Zealand I visited a sheep farm whilst they were shearing their sheep. As each wool bale was filled a bar code label was then printed and stuck onto the bale with all the relevant information about the wool including premises ID, weight, and grade. This prompted me to start thinking about how the printing of bar code labels could be used to improve the efficiency of blood testing the cows in my herd back home.

We currently blood test all our breeding animals as part of the Cattle Premium Health Scheme run by the Scottish Agricultural College (SAC). Up until now when we are testing we are sent a pre-printed bar code label for every breeding animal on the farm. As each sample is taken by the vet someone has to manually look through all the pages of labels to find the correct one for each animal to then attach to the test tube of blood. This current system is prone to error. What I am

What I am trying to develop at the moment is a system whereby a bar-coded label will be printed out automatically as each animal enters the cattle crush.

trying to develop at the moment is a system whereby a bar-coded label will be printed out automatically as each animal enters the cattle crush.

The problem that I am having is that the number the stick reader reads from the chip within the tag is not the animal number printed on the outside of the tag. In order for the chip number and animal number to be cross referenced a database of cattle tag information needs to be accessed at the time of reading the ear tag. The stick reader does not currently contain software capable of holding this database of information and therefore cannot directly print the labels with the animal number on them. This brings me back to the recommendation that all cattle RFID tags in Europe should contain a single number which is the animal number printed on the outside of the tag.

I am continuing dialogue with the manufacturers of the hardware to find out whether there is a solution to this problem which will allow me to convert the number on the chip to a bar-coded label relating to each individual animal.

Robert Neill

Executive Summary

With falling cattle numbers in the United Kingdom and the increasing uncertainty that climate change brings, the industry must look at ways of using technology to improve productivity and create a sustainable industry that will produce a marketable product that meets the needs of their consumers. In order to meet these criteria every part of the supply chain must work more closely together to gather and share information. In my opinion the way to achieve this is through the use of electronic identification.

I set out on my Nuffield Farming journey to investigate how the available technology was being implemented and to find out where future developments should be taking place. After coming home and having time to gather my thoughts I soon realised that all the meetings that I had were with people who are forward thinking; not afraid to try new ideas whether it was using new technology or expanding their business. These people were not afraid to push the boundaries. It is the people who would not meet with me who are the ones that we need to convince that using new technology will help their business by being more efficient.

Through economies of scale and the squeeze on profits, the number of people working in the cattle industry has continued to fall over the years, which brings about the issue of safety when handling cattle. When visiting sale yards and large feedlots that were working with electronically tagged cattle the ability to read tags from fixed panel readers and long pole readers reduces the likelihood of injury. During the last decade in the UK there have been fifty fatalities as a result of working directly with cattle. If the use of EID can reduce the risks involved then this must be an incentive to introduce compulsory electronic tagging.

The United Kingdom currently has one of the best cattle traceability systems that I have seen anywhere in the world. The current system of cattle passports and the BCMS database was brought about initially as a result of the outbreak of Bovine Spongiform Encephalopathy (BSE), more commonly known as mad cow disease. However, I believe that the high costs involved in the administration of the passport system need to be addressed. Electronic communication is no longer prohibitive to having a real-time cattle database operating in the UK. In the countries that I visited that had real-time databases already up and running, for example Canada, Australia and New Zealand, the systems seemed easy to operate and administer.

I hope that I can continue to be involved in the exciting developments that are being made within the cattle industry and to encourage and inspire other farmers who may be feeling apprehensive about the changes they may need to make to their businesses. I feel excited and enthusiastic about the possibilities ahead of us.

Acknowledgements

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Matthew Ipsen	Nuffield Farming Scholar, Maryborough, VIC
Paul & Kylie Serle & Family	Nuffield Farming Scholar, Tanatnoola, SA
Lachlan Sears & Family	Nuffield Farming Scholar, Lucindale, SA
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Dan Madden	Smithfield Feedlot

continued overleaf

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Appendix 1 : Terminology used in Electronic Identification

Antenna	Linked to the reader to transmit or receive electromagnetic waves
Data Logger	A small hand-held computer that can read the microchip number and can store a database that can be used to match up the numbers being read
Decimal	The format in which tags are read with 10 different values.
EID	Electronic identification
FDX	Full duplex technology used in ear tags. Full duplex refers to the transmission of data in two directions simultaneously. For example, a telephone is a full-duplex device because both parties can talk at once.
Hand-held reader	Portable device used for reading RFID tags
HDX	Half duplex technology used in ear tags. Half duplex refers to the transmission of data in just one direction at a time. For example, a walkie-talkie is a half-duplex device because only one party can talk at a time.
Hexadecimal	The format in which tags are read There are 16 Hexadecimal digits. They are the same as the decimal digits up to 9, but then there are the letters A, B, C, D, E and F in place of the decimal numbers 10 to 15: Hexadecimal: 0 1 2 3 4 5 6 7 8 9 A B C D E F Decimal: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 So a single Hexadecimal digit can show 16 different values instead of the normal 10 for decimal numbers.
Hybrid tags	Both Low frequency and ultra-high frequency available in a single tag
ICAR	International Committee for Animal Recording
ISO	International Standards Organisation
ISO 11784	The standard governing the data content of the microchip
ISO 11785	The standard governing the reading equipment protocols for RFID

LF	Low frequency. 125 KHz (only LF is currently approved in the EU regulation for livestock electronic identification)
Microchip	This is the device carried on the animal which can be contained in an ear tag or bolus.
PDA	Personal digital assistant (hand-held recorder)
RFID	Radio Frequency IDentification
Static Reader	Mounted in a static position (in a crush, race or kill line)
Transceiver	Reader to read the microchip can be static or hand-held
UHF	Ultra high frequency
VID	Visual identification (printed on outside of tag/bolus)
WYSIWYG	What You See Is What You Get

Appendix 2: International Committee for Animal Recording (ICAR)

ICAR is a world-wide organisation whose main objective is to promote the development and improvement of performance recording and the evaluation of farm livestock. ICAR sets out the rules, standards and guidelines in order to identify animals and record performance. Any rules and standards being set are based on scientific evidence. The aim is to have some degree of uniformity of recording throughout the world.

Country codes used in electronic identification for European Union member states are specified by ICAR and are shown below:

Country	**2 Alfa-code**	**3 Numeric code**
Austria	AT	040
Belgium	BEBE	056
Cyprus	CY	196
Czech Republic	CZ	203
Denmark	DK	208
Estonia	EE	233
Finland	FI	246
France	FR	250
Germany	DE	276
Greece	EL	300
Hungary	HU	348
Ireland	IE	372
Italy	IT	380
Latvia	LV	428
Lithuania	LT	440
Luxembourg	LU	442
Malta	MT	470
Poland	PL	616
Portugal	PT	620
Slovakia	SK	703
Slovenia	SI	705
Spain	ES	724
Sweden	SE	752
The Netherlands	NL	528
United Kingdom	GB	826