A Nuffield Farming Scholarships Trust Report

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Yorkshire Agricultural Society

Utilising precision technology in the UK Pig Industry to enhance profitability and sustainability

Hugh Shedden

July 2018

NUFFIELD UK

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A
Nuffield (UK) Farming Scholarships Trust Report

"Leading positive change in agriculture. Inspiring passion and potential in people."

Date of report: July 2018

Title	Utilising precision technology in the UK Pig Industry to enhance profitability and sustainability
Scholar	Hugh Shedden
Sponsor	Yorkshire Agricultural Society
Objectives of Study Tour	• To see what technology and techniques are available now and will be available in the future to help UK pig farmers thrive. • How we can meet the welfare and sustainability challenges of the future by using technology.
Countries Visited	USA, Canada, Brazil, Denmark, Norway, Germany, The Netherlands, Belgium, Republic of Ireland, UK
Messages	• Objectively benchmarking pig welfare using precision technology is an opportunity to promote the sustainability of the UK pig industry. • Gene editing technology has the potential to increase profitability and sustainability for pig farmers. • The interface between farmer and technology has to be kept as simple as possible to maximise utilisation. • Work out what needs measuring and analysing. Don't get bogged down with paralysis by analysis. • Create the data, collect the data, analyse the data and then act on the data.

EXECUTIVE SUMMARY

Pig production by its nature is a variable business. We are trying to produce a uniform product that can be affected by thousands of different inputs: from management, disease and feed to the good old fashioned British weather. How we as farmers can manage those variables to produce a consistent, high quality product which the consumer values is, and always has been, the key goal for the industry. Historically this has been done through investment in people, buildings and breeding stock. This is not going to change. What has the potential to change is the ability to harvest data from our production systems to enable us to make smarter decisions based more on facts and evidence rather than instinct.

My primary goal was to investigate and determine the successful attributes of Precision Livestock Farming (PLF) in use today and how they can help the UK pig industry meet the current challenges. I also wanted to look into the crystal ball and see if they will be able to help us in the future. The elephant in the room, that is Brexit, means that now more than ever we need to have full knowledge of our costs and our animal performance. Allied to that we need to know what the opportunity cost is of *not* marketing our pigs at the optimum weight for the contract we are supplying. At present in the UK we lag behind our continental neighbours in our ability to hit the top grades of our supply contracts.

Unfortunately, as I discovered, all that glitters is not gold. As with any relatively new industry there are snake oil salesmen selling dubious products and promising the earth with very little substance behind them. Just because you make a lot of noise and spend most of your budget on marketing doesn't mean it will make the farmer any more money. This comes down to the crux of the argument: as with any investment there has to be a return on it. And not every solution works on every farm. Therefore as farmers we have to be very careful not to commit to something that isn't right for our own business.

Technology alone is not the solution. There needs to be a significant level of knowledge transfer as well. The right technology on the right farm with the right farmer has the potential to help provide the safe, high welfare, sustainably-produced food which the consumer is demanding. Decisions made on analysis of the data produced from each individual farm is key to using PLF techniques successfully. Every farm is unique with different health challenges, staff competences, buildings and genetics. Precision techniques have the potential to help the industry overcome those challenges. It will not be easy but, from the evidence of my travels, I believe that if tackled properly they can be overcome.

Contents

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. Introduction

I am a second generation farmer based on the outskirts of York. We have a mixed farming business comprising arable, pigs, cereal drying and storage, environmental schemes and pulses processing. The business was established 50 years ago by my father and uncle and has undergone, and will continue to undergo, many changes since those early days.

After finishing University up in Newcastle with a degree in Politics and Government, like a of lot of my friends who are from a farming background I had no intention of going to work on the farm. I knew best, so after spending some time abroad seeing some of the world I studied for a master's degree in European Union Studies & International Political Economy. This was an excellent year meeting and studying with people from all over the globe. A bit of a forerunner to a Nuffield Farming Scholarship!

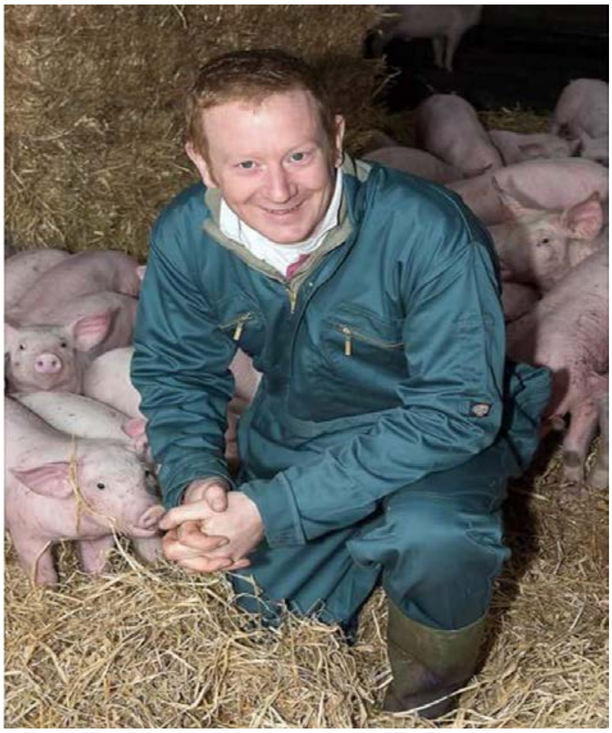


Figure 1: The author, Hugh Shedden

After deciding that the cut and thrust of industry appealed to me more than academia I entered the grain and animal feed trade. No matter how I tried I couldn't break that bond with farming and agriculture. The time spent was a great learning experience. Learning how markets worked and which factors moved those markets was an invaluable lesson.

However, on reaching my 30s the lure of home was getting stronger and stronger and in 2007 with the full support of my future wife, I bit the bullet and committed myself to the farm. The pull of the 4 am alarm call, working weekends and missed Sunday dinners fixing broken feeders was a lure that I could no longer resist. Despite the doubling of my hours worked and a cut in pay it has been the right decision, though at times I have doubted it!

Playing various sports, at an increasingly lower standard as I get older, has always been a passion of mine. Thankfully my 2 children love being outdoors and active, so I seem to spend most of my spare time ferrying them to various sports and activities. As a Yorkshireman there is great pride in seeing your children execute a classic Boycott-esque forward defensive shot and knowing that you have taught them. Thankfully my wife Rebecca knows that I need to show my competitive spirit at a weekend to avoid having another child in the house. Somehow, she manages to say the right thing at the right time even in the most trying of times.

2. Background to my study subject

For as long as anyone can remember the pig industry has been beset by the classic pig (or hog in the USA) cycle. This is as true for the UK as anywhere. The diagram below is an accurate representation of how the market works.

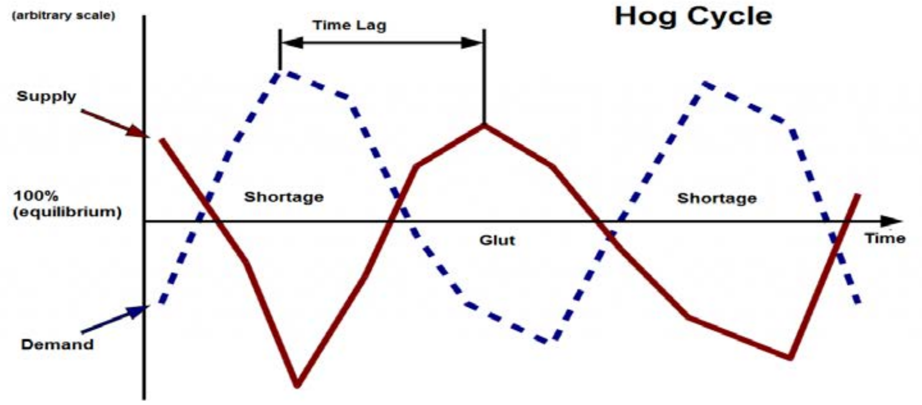


Figure 2: Classic Hog/Pig Cycle (*source:www.acting-man.com*)

What has happened in the past 20 years is that the cycles are getting closer and closer together. The time span between boom and bust is shortening. This has placed many businesses in serious short term cashflow problem as the window to repair bank balances gets shorter. From 1997 to 2014 the number of farmers in the UK producing pigs has dropped from 9700 to 6000 (*AHDB Pork*) but the number of pigs slaughtered is at a level not seen since 2001. We are producing more from less and getting more efficient.

the Danes can produce an 80kg deadweight pig over £20 cheaper per animal than we can in the UK.

However, many businesses are not generating enough profit to be able to reinvest and catch up with our European neighbours' cost of production. In 2015 the average UK cost of production was £1.33 per kg deadweight: this compared to Denmark at £1.06 and the Netherlands at £1.14 *(AHDB Pork*) The Netherlands and Denmark are the best 2 countries to use as comparisons because they account for 70% of our pork imports. To put this into perspective, the Danes can produce an 80kg deadweight pig over £20 cheaper per animal than we can in the UK.

We need to cut our costs to be able to better withstand the downturns and make the most of the upturns. Our own business had been beset by poor herd health and, because it was expanding quite quickly, a lack of management control. The idea that precision techniques could offer a solution on how we could close the gap took hold. As a result, we cut the size of our pig herd to try to regain some control and chase the holy grail of reducing costs whilst increasing efficiencies.

We started to use some impressive data collecting and management software which has enabled some decisions to be based on facts rather than instinct. At present it is limited to certain areas of the farm so much of my study and travels has been trying to find out what is out there today. And, perhaps more importantly, what is there in the pipeline for tomorrow.

On my travels I had 4 simple criteria which I applied to the technology I encountered:

1. Does it work on a commercial basis?
2. Would it work in the UK?
3. Is it affordable?
4. Will it make management more effective?

3. My study tour

When it comes to pig farming certain countries stand out to visit. Some were visited more than once due to depth and breadth of people to see and unfortunately some were visited far too briefly. When deciding where to visit I had 4 main criteria:

1. Did the country have big pig populations as well as excellent university research departments that were commercial in their outlook?

2. Were those countries a threat to the UK industry in terms of present or future competition?

3. Were the environmental and welfare legislations similar to the UK to enable a proper like-for-like comparison?

4. What were the chances of getting in front of the right people?

The last point might seem a bit flippant but in certain countries the pig industry is exceptionally wary of prying eyes and getting to see certain people proved very difficult. It wasn't so much a case of not trying but certain doors were not opening no matter how hard I tried. Also, with the spread of African Swine Fever (ASF) moving west across Europe a lot of extra biosecurity protocols had been put in place which meant it was impractical and irresponsible to visit certain countries.

Details of my study tour are:

Date	Country
May 2017	Norway-European Pig Producers Congress
June 2017	Canada – Ontario, Quebec, Manitoba
July 2017	USA – Iowa, Nebraska, Missouri
December 2017	Netherlands, Belgium
January 2018	Netherlands
March 2018	Germany
May 2018	Republic of Ireland
June 2018	Netherlands, Belgium, Germany, Republic of Ireland
Throughout 2017-18	UK

4. Precision Farming

Precision Farming: "A farming management concept based on observing, measuring and responding to inter and intra-field variability. The aim of precision farming is to define a decision support system for whole farm management with the goal of optimizing returns on inputs while preserving resources." (Wikipedia)

As farmers we have often been told that we are going to have to feed more people with less resources. The world population is estimated to be 9.7 to 10 billion people by 2050. They have to eat: therefore a way has to be found to feed them.

What springs to my mind when thinking of Precision Farming is shown in the diagram below:

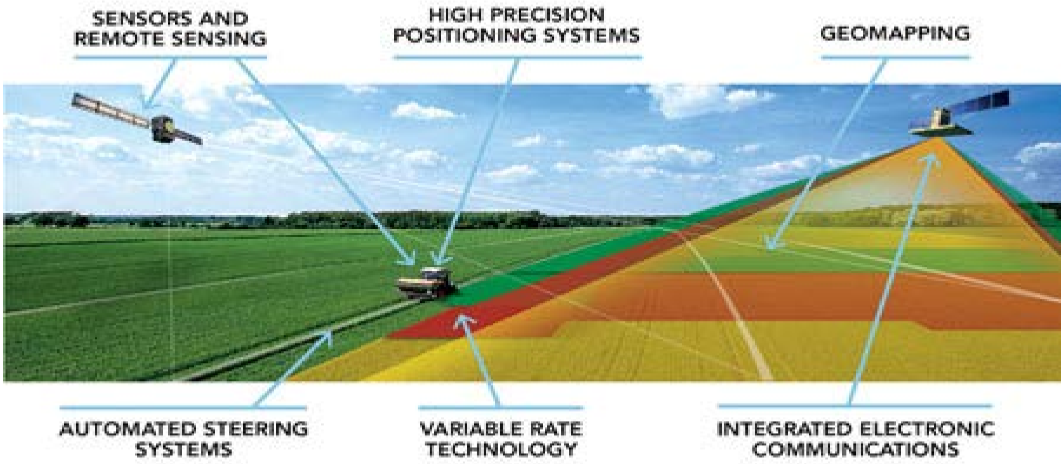


Figure 3: Precision Farming Explanation (*source: Precision Decisions*)

The first wave of the precision revolution came in the forms of satellite and aerial imagery, weather prediction modelling, variable rate fertiliser application and crop health indicators.

The second wave is the aggregation of data, machine learning and the preservation of resources. It is this second wave which is of most interest to livestock farmers. A subsection of Precision Farming developed which focused on Livestock Farming.

4a. Precision Livestock Farming (PLF)

"Management of livestock farming by continuous automated real-time monitoring/controlling of production/reproduction, health and welfare of livestock and environmental impact."
Prof. Daniel Berckmans, KU Leuven, Belgium

Livestock farming has undergone massive change in the past 20 years and needs to continue to change to be able to meet the demand for livestock products. More animals, fewer and bigger farms, is a trend seen all over the world. This can stress the relationship between the farmer/stockman and the animal as so many more are looked after by each individual. PLF seeks to aid this by providing tools to improve animal welfare and management.

The increase in world population is going to lead to an increase in the requirement for livestock-based products. The World Health Organisation (WHO) estimate that whilst 321 million tonnes of meat and eggs were produced globally in 2005, by 2050 that number could increase to 557 million tonnes.

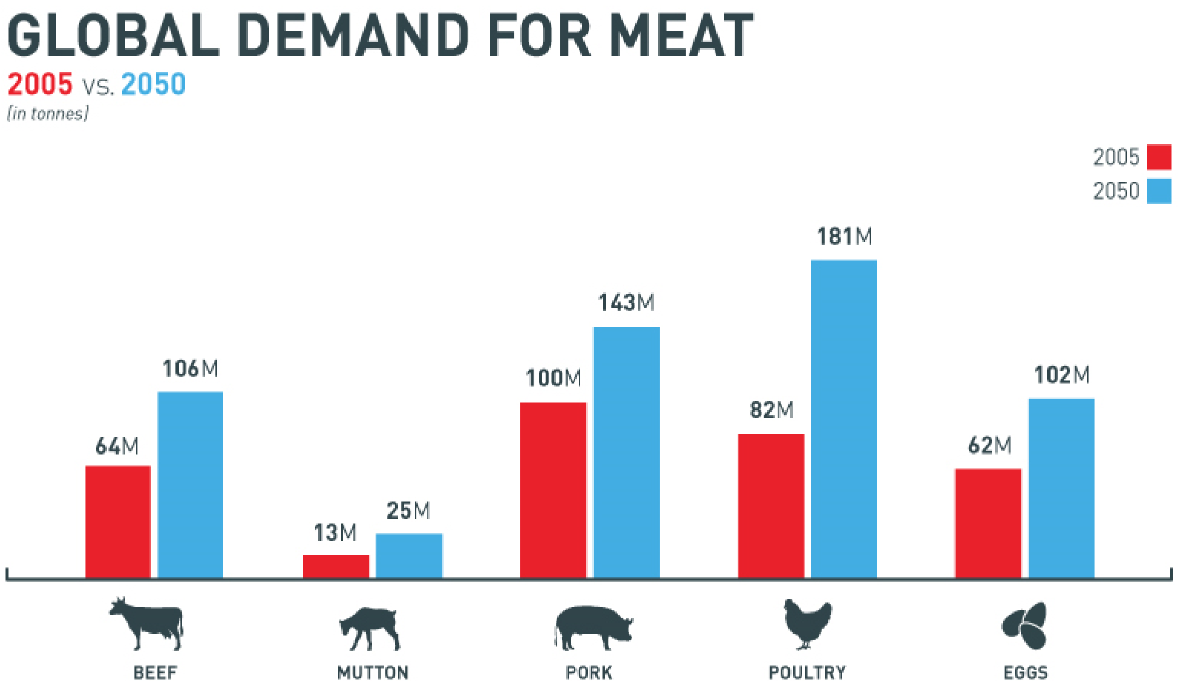


Figure 4: Global Demand for Meat (*source:www.gatesnotes.com*)

These numbers are not going to be achieved using existing production methods and techniques. We need to be able to look at livestock production with a fresh set of eyes, develop new techniques and better understand our animals. We need to improve efficiency whilst maintaining and improving animal welfare, as well as attempting to lower the environmental impact of production systems.

To meet the challenges of the future, livestock farmers need to be able to know what is happening on their farms in real time. **Data analysis after the event is a bit like working out why the car crashed, whereas PLF has the potential for you to see the car crash coming and do something to avoid it.** The tools are slowly but surely starting to move out of the development phase in the lab to the commercial phase on the farm. However, for them to be commercially successful they need to deliver a real return on investment for the farmer.

For the purposes of this report I decided to focus on 3 main areas and how they affect the UK pig producer:

1. Genetics
2. Recording and Monitoring
3. Precision Medication

5. Genetics

"Innovations are crucial in order to meet the global demand
for high quality animal protein in a sustainable way.
Intelligent breeding programmes are necessary to increase the efficiency of the food chain,
minimise the ecological footprint, address consumer demands
and contribute to the wellbeing of people and animals alike."
Johan Van Arandonk- Chief Innovation Officer, Hendricks Genetics

As pig production has consolidated into fewer hands so has the number of breeding companies. The UK now has one, perhaps two, companies considered to be British. The rest have either fallen by the wayside, sold out, or are now powered by overseas genetics. Therefore a key part of my travels was to go and find out what those companies with a global reach are doing to meet the expectations of the above quote.

5a. DanBred, Vejen, Denmark

Up until the last 3 years DanBred had a monopoly on genetics in Denmark which has enabled it to build a massive database of sow performance over the past 40 years. This volume of data enables them to see the outcomes from breeding decisions. This is important as it stands up in the market as commercially validated performance.

Figure 5: Sven Agergaard, Herning, Denmark

The pig market in Denmark is split with 50% of pigs being finished in the country and 50% being sold as piglets and weaners to neighbouring countries near and far.

One farmer visited, Sven Agergaard, has in the past 2 years sent pigs to Germany, Spain, Italy, Poland, Ukraine and Romania. These customers want the DanBred genetics, the health benefits and to import the expertise of the Danish farmer in producing piglets. This trade is about 15 million pigs per year. The more sales that are made the more sows are needed for breeding, therefore producing a bigger data pool to be able to select the next generation of breeding animals, resulting in a better quality animal.

More sales = better quality.

DanBred has a turnover in excess of £200 million per year and has nearly 10 times as many commercial sows as the UK has in total. The diagram on next page shows that despite their size all genetics come from 23 nucleus herds in Denmark.

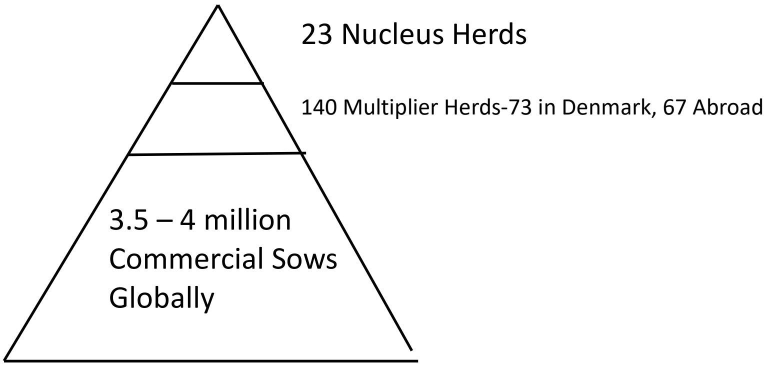


Figure 6: DanBred Global Breeding Operation (*Source: drawing author's own*)

Therefore, genetic selection must keep moving forwards at a rapid pace to keep evolving. The problem is that consumer tastes keep changing so breeding programmes must change. In the recent years the Danish have made a move to try to get more Intra Muscular fat into the meat. It became a more important breeding goal, and this is where the 40 years of data enables Danbred to reach back into the archive and find the genotypes that will enable them to meet this goal.

There is an estimated $2 per year gain per animal sold due to genetic improvement. It takes 1 year to get an effect from genetic improvement into the nucleus herds, and a full 3 years before it is felt on a commercial level. Therefore 5 -6 years' worth of R&D and breeding might come to nothing if it doesn't work on a commercial scale.

This focus on continual improvement is reflected in how DanBred see the future progressing with their projections for Danish producers between now and 2025:

	Now	2025	Best in 2025
Daily Liveweight Gain(g)	940	1105	1253
Food Conversion Ratio	2.7:1	2.35:1	2.1:1
Dead Weight (kg)	85.1	85.1	86.6
Born Alive per litter	16.3	19.1	20.9

Table 1: Future Production Predictions for Danish Pig Producers
(Source: Author's own from DanBred figures)

Some of these numbers are staggering and, if true, are going to place pressure on existing systems.

The Danish experience is one of continual change, producing piglets for the least cost and numbers, numbers, numbers.

5b. Choice Genetics, Des Moines, Iowa

For a different outlook on genetics I visited Choice Genetics in the USA and their angle was all about precision. Knowing that their genetic pool was smaller than most of their competition meant they had to come from a different angle. They make full use of Computed Topography (CT) scans. This is an expensive procedure but one that Choice believes is bringing results. In 2017 Choice scanned 14,628 animals, this compares to 2,825 animals in 2013. A 5-fold increase in 4 years shows the faith that Choice have placed in this precision technique.

The CT scan takes an image every 7mm. It measures the % of bone, lean meat and fat so that each selected animal can be graded. There is currently work going on to see if Intra Muscular fat can be measured as well. One of Choice's mottos is "You can't improve it if you can't measure it."

Create the data, collect the data, analyse the data and then act on the data.

Figure 7 : Breeding Sow being CT Scanned

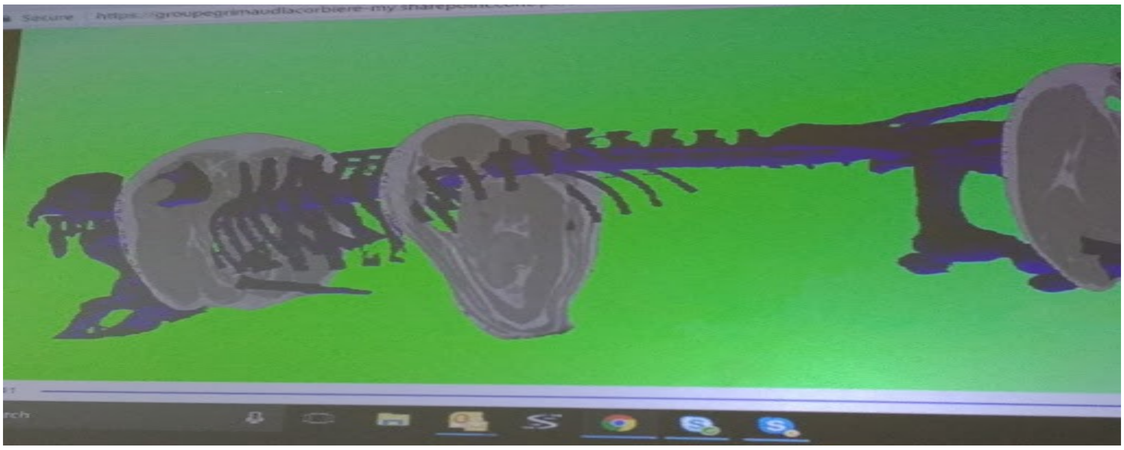


Figure 8 : Computer Simulated Results from a CT Scan (*source: Choice Genetics*)

What procedures like this do is enable breeding companies to get closer to the consumer.

I must admit to being blown away when seeing the above image. The level of detail and precision is amazing. What this enables Choice Genetics to be able to do is to select certain animals for certain markets. For example, the US market in the summer values pork bellies more highly than legs or loins so by using the right sire line genotype there is the potential to hit a specific market at a specific time thereby giving maximising revenue.

5c. Genomics

Genomics is an area within genetics concerned with the sequencing and analysis of an organism's genome. The pig genome was released in 2012 so its potential benefits have not been fully developed yet but it offers the opportunity to build a farmer's profitability and sustainability. The pig's genome contains 19 pairs of chromosomes and is 2.7 billion pairs long – this compares to human genome being 3 billion pairs long.

Traditionally breeding and performance improvement has been based on data, not DNA. Physical attributes and growth rate measures have dominated selection processes. One of the most widely used methods for breeding selection in use today is the Best Linear Unbiased Prediction (BLUP) model. The BLUP model gives the best estimates for the breeding value, or to put it more precisely, this minimises the variance of difference between the estimates and the true breeding values.

The precision that genomic selection offers is the ability to select on many markers across the genome that explain most of the genetic differences between animals. This precision phenotyping can allow for more accurate selection of traits that have always formed the cornerstone of traditional breeding programmes:

- Feed Intake
- Food Conversion Ratio
- Sow Longevity
- Hardiness/Resistance to Disease
- Daily Growth Rate
- Sow Prolificacy

The precision phenotyping has the potential to turn pig production into precision production. PIC have been at the forefront of genetic selection for pigs. In 2013 they developed a new method of selection called Relationship Based Genetic Selection (RBGS). In the first 3 years of the new criteria they saw the rate of genetic improvement jump by 35% a year.

As the graph on next page shows, this is an incredible jump.

(see graph on next page)

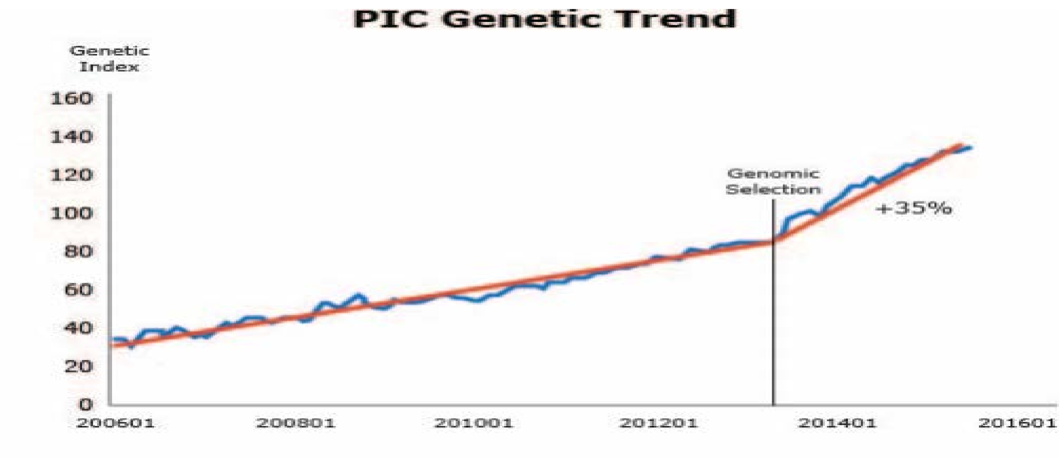


Figure 9 : Increase in Genetic Improvement since the implementation of RBGS (*source: PIC*)

It is now possible to investigate genes in certain animals that are resistant to disease. The best example is with the CD163 gene. Sows born without this gene are resistant to Porcine Reproductive and Respiratory Syndrome (PRRS). PIC have been at the forefront of this global research. **In 2013 PRRS was estimated to have cost the global pig industry over $2 billion and the USA $664 million alone in direct costs, and over $1 billion in total.**

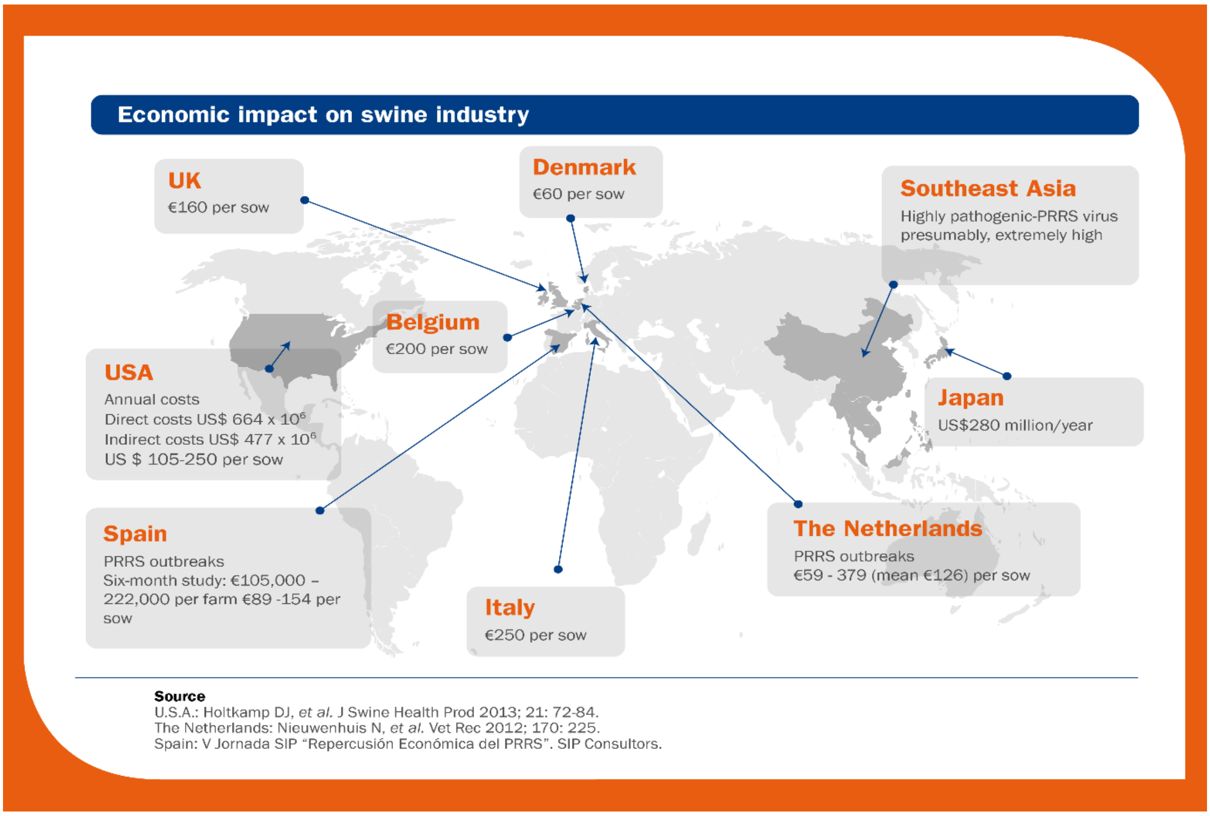


Figure 10 : PRRS costs per sow in selected countries (source: Hipra)

The potential is massive. The barriers are high. The main one is consumer acceptance. The work being carried out is gene editing - not transgenics, so no genes are being introduced to the pig from other species etc. Consumer acceptance will most likely come when the technique has been tried and tested in human health. This going to be a long process.

If the techniques can be developed to determine how nutrition or the pig's environment affects the pig's genome then every country, region, or if large enough, pig business, could have a precise map of their pig's genome. The potential is enormous.

However, all that glitters isn't gold. Because pig breeding is split between pure bred herds and commercial cross bred herds the level of genetic variation is sizeable. The genetic variation between a commercial pig breed can be 2 to 3 times larger than in the same population of humans. This diversity means that the DNA testing becomes prohibitively expensive for all but the biggest operators.

Restraints on Genomic Selection:

- Cost
- Can't replace accurate recording
- Requirement for a massive base to start the selection pool
- DNA needs to be constantly updated

Genomics is going to become increasingly more important in pig breeding, but it will not replace conventional selection models. The future will have a mix of genomic and conventional selection. The key question is: what the ratio will be and who will pay for it?

The innovation and precision offered by genomics in pig breeding is a unique opportunity to contribute to the challenges of the future. It will help farmers establish robust production systems with healthy animals that supply more meat from less inputs. **Perhaps it is the ultimate expression of PLF:**

- Better welfare because the pig is more resistant to disease.
- Better for the environment as more efficient animals come to the fore, meaning less emissions.
- Lower antibiotic and vaccine use. Healthier animals need fewer medicines.
- Better FCR means less feed needed to produce the same size of pig meaning a more sustainable production system.

So, to answer my 4 key points set out at the start:

1. Does improved genetics work on a commercial basis? As the evidence shows the answer to this is a resounding yes.
2. Would it work in the UK? Traditional breeding is and will continue to do so. Gene editing is going to be a hard sell until it is accepted in human healthcare.
3. Is it affordable? Traditional BLUP programmes are affordable. Newer genetic selection programmes will have to be affordable if they are going to succeed because there is increasing competition out there.
4. Will it make management more effective? Yes

Please see overleaf for a summary of the Key Points in this chapter:

KEY POINTS:

- **Genomic selection is rapidly accelerating the rate of genetic improvement, but consumer acceptance is needed to be able to reap the full benefits of the technology.**
- **Genomic selection has the potential to save farmers $ billions as well as increase welfare and sustainability by keeping animals healthier and wasting fewer resources.**
- **Changing selection criteria to be based more on FCR and piglet viability. Increasing sustainability.**
- **Increased levels of specialisation to breed an animal to supply a specific market. Moving into niche markets to increase margins.**

6. Monitoring and Recording

"Precision Livestock Farming (PLF) is a series of practices aiming at increasing the farmer's ability to keep contact with individual animals despite the growing intensification of livestock production. PLF aims to achieve economic, environmentally and socially sustainable farming through the observation, behavioural interpretation and control of the smallest possible group of animals. It enables farmers to reduce operational costs such as expenditures to feed, medication and energy. Moreover, farmers can use PLF technologies to monitor animal health and welfare to ensure that animals live well and free of diseases. PLF systems aim to translate the output of the technology to useful information for the farmer." (Gregerson et al)

So historically the basics that have been monitored in the pig sheds are:

- Temperature
- Ventilation
- Food consumption
- Water usage

Temperature is an obvious variable to monitor because at each stage of a pig's life it has an optimum temperature at which it grows most efficiently. The same is true for ventilation. Too much or too little ventilation can not only stifle growth rates but can lead to vice, like tail biting, therefore it is essential to know that your pig sheds are being kept at the right ventilation level. Food and water are obvious variables to measure. **24 hours without food will stop a pig growing, 24 hours without water will kill a pig.**

Monitoring these variables has given farmers the ability to analyse the data that has been harvested. It has given us the insight to see in real time the conditions in the sheds but quite often that's it. The data sits there looking pretty in a nice graph, but it doesn't affect how we go about our daily business. The data is in real time but our understanding of what that data is telling us lags some way behind.

For some farmers this is the extent to which they want to see what is happening on their farm. They are happy with that, but some want to go further: they see the pig as a mobile data centre giving off signals and information all day, every day. From my travels some of the key variables that farmers and researchers are starting to/wanting to monitor are:

- Animal weight
- Growth rates
- Food conversation rates
- Air quality levels
- Animal movement patterns
- Vice/tail biting
- Pig coughs

The goal of widespread adoption of PLF at this level in pigs is a way off. The feeling is that we are starting to move from the innovation stage to the early adoption stage for this second wave of PLF in pigs. The thing is, new waves are starting all the time. As confidence builds and research continues, the scope and span of PLF in pigs is going to grow.

As to be expected there are farmers in every country I've visited who seem to be waiting to see the commercial viability of the emergent technology before they dip a toe into the market, these sceptics or late majority would no doubt also have been in the same position during the first wave of climate, feed, water etc monitoring.

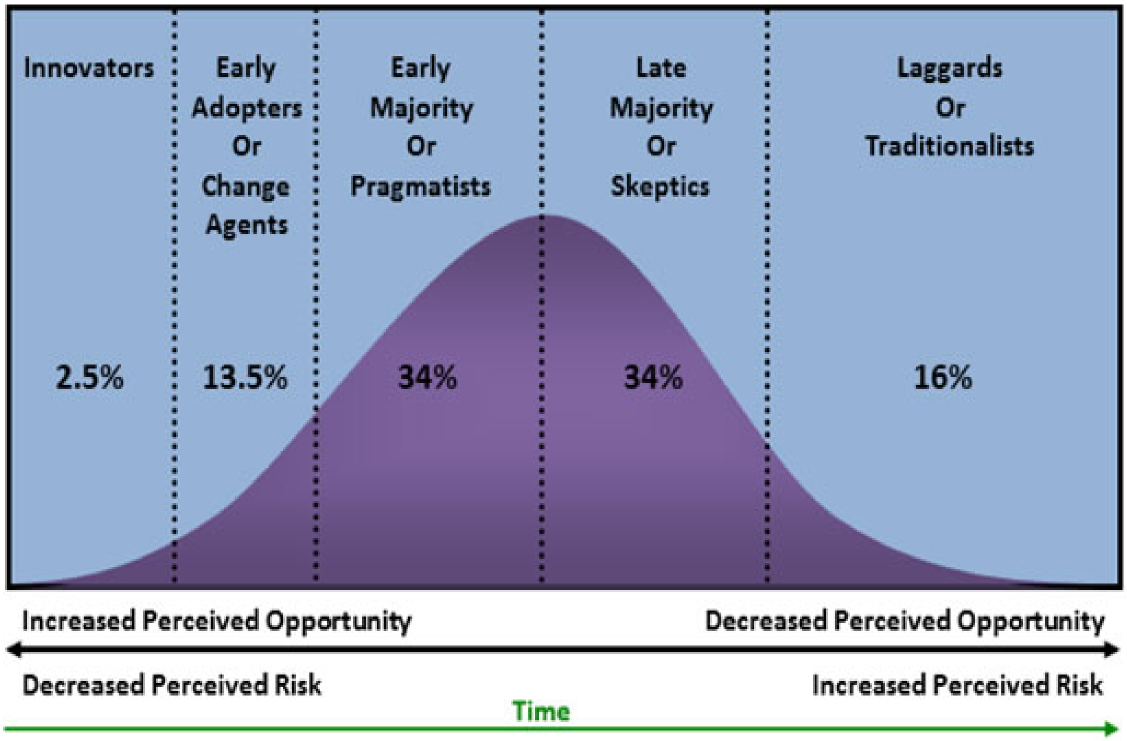


Figure 11: Technology Adoption Life Cycle (*source:Wikipedia.com*)

6a. Monitoring for growth

6a.i. Thomas Livestock Company, Broken Bow, Nebraska

THOMAS LIVESTOCK CO. T.L.C. Creating Community Opportunities

TLC are a family-owned pig enterprise with 16,500 sows and expanding. They have fully embraced PLF and set their standards and protocols at a very high level. This is driven by the management who are meticulous and focused in their pursuit of targets.

Their view was that there will be others who can produce pork meat more cheaply but they themselves were not going to compromise on their standards. The level of detail in the day-to-day operation was inspiring to see and the ability of the management to get the various teams to buy into the strategy was excellent. Everybody knows exactly what their role is and how it all fits together. An example of this is that every piglet is dried at birth with a towel to prevent chilling in farrowing houses that are manned 24/7. To put that into numbers that is over 500,000 piglets per year – a lot of towels! The reason they are dried is that a cold new born piglet will lie next to the sow to try to keep warm therefore increasing the chances of being crushed.

The photo shows Tim Friedel, general manager of TLC, and 2 Chinese farmers visiting to learn about how PLF can be incorporated into the Chinese pig industry. Those 3 men in the photo manage the equivalent of 1/3 of the total pigs in UK industry. The big players globally are starting to get switched on to PLF and are seeking out the innovators and early adopters to learn more.

Figure 11: Tim Friedel, TLC General Manager, with Chinese Visitors. (*source: author's own*)

TLC are using the Barn Report Pro system from Farmex, a UK provider of hardware and software. Barn Report Pro allows oversight of all sites from a smartphone or PC no matter where you are in the world. You can remotely monitor and alter the climate in your pig sheds. In a climate that varies from -30C in the winter to +40c in the summer this a vital tool.

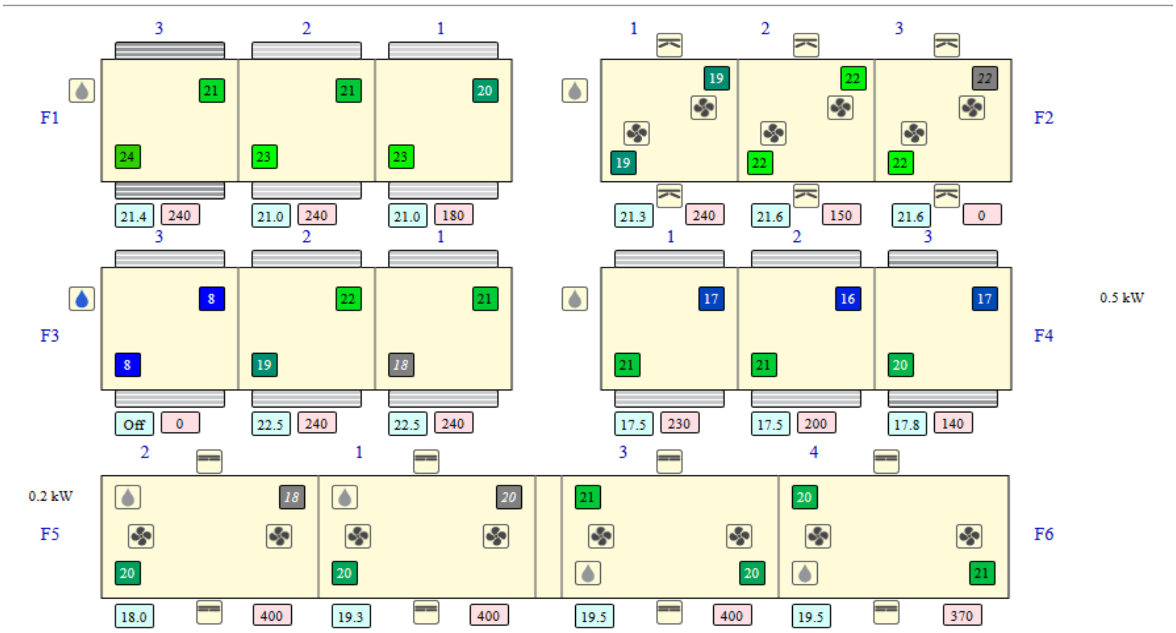


Figure 12: A Site Map Representation of a Finisher Farm (*source: Farmex*)

Farmex call this "Site Map". It gives the farmer the ability to see in real time what is going on in the pig sheds. It can show temperature, fan speeds, electricity usage, water usage etc. This can be used to help the farmer as another set of eyes, especially for those businesses with multiple sites which are not manned 24/7 by a member of staff. Alarm levels can be set so that if, for example, the temperature goes above a set limit then the farmer will be made aware of it.

Another area where TLC were differentiating themselves was in the use of Electronic Sow Feeding (ESF). It is far from being a new technology but its uptake in the USA has been slow. The majority of pregnant sows are still housed in individual stalls and not group housed. A lack of Government stick or consumer carrot has meant that group-housed sows are still in the minority.

An ESF works by a sow entering the station at which point the entrance gate locks behind her and she is identified by means of a Radio Frequency Identification (RFID) Tag in her ear. The computer-controlled feeder allots her a specific amount of feed, dropped into the feed bowl. During the feed drop, and for several minutes afterward, the entrance gate remains locked so that no other sows can enter. The sow may leave at any time, stopping the dispensing of feed and unlocking the entrance for the next sow. The computer records the amount of feed that has been dispensed to each sow and allocates any undispensed feed to a later entrance by the same sow.

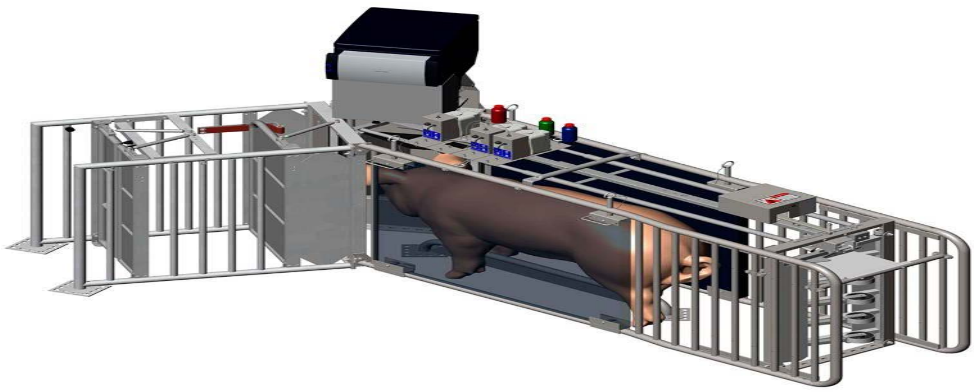


Figure 13: Nedap ESF System like the one used at TLC (*source: Nedap*)

The key to any ESF system is the RFID tag as it allows the system to correctly identify each sow. It allows a level of precision in feed intake that no other group housed system can. Then when the sows are ready to move into the farrowing house the system can be set so that the right sows are shed off into holding pens ready to be moved, saving time and effort for the stockman.

TLC were taking this a step further and carrying out trial work with Kansas State University to see if there was a link between food intake, sow backfat and live born piglets per litter. The hypothesis was that if a sow was having the same live born as the next sow but eating 30% less food, then that sow is going to earn you a higher margin over feed costs. The data stored in the RFID tag in the sow's ear could then be analysed to trace the specific dam line for that animal, thereby leading to the potential to produce the next generation of breeding animals that are more efficient at turning food into liveborn animals.

It was a privilege to visit TLC as they set themselves high standards and refuse to compromise on them. They were also early adopters of PLF techniques. Not only that but they saw it as key to them increasing productivity, margins and revenue.

Create the data, collect the data, analyse the data and then act on the data.

6a.ii Basil Baird Farms and Holscher & Leuschner

Sometimes you travel across continents looking for new ideas and inspiration but find it on your own doorstep. I had that moment when visiting Baird's in West Sussex. They are outdoor pig producers with a difference. They have fully embraced PLF for their finishing pigs but the pigs are finished on straw so that they can attract a significant premium from the processor.

The technology is provided by Holscher & Leuschner, a German company who provide technology-based housing systems. The principle is the same as any system - grow the pigs as fast and sustainably as possible whilst eating as little feed as possible to reach the desired weight.

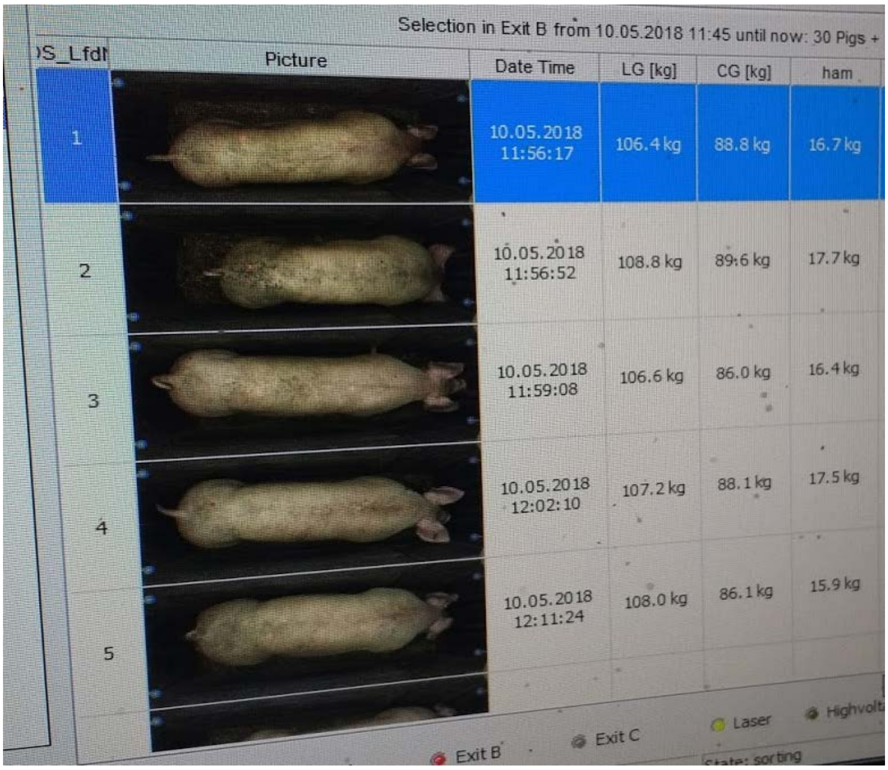
What set this system apart is the technology used to do it. H&L call it "Optisort". In any given pen of pigs you are going to get some fast growing and some slower. The standard is for those pigs to all eat the same food from a communal trough.

Where the Optisort differs is that the pigs enter the feed area through an access gate. A camera which sits above the pig then scans the pig and uses algorithms to calculate the weight. The pig is then diverted to one of 2 feeders with a high or low density feed. The pig gets the most appropriate feed for that stage of its development.

When time for slaughter comes, those pigs which meet the set parameters can be selected and held in a separate lairage pen. The system does the work of selecting the right pig so the stockman doesn't have to.

The great thing about the Optisort is that it can provide both real time and historical information about the animal's growth. Like the ESF this is underpinned by the use RFID tags.

Figure 14: Optisort from H&L like installed at Baird Farms. *(Source: H&L)*



The result of the camera and algorithms working provides an image which can then be analysed by the farmer. In this instance it is showing the last 5 pigs to go through the sensor and their live weight.

The system works to a 97% accuracy which allows for a high level of confidence in the technology. This is not a cheap system but is now increasingly starting to meet targets after some inevitable initial teething problems.

Figure 14: Imaging from the Optisort. This is what the farmer sees on a day to day basis.

Another area of real innovation within the Optisort system is the use of Autofom carcase grading technology. This technology takes the image generated by the camera and then breaks down the composition of the pig's carcass in real time. It can measure hams, legs, shoulders, loin depth, belly and more. The potential for this technology is considerable. For example, in the future a retailer may phone a processor wanting pigs with a higher belly percentage. The farmer could then set the system to select pigs based on that.

As with everything there is only value in this if it attracts a premium. This would face considerable opposition from the processors because they are the ones adding the value. They take a commodity from the farmer, break it down and add the value. That is why it could be 10 years before we see anything like this widely accepted in the UK.

Sorting systems are not without their problems and in many countries I visited they are being taken out and replaced with traditional feeding stations. They can restrict growth due to a lack of access to the feed. The figure put to it was 80-100 grams per day. So, over a 12-week finishing period that equates up to 8.4kg - or 8-10 days at conventional growth rates - slower to reach target weight. The net result is that you need more space to finish the same amount of pigs if you want to achieve the same weights or sell at a lighter weight.

If you have 350 pigs trying to access the feed through one gate inevitably you are going to get some pigs getting fed up of waiting. However, for some farmers it fits their system and how they want to farm. The level of automation turns a stockman into an animal systems technician. They need to know as much about the technology as they do about the pig.

Baird's shows how PLF technology can be used in straw-based large groups of pigs. For the UK this area is where we can utilise the technology in innovative ways. No other country has 40% of their pigs finished on straw. It could be a real opportunity for farmers to standardise production across sites and market pigs more effectively, increasing profitability.

6a.iii Optiscan

Optiscan is a product from H&L that takes the static camera technology from the Optisort system and makes it mobile. So instead of needing to purchase expensive static hardware a farmer could do the same job over many pens of pigs. There is a significant potential market for this product. As farmers we miss a large amount of revenue potential that is lost by not marketing pigs at the optimum weight. If an extra 2kg of weight could be added to the carcass then this product would have a payback of under 6 months for a 500-sow farm finishing its own progeny.

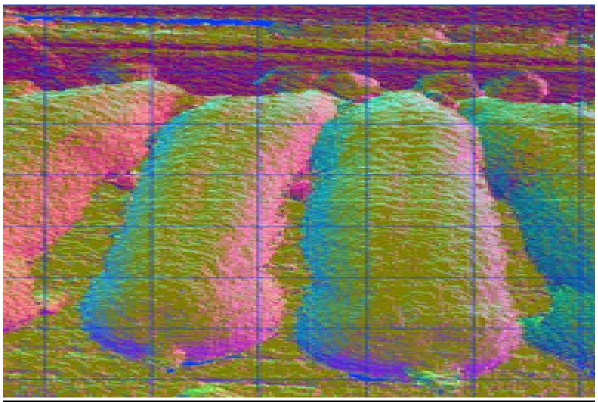



Figure 15 : Farmer using the Optiscan and the image generated (*source: H&L*)

Not surprisingly this was music to a farmer's ears. For some producers this type of product is what the market has been crying out for. In the UK several early adaptors bought the Optiscan whilst others were intrigued to see how it would perform on a real pig farm. Unfortunately, it just didn't perform anywhere as well as it should have done. The reality is that it was brought to the market perhaps 3 years too early.

I have included this to show that when dealing with new technology not everything is going to work perfectly despite the money, time and effort invested in it. The demand for a product like the Optiscan still remains but perhaps in future it will be app-based on a smartphone where you pay for each image you take rather than a standalone piece of kit with a large upfront cost.

4 Key Questions:

1. Does monitoring and recording pig growth work on a commercial basis? Yes. The success of any system depends on the buy-in from the farmer and stockmen. On many pig farms there are problems like how to stop fly faeces affecting the efficacy of the sensors and the unreliable nature of broadband.

2. Would it work in the UK? It does, as several early adopters have shown.
3. Is it affordable? As with all new technology the more people adopt it the cheaper the hardware becomes. Prices need to come down further before it is more widely adopted.
4. Will it make management more effective? Yes

KEY POINTS for chapter 6a

- **Both of the businesses discussed are early adaptors using data to drive decisions and make management more effective.**
- **If you measure it you can improve it.**
- **By weighing pigs more often it is possible to hit a higher % of pigs reaching top grade therefore increasing revenue.**
- **The technology has to fit the farm rather than vice versa.**

6b. Monitoring for health and welfare

What is welfare? For the purposes of this report it refers to the 5 freedoms of animal welfare as outlined by the UK Farm Animal Welfare Council are:

1. **Freedom from hunger or thirst** by ready access to fresh water and a diet to maintain full health and vigour
2. **Freedom from discomfort** by providing an appropriate environment including shelter and a comfortable resting area
3. **Freedom from pain, injury or disease** by prevention or rapid diagnosis and treatment
4. **Freedom to express (most) normal behaviour** by providing sufficient space, proper facilities and company of the animal's own kind
5. **Freedom from fear and distress** by ensuring conditions and treatment which avoid mental suffering

When I started out on my Nuffield Farming adventure PLF for me was all about faster growth, better food conversion and increased revenue. However, after many months of travelling it became apparent that it can offer the farmer effective tools to monitor the welfare of their animals. If we can monitor the growth or the food consumption of the pig 24/7 why can't we monitor the welfare of the pig? The answer is we can. The reason it wasn't thought of to start with is because it is difficult to quantify the value welfare has to the farmer.

It is easier to measure feed usage - which is 70% of the cost of finishing a pig - and growth. Both these can be seen very quickly on the bottom line. As time has moved on and more questions are being asked about the sustainability of modern agriculture. As farmers, we need to be able to prove our credentials. One way to do this is going to be through data analysis and evidence rather than gut feel and emotion.

Create the data, collect the data, analyse the data and then act on the data.

6b.i Pro Grow from Skov & Tailbiting Research

ProGrow is a camera-based sensor system from the Danish company Skov which works similarly to the Optisort system. The difference is that it is fixed above the pigs in a pen with non-restricted feed access. The technology for the ProGrow sensor came from a Scottish company, Innovent UK, and was originally called the Q-Scan. Unfortunately, there is significant PLF innovation conceived and developed in the UK which then has to go abroad to find commercial partners.

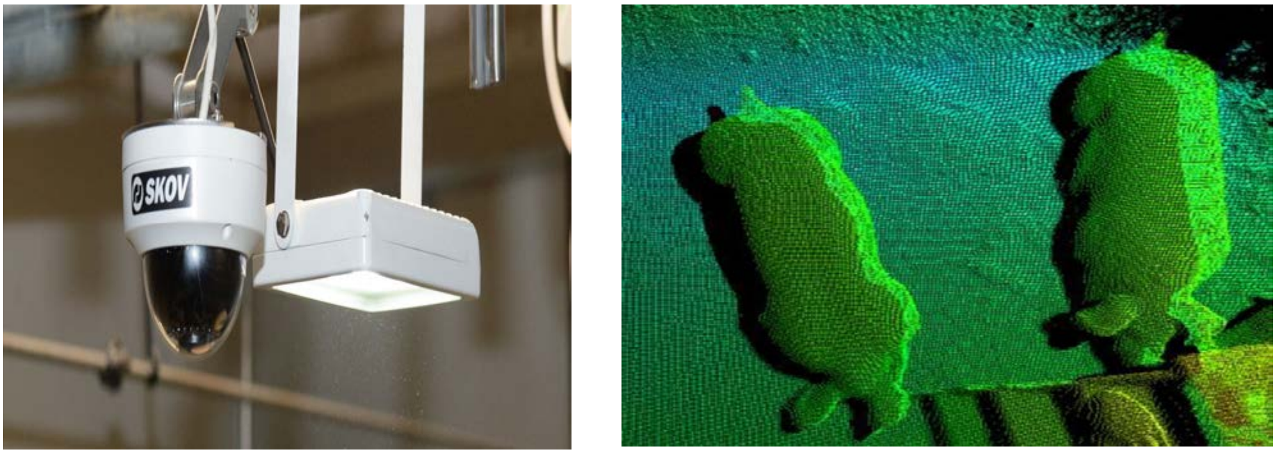


Figure 16 : Installed Skov ProGrow and image generated (*Source: Skov)*

The images generated by the ProGrow really do not look any different to the images from other systems. Where this gets interesting is the research carried out by the Roslin Institute in Edinburgh. Dr Rick D'Eath and his colleagues wanted to see if they could find at correlation between the position of the pig's tails and prevalence of tail biting.

Tail biting is a big issue for the pig industry globally. There is no one factor which triggers it, it is multi-factorial. It is painful for the pig and is estimated to cost the UK pig farmers over £10 million per year in carcass losses. The most difficult thing is that it has proved almost impossible to predict when it will happen and it can spread quickly in the pen.

The researchers set out to see if they can reduce the unpredictability of tail biting. They noticed 3 common behaviours in pens where tail biting took place:

- Lowered tail posture
- Increased activity
- Tail-directed behaviours

So could they use the 3D images from the ProGrow to detect those behaviours before an outbreak of tail biting? The scope of the research was to assess whether a lowered tail position was an early warning sign of tail biting. If it was, could algorithms be developed that would then give the farmer an early warning signal of an outbreak? The researchers found evidence of a statistical correlation between tail position and tail biting up 10 days before stockmen started to notice clinical signs. For the farmer this is exciting news.

Currently more trials are being carried out on different farms with pigs having differing tail lengths, to test more variables. The end goal is an early warning system for tail biting.

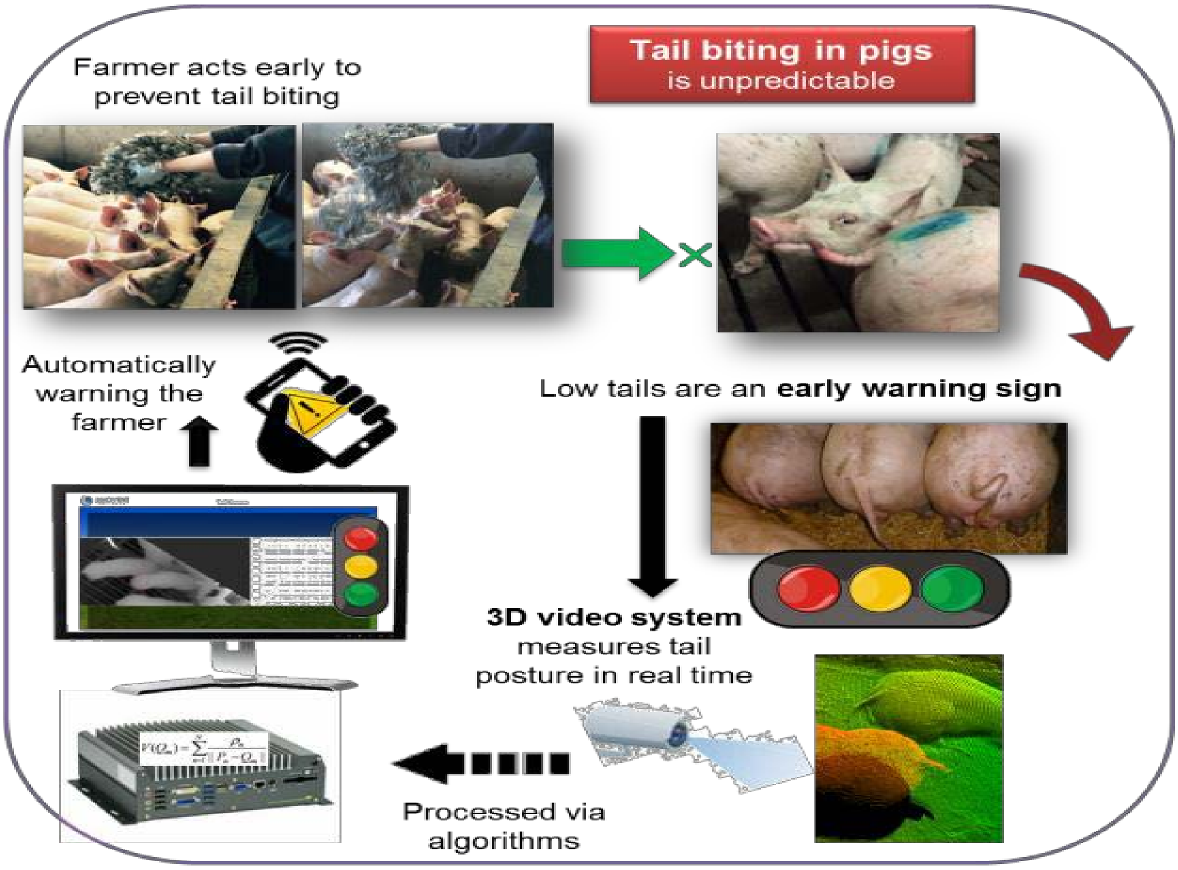


Figure 17: Tail Biting Infogram (Source Rick D'Eath, Roslin Institute)

So not only can the ProGrow determine the pig's weight, it can also provide an early warning system for tail biting. If it can do that what else can it do? From a UK perspective it would be good to see some trials carried out in straw yards on pigs with undocked tails. The pigs have straw to root around in so in theory should be less predisposed to tail biting.

6b.ii Soundtalks, Leuven, Belgium

Soundtalks are PLF start-up company based in Leuven, Belgium headed by Dries Berckmans. His father, Daniel Berkmans, is considered one of the leading pioneers of PLF. Soundtalks's take on monitoring for welfare is to record pig's sounds by using microphones. Soundtalks "*continuously and objectively monitors the health of a herd of fattening pigs by automated analysis of pig sounds.*"

Ensuring good respiratory health is vital in efficient pig production. Bad respiratory health can adversely affect growth, increase mortality and increase weight variance in a group, leading to poor pig marketing. On a badly affected unit, respiratory disease can cost up to £10/pig. Respiratory problems are multifactorial and complex diseases to diagnose and deal with. As farms are getting bigger we need tools to act as our eyes, ears and nose. Soundtalks fits the nose part of the jigsaw.

By analysing sound, Soundtalks believes that they can detect potential problems 10 days before the farmer. The case study shows work carried out on a commercial farm in the Netherlands.

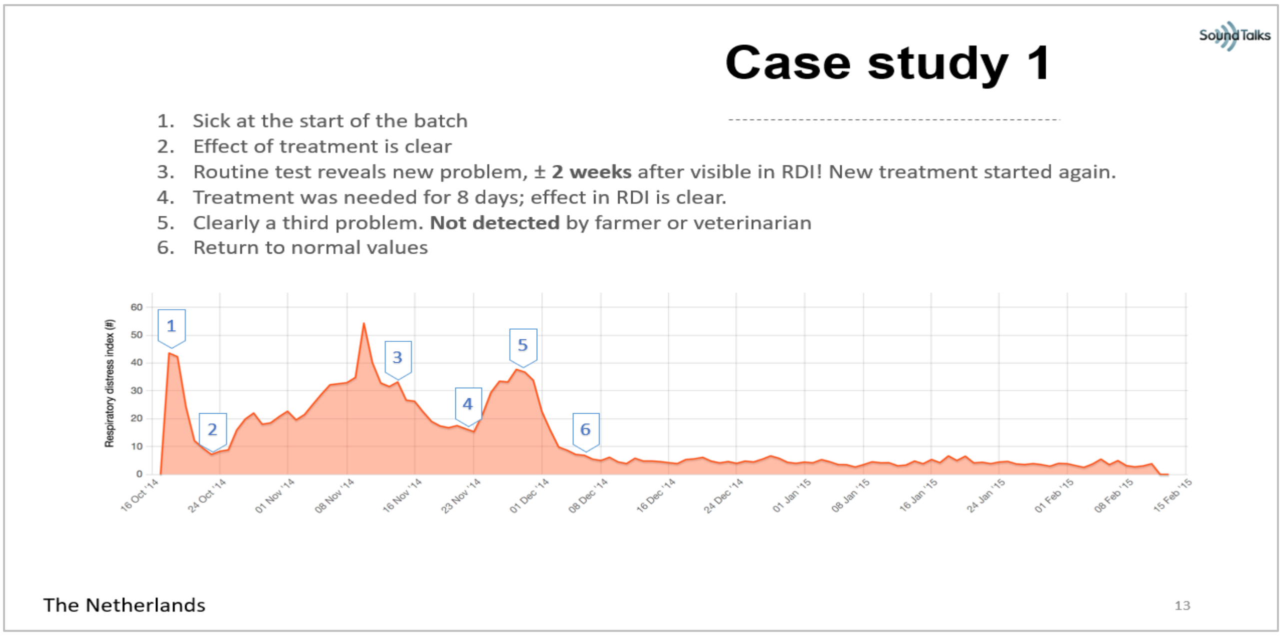


Figure 17: Sound Analysis Case Study (source: Soundtalks)

From the graph it is possible to see how the data the microphones collect is transferred into a format that can be easily analysed. Work is ongoing to differentiate respiratory sounds so that individual diseases can be identified. This should hopefully be available by 2020.

The concept hasn't been without its problems. Cost has been a big stumbling block. The hardware is not cheap and for it to be more widely adopted it needs to be cheaper. One solution to this problem has been to develop a plug-and-play mobile device that can be moved around the farm. By targeting this mobile device at vets and health professionals Soundtalks have increased sales.

The 24/7 real time monitoring of sound data enables the vets to be in the sheds even if they are hundreds of miles away. A vet only sees a snapshot of health in a shed; they can't be on farm all the time so this technology can be their ears.

Dr Berkmans was adamant that the new technologies like his will only work if there is collaboration amongst suppliers. He is happy to open up the data to work with others who have the same mindset so that the Soundtalks data and information sits in a platform operated by others. Farmers want the information in one platform from all providers to keep life as simple as possible.

A further interesting point from Dr Berkmans was about the value of the data that is generated on farm. He didn't think it was going to revolutionise pig farming, but that data about the animal and the conditions it was reared in could have a value of €3-5 per pig. As consumers ask more questions about where their food comes, farmers will be able to give them a lot more answers thanks to 24/7 real time monitoring and recording.

6b.iii Swinetech, Cedar Rapids, Iowa

Another company looking at using sound as an early warning system is Swintech based in Iowa in the USA. When visited in July 2017 their product called SmartGuard was still in the development stage but it was possible to see the potential.

In the first 48 hours of a pig's life the biggest threat it faces is being crushed by its own mother. When a piglet is laid on, it emits a squeal that is a different frequency to any other sound it makes. Matthew Rooda, the founder of Swinetech, believed it was possible to isolate that sound and use it as a trigger to try to get the sow to stand up.

- What has been developed is a unit which sits between 2 sows which wirelessly monitors information coming from the sow.
- The sow wears a patch which is glued on and designed to stay there for the first 5 days after giving birth.
- If the system detects the squeal of crushed piglet, then after 8 seconds the sow is given a vibrating stimulus through the patch.
- If the sow fails to respond then the stimulus is increased until it stands up.
- As a last option the sow is given a small electric stimulus like a dog training collar. The idea is the sow learns by behaviour so that it doesn't get to this stage.

Figure 18 : Installed Smartguard from Swinetch (*source: Swinetech)*

There are certain ethical questions to be asked about using electric stimuli. It is difficult to see this type of concept being accepted in the EU but in countries with different welfare standards it could help in reducing pre-weaning mortality.

One unintended consequence of using a patch is that the temperature of the sow can be monitored 24/7. When a sow gives birth her body temperature rises by 2'centrigrade so the farmer can be given an early warning that a sow has entered labour. I think as this product continues developing its original purpose will become *another* selling point rather than *the* selling point.

Both Soundtalks and Swinetech have taken the route of being the ears of the farmer using PLF technology to learn what the sounds are telling us. This interesting development has the potential for much further growth as our understanding increases. For me they need to be part of an integrated system that acts as the eyes, ears and nose of the farmer because that is where the value lies.

6b.iv The nose of the farmer

As shown, the sensors used in PLF can act as the eyes and ears of the farmer. They can also act as the nose of the farmer. Ammonia and carbon dioxide monitors are frequently included as part of a suite of sensors to help monitor the welfare of the pig.

A well-run pig finisher shed will have ammonia levels below 10 parts per million (ppm). When the level gets up to 50ppm and above daily live weight gain can be impaired by up to 10% because clearance of bacteria from the lungs is impaired; therefore the animal is more susceptible to respiratory disease. It is relatively easy to lower ammonia levels:

- Increase ventilation rates.
- Empty slurry pits more often.
- Use feed additives like Yucca extract which reduces ammonia production in slurry.

This is an easy to fix problem but is often overlooked. By using sensors it is possible to monitor the ammonia levels to stop it becoming a clinical issue.

It is often said where the chicken industry goes the pig industry follows. Whilst on my studies I met Andrew Stacey from Cellular Systems who, along with Roboscientific Ltd , are carrying out research to see if the presence of Campylobacter can be detected in chicken sheds in real time. For the broiler industry Campylobacter is the number one public health issue. Air samples were taken in various sheds and put through Volatile Organic Compund (VOCs) analysers. The partners found the VOCs from the campylobacter can be detected and isolated.

In theory if it works for that, it could work for Ecoli, salmonella or other pig diseases where, by the time you see clinical outbreaks of disease, you are curing rather than preventing. Like the eyes and ears this is another early warning system that will improve pig welfare and health. The trial partners certainly seemed confident that it could be done but it would need some serious time and money.

Using PLF technology to act as the eyes, ears and nose of the farmer

1. Will the technology work on a commercial basis? Some of it is well proven and in full commercial use. Some is still in the early development phase. The rate of development is increasing and more and more products are going to become available to farmers.
2. Would it work in the UK? Same as above; some is working well but perhaps the more exciting products are yet to come.
3. Is it affordable? Hard to quantify this. If it improves pig welfare and health which leads to a lower cost of production and a decent return on investment then yes, it is. If it masks deeper underlying issues then no.
4. Will it make management more effective? The right tools in the right hands will improve farm efficiency. These tools will not turn bad buildings into good buildings or poor pig herd health into good pig herd health.

(see Key Points from Chapter 6b on next page)

Key Points from Chapter 6b:

- **The technology is available today to help good farmers who understand their herd health and costs to better manage their pigs.**
- **As mentioned earlier the robustness of the sensors needs to keep improving to increase hardware longevity and software effectiveness.**
- **Harvesting the data generated by the mobile living sensors (the pigs) will have a monetary value in the future. How much it will be worth is unknown today.**

6c. The future - platforms and sustainability

Using precision technology to help the farmer by being additional eyes, ears and noses is an excellent example of how data can drive decisions. As I see it, one of the biggest issues to widespread usage is the lack of a common platform that is user-friendly.

If you sell a ventilation system you want farmers to use your computer, if you sell a feed system you want farmers to use your computer etc. Before you know it there could be a dozen different interfaces on the farm leading to inefficient use of the technology.

As a farmer what I want to see is a common platform that each application sits in, that is a one stop shop for information. This would require different technology providers to be more open with the generated data. For PLF to truly work it has to be simple to use. Let the algorithms do their clever work in the background so that the action can be taken on simple, concise and easy to understand information. If my 10 year-old could make sense of the information then that's just right, any more than that it will be too complicated.

6c.i OPTIfarm

To run things as efficiently as possible has been the goal of every farmer I met. Some of the most forward thinking were contracting out various jobs because it made more sense to hire in specialists rather than doing it yourself. The old adage, "do it right, do it once" springs to mind.

OPTIfarm is part of the Applied Group of companies run by David Speller focusing on the broiler industry. David is real blue sky thinker and a couple of hours in his company really makes you challenge your own perceptions and beliefs on how to farm.

Essentially OPTIfarm is a 24/7 monitoring and optimisation service that uses PLF technology to remotely monitor broiler farms across the globe from an office in Chesterfield.

It uses the buildings as data gatherers to ensure that optimal conditions are being observed and the most efficient growth achieved. Good welfare leads to good performance.

Where this starts to get interesting is when talking of the future. 40% of labour in a broiler shed is used to collect dead chickens. Therefore, why not let the OPTIfarm system direct a robot to the animal and collect it remotely, possibly from thousands of miles away, then alert the farmer?

Also the use of smart glasses could be a really interesting development. Let the expert see what you're seeing.

Picture 9: Smart Glasses with inbuilt Camera (*Source:Google*)

If your stock are having health issues and the vet can't get to site they could see and hear what's happening through the glasses in real time so they stand a better chance of being able to diagnose an issue than if the farmer is trying to explain it. **Take the farm to the expert rather than the expert to the farm.** Potentially it could mean that the expert could "see" a lot more facilities and only visit those that are experiencing continual issues.

If we understand how our animals behave then we are moving away from farmers in green wellies towards being animal technicians utilising the PLF technology and equipment to the maximum of what we know it will do today. For farmers, part of the problem is that the technology is developing faster than we can understand it. David Speller believes that he is only monitoring 10% of what is possible. How much and how far we monitor will be decided by the financial return. That could be in efficiency savings or even penalties for poor welfare, emissions or sustainability when benchmarked against others.

Therefore, for some, it may make more business sense to let a remote expert who can utilise the tech analyse the data to then tell you what it means. Let the company be the platform that then tells you what you need to know to run the sheds as effectively as possible. Today that would be probably be a step too far for the UK pig industry. But longer term it may be that for a section of the industry it could enable them to be overcome labour issues and remain sustainable and profitable.

6c.ii Fancom

'If innovation allows us to improve and puts us on the path of the individual care of our animals, can we, by using an integrated approach, become more informed? Whether we're Farmers or Consumers, information will allow us to make

an intelligent decision as to whether intensification is acceptable and that ultimately 'industrial' is just Big Farming'. Simon Lague, Fancom

Big farming, smart farming, iFarming, PLF - call it what you like - is a great opportunity for collaboration by stakeholders from multiple disciplines to come together to make farming more sustainable. This is the Fancom way. If we can monitor growth, welfare and health why can't we monitor sustainability. Take ownership by making objective rather than subjective judgements. If it can be measured it can be analysed.

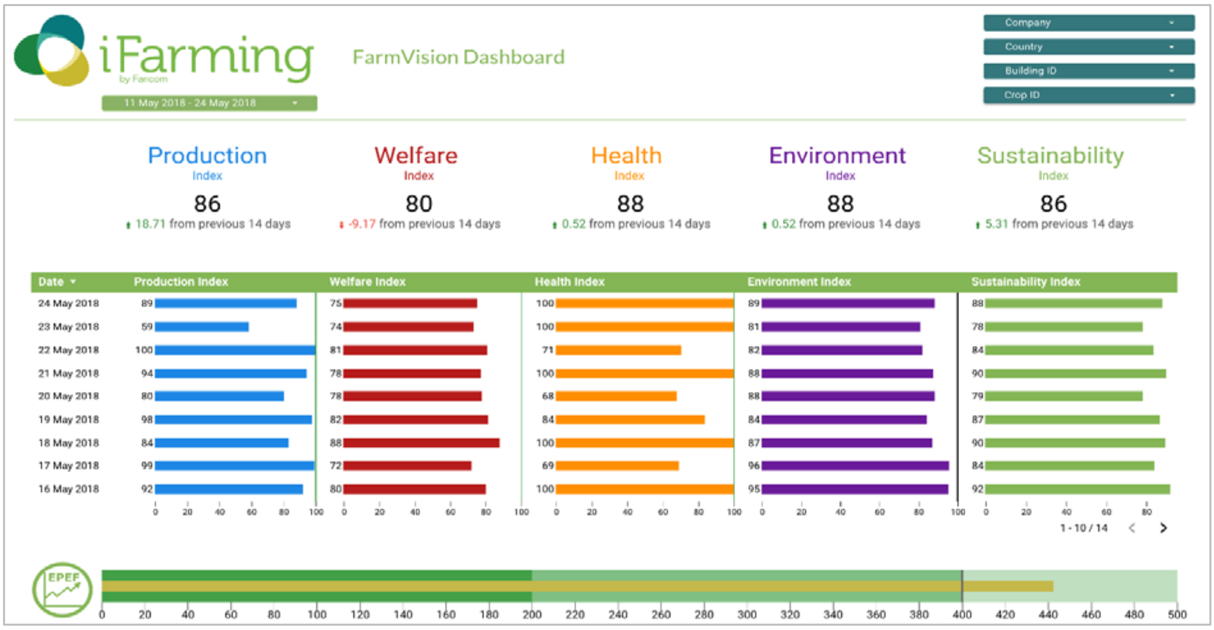


Figure 19: Fancom Welfare & Sustainability Dashboard (*source: Fancom*)

This dashboard from Fancom is an excellent example of measuring criteria and putting a number to an area that hasn't been measured as effectively before.

For too long the narrative about farm sustainability has been driven by those who have moved into the farming space with a different agenda. For too long the image of "big farming" has been doom and gloom. By quantifying sustainability, welfare, health and environment we can fight the misinformation and put across the message of safe, affordable food produced to some of the highest welfare standards in the world and using less antibiotics every year. We need to do this to tell our side of the story because no-one knows it better than we do.

For Fancom sustainable production has 3 elements

- Production efficiency
- Animal welfare
- Environment

Production efficiency is about giving the pig the right food in the right environment at the right stage of its development. Control these elements effectively and the outcomes will be positive. With welfare and environment the more we can measure the more we can prove. Use the vast swathes of captured data to analyse performance so that it can be benchmarked against independently set performance targets. By continually improving against targets farmers can prove that they are farming in a continually improving and sustainable way.

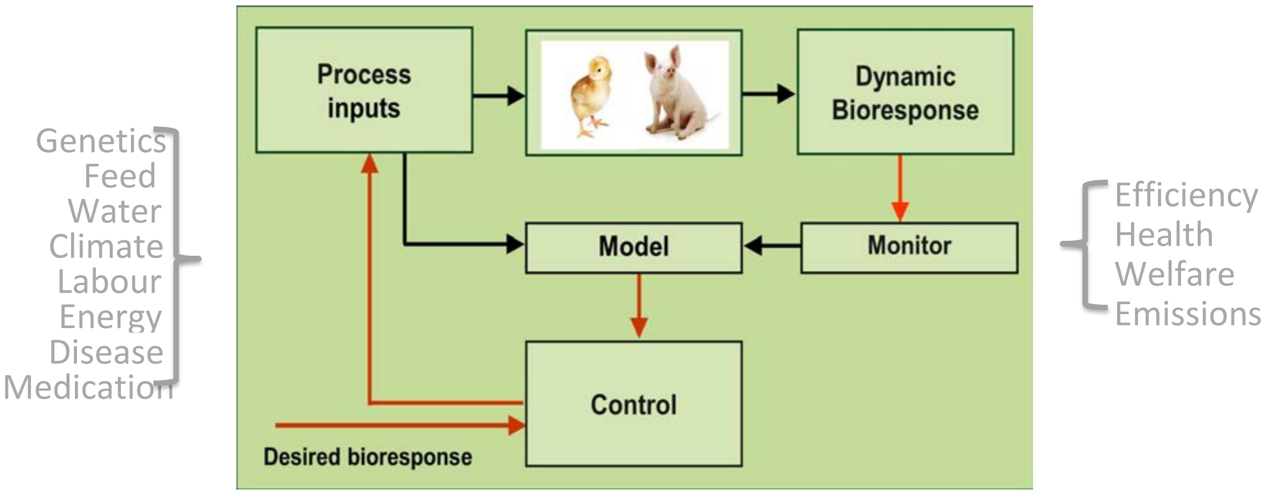


Figure 20 : Sustainable Production Flow Diagram *(source: Fancom)*

Create the data, collect the data, analyse the data and then act on the data.

Using PLF technology to provide a common platform and help sustainability:

1. Does it (or could it) work on a commercial basis? The technology is still new but the potential to have a PLF technology on 1 platform is huge.
2. Would it work in the UK? Yes.
3. Is it affordable? If it comes as part of a current subscription then it will have to be to ensure sufficient uptake.
4. Will it make management more effective? The simpler the interface for the farmer the more successful the product will be so the potential is there to help.

Key Points from Chapter 6c:

- **The existing technology providers may not be the ones to tie everything up under one roof. There is room for a left field entrant, who doesn't have to come from an agricultural background, to disrupt the market.**
- **Being able to treat sustainability and welfare in an objective rather than subjective way will enable the pig industry to prove our long term credentials-no matter the production system.**
- **Not all the answers will come from within the pig industry, there is plenty to learn from other sectors.**

7. Precision medication

In a world where farmers are being challenged to reduce the usage of antibiotics the need for solutions has never been greater. Antibiotics are not being developed at the same rate as vaccines or solutions for chronic care. Antibiotics are designed to cure; therefore there are no ongoing sales, which has led to a drying up of investment. Why invest in research and development in antibiotics if you can have R&D products for use in chronic therapy? i.e. if someone lives for 20 years with a problem they are going to need medication for 20 years, bringing continued revenue streams for the pharmaceutical companies.

For pig farmers, using sensors and data capture as the eyes, ears and nose of the farmer to provide an early warning system will be a part of keeping pigs healthy. Unfortunately, no matter how much technology is used, some bugs and diseases may inevitably get through the safety net.

Traditionally what has happened on farm is a vaccine has been used if the problem is viral, and antibiotics used if the problem is bacterial. We can use vaccines to prevent a disease outbreak when we know there is a problem and we can also use antibiotics in the same way. However, this metaphylactic use of antibiotics is now not allowed in the UK.

The major retailers are all falling over themselves to prove that their supply chain is the best at reducing antibiotic usage. Asda at the cheap end of the market have followed national guidelines for pork at under 100 mg/kg of antibiotic active ingredient per weight of pig produced. Marks & Spencer near the top end of the market say:

> *"Our farmers use antibiotics responsibly. They never use them routinely, never use antibiotics that are critical to human health and are committed to reducing use every year. However, we do not envisage <u>never</u> using them. Animal welfare is at the heart of our business and using antibiotics responsibly is appropriate treatment, under veterinary supervision, when they need it."*
>
> *Steve McLean, Head of Agriculture at M&S*

On our own farm we have worked very hard to reduce our antibiotic usage over the past 2 years. As the graph shows we are now using 1/3 of the antibiotics we were 2 years ago.

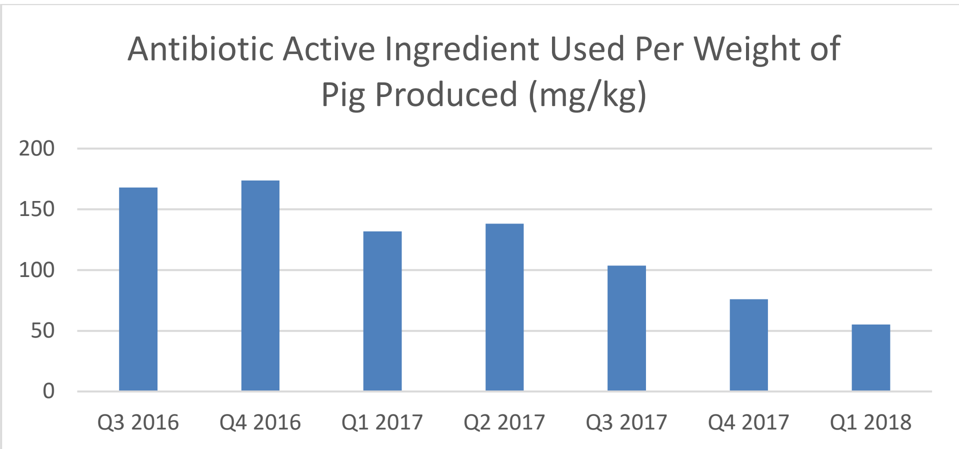


Figure 21 : Shedden Farms' Antibiotic Reduction Q3 2016 to Q1 2018 (*source: Author's own*)

This is possible without compromising production efficiency. Better cleaning and disinfection, lower stocking densities, better management and the use of autogenous vaccines have been key for us to achieve these reductions.

7.1 Anicon Labor, Hoeltinghausen, Germany

I went to visit Anicon as they have been making a vaccine for us for the past 2 years, based on specific pathogens from our farm. We have had a *streptococcus suis* problem that led to increased antibiotic use. We were really trying to cure rather than prevent the problem. However, Anicon were able to develop a bacterial vaccine based on the strep strains from our pigs. This pathogen is notoriously difficult to pin down but after a period of trial and error the right pathogens had been identified by Q4 2016 and since then our antibiotic usage has plummeted.

We now have the confidence to not go in with antibiotics at the first sign of trouble. The bacterial vaccine is doing its job. Importantly, though, we still have the ability to treat individual pigs to prevent further health or welfare issues.

Custom made vaccines can be an effective solution when there is no commercially licensed product available. Because a pig herd is constantly changing with animals coming in and out, the number and type of pathogens are also changing constantly. This ability to move quickly is key to maintaining pig health.

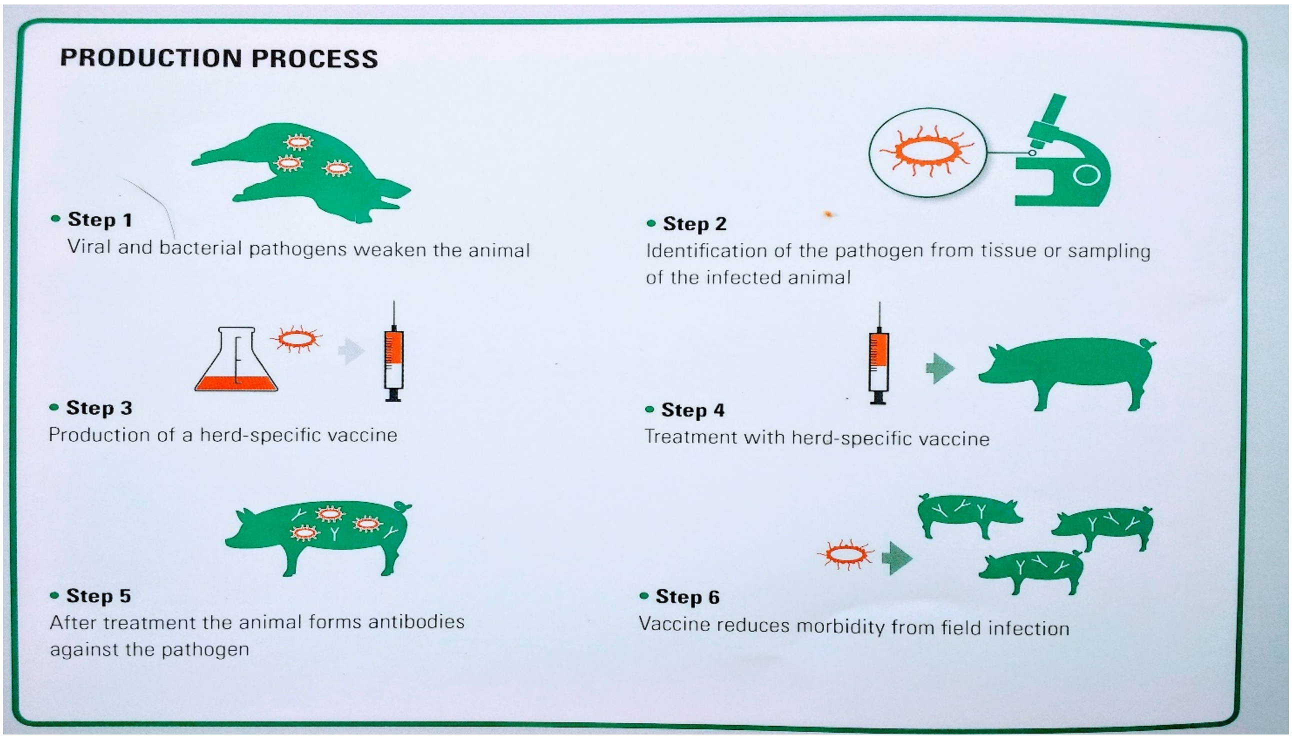


Figure 22: Autogenous Bacterial Vaccine Development Stages (*source: Anicon*)

Producing autogenous vaccines for use on an individual farm is a great example of using precision farming to solve a specific problem. By doing this Anicon have tapped into a market that is demanding quick solutions. It is not a fail-safe technology and doesn't work every time but it offers farmers another tool in the armoury.

Using precision medication to help profitability and sustainability:

1. Does it (or could it) work on a commercial basis? As we have shown on our own farm it does work. There is an inevitable amount of trial and error to see what works on each farm.
2. Would it work in the UK? Yes.
3. Is it affordable? This depends on the level of the problem. As economies of scale kick in the bigger the problem the more affordable it is.
4. Will it make management more effective? Anything that keeps pigs healthy and reduces disease is going to aid management.

Key Points:

- **Some bugs and diseases will get through the PLF technology net. It is important to have a medication plan which can act as a failsafe.**
- **No back up plan is a substitute for thorough management practices. There is no short cut.**

8. Conclusions:

1. The UK pig industry has consolidated after a pretty traumatic time, halving in size over the past 20 years. The national herd has stabilised over the past 3 years and feels as if it is going to stay near its current level (420,000 sows) for the foreseeable future.
2. There are enough PLF precision products available today and in the pipeline to ensure that they can help UK pig farmers increase profitability and sustainability.
3. Gene editing technology is available today but may take a long time be acceptable to the consumer in the UK.
4. Off-the-shelf weigh sensors are available and proven. It gives farmers another tool to try to maximise income by meeting contract specifications.
5. Perhaps the most exciting thing is the potential ability of the PLF to score welfare and sustainability. A common platform is needed to keep things simple and recognisable by consumers.
6. In the age of reducing antibacterial usage it is vital that other tools are available to fight disease and infection. Autogenous vaccines are going to help this process.
7. There will be no replacement for good stock skills. PLF will only work in the right hands. It will not turn a bad farmer into a good one but it could turn a good farmer into a very good farmer.
8. Because of PLF's modular nature you can utilise as much or as little of PLF as you want/need. Size should be no barrier to access the technology. The individual mindset will be the barrier.

9. Recommendations

1. Use the right technology for your farm. Just because it is big, shiny and cost a lot of money doesn't mean it will work for you. Take advice, talk to other farmers - they will give you the best advice.

2. If a ten year old can't understand the information generated then it is too complicated. Only use what you or your advisors (i.e. vet, nutritionist etc) understand. Keep it simple.

3. We have to embrace the opportunity to make objective judgements in areas that are at present subjective. The scoring and benchmarking of welfare outcomes using 24/7 monitoring will be a major tool in the long term sustainability of the industry and maintaining the UK price premium.

4. Any new technology has to fit in the farm system if it is to succeed. Make the technology work for you rather than you working for the technology.

5. We need to use the technology in the 40% of the UK pigs which are finished on straw. There is plenty we can learn from the poultry industry. Straw-based is a premium production system that may benefit from the application of the latest technology. There are businesses out there that are breaking boundaries.

6. Data for data's sake will only lead to paralysis by analysis. Work out what needs to be analysed and interpreted to maximise sustainability and profitability.

7. Investment is needed to design a common platform that can house the various technologies. The winner of this race may not be from the livestock industry. There is the potential for a disruptor from outside to provide the solution and get the rewards.

8. **Create the data, collect the data, analyse the data and then act on the data.**

10. After my study tour

My study tour enabled me to meet and spend time with some excellent pig producers and technology providers. The one common thread amongst all of them was their refusal to sit still. Their businesses are continually evolving to meet the changing challenges they face. They are not scared of investing with the potential for little return. This brought home to me the need with our own business for some serious consideration about how we are going to face the future.

With an ageing site and a pig herd that is far from healthy the choice became apparent during my travels. It was with a heavy heart that we decided to stop breeding pigs after 48 years. The cost of destocking and restocking our herd along with rebuilding the unit from scratch would be capital that would be better allocated elsewhere in the business. My study tour allowed me to see best practice in action and it reinforced the reality that we would not be able to reach the level required for me to be satisfied.

The good news is that we are staying in pigs, simply not producing our own. A lot of the PLF technology I have seen on my travels can be utilised in our growing and finishing accommodation. Some of it we have already invested in and there is more in the pipeline! As well as capital and pig health the streamlining of our operation has been in part due to a shortage of quality labour plus growth in other parts of the business.

We have a venture - cleaning pulses - which are then exported that has expanded substantially over the past 5 years and is continuing to grow. It offers us potential for agronomic and economic benefits as well as by-products that can be fed back to the pigs creating some closed loop feeding. Change in any business is not only inevitable, it is desirable. You can either be engulfed by it or run with it. Time will tell where we get to.

Hugh Shedden

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12. Bibliography and References

- Berckmans D, **Soundtalks Conference Presentation**, 2017.
- Berckmans D**, Automatic Monitoring of Livestock for the Benefit of All**, EU Precision Livestock Project Conference Paper, 2016.
- Berckmans D, **EU PLF Project Final Report**, Smart Farming for Europe Conference, 2017.
- D'Eath R, Jack M, Baxter E,**3D cameras to detect tail biting in pigs- story so far and what next**, SRUC Conference Presentation, 2017.
- Ghosh P, **Gene-edited farm animals are on their way,** BBC News Website, 20th June 2018.
- Halachi M, **How PLF delivers Added Value to Farmers**, Precision Livestock Farming Applications, 2015.
- Hartung J, Vranken E et al, **European Farmers' experiences with Precision Livestock Farming systems**, Animal Frontiers, Jan 2017 vol.17 no.1.
- Holscher & Leuschner, **Happiness of Pigs**, Technical Brochure.
- Hudson J, Stewart G et al., **The Agrifood Chain & Antimicrobial Resistance: a Review**, Trends in Food Science & Technology, Sept. 2017.
- Lehr Dr H, **Recent Advances in Precision Livestock Farming**, International Animal health Journal, Vol.1 Issue 2.
- Maselyne J, Van Nuffel A et al., **Registering Feeding Pigs in Group Housing**, Computers & Electronics in Agriculture 102, 2014.
- Matthews S, Claap j et al., **Early Detection of Health & Welfare Compromises through Automated Detection of Behavioural Changes in Pigs**, The Veterinary Journal, Sept. 2016
- Murphy Dr R, **Microfloral Rehabilitation: Normalisation of Gut Function**, International Animal Health Journal, Vol4 Iss. 2.
- Norton T, Berckmans D et al., **A Blueprint for Developing & Applying PLF Tools:A Key Output of the EU-PLF Project**, Animal Frontiers, Jan 2017, Vol.17 no.1.
- O'Grady M & Gregory M, **Modelling the Smart Farm**, Information Processing in Agriculture 4, 2017.

* Pastell M, Mottram T et al., **EIP-Agri Focus Group Precision Farming Final Report**, EIP-Agri, Nov 2015.

  Saeys W, Maselyne J et al., **First Results of a Warning System for Individual Fattening Pigs Based on Their Feeding Pattern**, Conference Paper, Sept. 2017.
* Skov Ltd, Progrow- **Taking your Pork Production to the Next Level**, Skov Technical Brochure.
* Ter Beek V, **Why Precision Farming Takes its Time with Pigs**, Pig Progress, Sept. 18 2017.
* Vranken E & Berckmans D, Precision Livestock Farming for Pigs, Animal Frontiers, Jan 2917 vol.17 no 1.

* www.actingman.com/hogcycle
* www.gatesnotes.com/About-Bill-Gates/Future-of-Food
* www.PIC.com
* www.Nedap-livestockmanagement.com/pigfarming/solutions
* www.hl-agrar/happinessofpigs.de
* www.skov/en/pig/farmmanagement.com
* www.soundtalks.com/products
* www.fancom/com/iFarming/en
* www.anicon.eu
* https://pork.ahdb.org.uk/media/273760/ahdb-pork-yearbook-2016-17.pdf

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