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Born and educated in Scotland (subsequently re-educated in Queensland), his first farming experience was in dairy and beef.

He has been involved with beef ever since, with 37 years experience around the world. This year he celebrated 30 years in Australia.

Don's experience covers a wide range of positions – he managed a large cattle ranch in the plains of Venezuela at the age of 21, has been a government adviser in Queensland, introduced BREEDPLAN to the Australian beef industry, was technical consultant to the Angus Society of Australia for 10 years, was divisional manager with the largest beef producer in Australia, consults to a vertically integrated company in South East Asia, consults to Genetic Solutions the DNA marker test pioneers, and is a member of the Management Committee of the MLA National Beef Extension Team.

He lives in Brisbane with his wife Pam and has three daughters. His hobby is World music, hunting upland game with pointing dogs and training gundogs.

INTERNATIONAL BENEFITS OF MODERN BEEF BREEDING TECHNOLOGIES

In this paper I will review modern beef breeding technologies that are available to Hereford breeders around the world today and in the future. In addition I will give my thoughts on the likely future impact on Hereford breeders and in conclusion I will present a recommendation for future action.

Beef Breeding Technologies:

These can be usefully separated into two classes.

1. Reproductive Technologies
2. Genetic Information Technologies

Reproductive Technologies

- a. Artificial Insemination (AI)
- b. Embryo transfer (ET)
- c. Oocyte pick-up and In Vitro Fertilisation (IVF) including Juvenile In Vitro Embryo transfer (JIVET)
- d. Sexing of semen
- e. Cloning

My expertise in the technical aspects of these reproductive tools is not that high but I do have extensive experience in the practical application of them. As a cattle breeding consultant my clients use or intend using some or all of these technologies and indeed some of my clients have been pioneers in the use of these technologies, in taking them from the laboratory to the paddock.

AI – Artificial Insemination

Decades after its practical introduction to Australia in the 1960's, AI is still the most under-utilised reproductive technology in the beef industry. Semen from high genetic merit bulls is available from many countries and is a significant tool in genetic progress in beef breeding. It is also one of the lowest cost reproductive technologies and leads to rapid dissemination of superior genes.

International shipment of semen is becoming easier each year as breed societies lower the 'barriers to entry' created by their ownership rules and regulations. To continue to encourage greater genetic improvement, breed societies must continually review these rules and regulations, where possible making it easier for wider use of semen. A few major artificial breeding companies are now powerful global players in the beef semen market, however their main business is selling dairy semen. Their catalogued stocks of semen in a country tend to reflect their views of where different breeds are going in a country, continent or in the world. Breed societies should be pro-active in encouraging the AI companies to stock as many bulls of their breed as possible.

In spite of this global supremacy, individual Hereford breeders should never stop being entrepreneurial in selling or exporting semen on a bull with special merit. Give the 'big boys' competition! Cost of semen for imported bulls in Australia is relatively high.

Artificial insemination is extremely important for breed society improvement programs to create genetic linkage between herds in the same or different zones, to enable high-quality genetic evaluation and analysis. The performance of progeny of a reference sire used in many herds and different environments, in a head-head comparison with individual herd bulls, is extremely important.

AI is the basis (and will be for years to come) of many genetic improvement strategies such as young bull proving schemes. Breed societies should be continually exploring ways of using AI for genetic improvement programs in both the seedstock and commercial sectors.

ET – Embryo Transfer

The advent of multiple-ovulation, embryo transfer has been the multiplication of the genes of top cows. It tends to be the bigger programs that are more successful. Often seedstock producers have started with a small program with poor success and have given up on the technology, whereas breeders that have started with larger programs have often achieved 5 transferable embryos per flush with >60% pregnancies. They tend to have gone on with the practice annually to give good results from a genetic progress point of view. So if you have tried once and had a failure, give it a go with a bigger number of donors. It will give you good genetic gains out of top cows.

In Australia the direct transfer (Quick-thaw) embryos is less popular than in other countries. To a large extent this has been caused by extremely poor efficiency of imported direct transfer embryos. A clear cause for the poor efficiency is not known but it is a fact in many programs I am aware of.

Experience with local donors does not support the lower efficiency of quick-thaw techniques and it is gaining fairly wide acceptance.

Oocyte Collection and IVF

This involves collection of ova (oocytes) from females, followed by in-vitro fertilisation (IVF). In recent times it has been used relatively widely in the beef, dairy and prime lamb industries in Australia.

In the early days (5-7 years ago) it was conducted surgically on 3-month old heifer calves or six week-old female lambs but more recently the trend has been to older heifers, once their performance data for birth, pre-weaning and yearling weights have been recorded, so that their own EBV (EPD) has been computed, rather than depending on the mid-parent value for selection.

This process with very young sexually immature females is called JIVET – Juvenile In-Vitro Embryo Transfer. When a heifer calf is born she already has >100,000 oocytes (ova or egg) in each ovary.

In the early days the efficiency of fresh transfers was <40% and for frozen embryos was 20-30%. However, today with refinements in all procedures, especially freezing (vitrification) there are reports of 45-50% for frozen embryos and >55% for fresh.

It is possible to mix oocytes from different donor heifers and/or mix the semen from donor sires, in an attempt to improve efficiencies. As attractive as it might sound, you must also factor in the cost of DNA fingerprinting and parent verification for each of the live progeny of these flushes.

Some practitioners transfer more than one IVF embryo to each recipient, again trying to improve efficiencies, but then you must consider the risk of twin calves with all the potential problems that can occur.

With the advent of sexed semen, the combination of JIVET and sexed-semen allows a high degree of pre-determination of the sex of the calves from frozen (vitrified) embryos and will be especially important for large breeding programs, especially for export dairy projects in the short-term, and beef in the long term.

The benefit of this technology is to reduce generation interval dramatically. A heifer could have 20 to 30 calves by 2 years and could continue to be collected if required. It is especially useful when the goal is to multiply a new strain or breed.

Cloning

In my view cloning will be a 'niche' technology in the International beef industry and will remain that way for a long time. For cloning to become popular it will need a significant drop in cost from the current five-figure prices.

Realistically, what do you gain by cloning a famous bull? Only if you were short on semen would you consider cloning him. Like a straw of semen, a cloned bull passes on half of his genes to his progeny.

Therefore a cloned bull would only be really useful if the price of producing him was reduced to that of a good herd bull and that is not likely for a long time.

Some may not realise that cloning only copies the genetic make-up of an animal; environmental influences will be totally different for every clone. And remember that most traits have a heritability of less than 50% so the environmental influences are considerable. To use an example a clone of a steer will not produce the same carcass attributes as the original animal because the clone will have been raised under a different environment or a female will not have the same fertility or calving ease attributes as the original female as both these traits are lowly heritable.

At present cloned animals cannot enter the food chain but US legislation may be passed in the next year or so that will allow it.

Pharmaceutical companies who want to clone transgenic dairy cattle for the production of pharmaceuticals will be the main users of this technology.

Sexing of Semen

Throughout my career I have heard cattle producers say, "if only we could sex semen". Well now you can, admittedly at relatively high costs and with few commercial services at this point in time. There are commercial projects in place, mainly in dairy, where Holstein IVF embryos produced with sexed semen to produce live heifer calves with a 85-95% accuracy at birth are being frozen mainly for export to China, the world's largest growth centre for dairy production. Trial beef projects are underway in Australia but at this point there is not a clear service provider in Australia. Cogent, a UK AB company is marketing sexed semen from Holstein bulls.

Sexing of semen itself will actually do little for improved genetic gains in beef seedstock herds. It is in the commercial herds that the effects of sexing will make most impact, when (and if) the prices of sexed semen drops. Low-priced sexed semen would be the best 'carrot' to get the commercial producer inseminating his cows.

In that case it will probably also lead to an increase in crossbreeding. The commercial production of F1 females to then be mated to a terminal sire, to maximise production per hectare, would become much more popular.

Bull breeders will want sexed sons of high accuracy bulls that the commercial market is looking for, but they will also want daughters to build new pedigrees, so at the beef seedstock level it is likely only for special combinations that people will pay the extra price for sexed-semen.

Reproductive Technologies Summary

A range of modern reproductive technologies is available to the Hereford breeder around the world and they can confer benefits to breeding programs. Utilisation of these technologies by Hereford seedstock producers will depend on the cost and the potential impact on their particular breeding programs, whether it is in an expansion phase or stable state.

In the beef industry a clear direction is lacking due to industry structure but the lack of value-based marketing is a large problem. The dairy industry is better served where the value of the product is generally very clear with price based on quantity but with a premium for milk quality.

These technologies can all contribute to genetic gains by increasing selection intensities, reducing generation intervals and increasing accuracy of selection. However in Australia in particular the question of cost effectiveness means that each technology needs to be carefully evaluated on a case-by-case basis. Our variable climate is a further challenge to successful outcomes.

Seedstock breeders normally view these technologies with a deal of wariness at first asking, "will it mean commercial producers will buy fewer bulls?"

None of these technologies are likely to impact on the commercial producer unless the cost and efficiency of sexed semen gets to a point that commercial producers will see the value of the tool too great to ignore.

A common element to these complex technologies is that they tend to increase inbreeding levels in a breed. Inbreeding can lead to loss of production efficiency, especially reproductive performance.

The question is often raised if large commercial breeding companies will use these commercial technologies to buy a few outstanding donors of a breed then produce large lines of commercial bulls to by-pass the traditional bull supplier?

At this stage I think I personally cannot foresee this happening in Australia unless the "Hereford Prime" brand gains such demand and premiums that investors outside the industry saw the Hereford breed as a high premium breed. The fact is that breeding companies tend to keep such schemes for the dairy industry, where higher profits per animal can be generated.

As concentration in ownership of grazing land occurs then companies are attracted to these technologies to lower their bull costs. Large cattle companies in Northern Australia are already embarking on these types of projects, one of them probably producing the biggest number of beef JIVET embryos in Australia last year.

2. Genetic Information Technologies

In this section I would like to cover the main genetic information tools, their importance and where the main benefits and future trends are.

A recent Australian economic evaluation of the returns to beef cattle genetic R + D in the southern beef industry showed a net present value (NPV) of \$861 million, a benefit cost ratio of 3.6 and an internal rate of return of 19%. These are net benefits to all in the supply chain plus consumers.

With a suite of world-class genetic information tools in place the opportunity is there for Hereford breeders worldwide to improve genetic gains for profitability, production efficiency and consistency of product. However having a good suite of description tools does not increase the rate of genetic gain. It takes seedstock producers to capture those gains from their selections, passing it to the commercial industry via the supply of superior bulls.

The tools include:

- a. EBV or EPD
- b. \$Indexes and Breeding objectives
- c. DNA Markers
- d. EBVs fortified with Molecular Data

a. EBVs or EPDs

In the last few decades we have seen the combining of pedigree information with performance information to produce an EBV or EPD via BLUP evaluation procedures.

The EBV is the breeding value of the individual animal whereas the EPD is what an animal transmits to its offspring, i.e. half its genes. Therefore an EPD is 1/2 an EBV. Now because many EPDs are weight related, and in some countries are expressed as pounds (lbs), you will often see EPDs expressed in lbs that are similar to an EBV expressed in kgs, so beware if you mix and match sources of information.

EBVs are based on measurements of traits that are economically important or traits that are related to those of economic importance (eg scrotal size is measured to indicate fertility). They are unique because they estimate the genetic merit rather than just the phenotypic (what you see) merit. To do this they combine information about the heritability of the trait, the relationship of the trait to other traits and information from relatives (pedigree). The calculation also corrects for known environmental differences such as age and age of dam. The solution comes from a very complicated algebraic calculation that has only been possible in the last 15 years due to improved computer power, even though the logic was proposed over 50 years ago.

EBVs for traits

The last two decades have seen EBVs being produced for more than twenty traits of economic importance. The benefit of gains using EBVs or EPDs in selections has given a many-fold increase over the weight ratios that preceded them.

EBVs and EPDs – They Work!

The introduction of EBVs was greeted by some people, as the tool they had been waiting a long time for. Others were sceptical not wishing to place their faith in a 'black box' that made calculations beyond their comprehension.

EBVs do work and every year we see more proof of profit of selection using EBVs. In producer-run trials in northern Australia where high and low EBV bulls, for growth traits have been mated randomly the resulting actual progeny performance has accurately reflected the difference in EBV between the sires.

In more rigid regional trials run by the Beef and Meat Quality CRC where high and low marbling EBV sires, high and low yield % EBV bulls and combinations of both EBVs have been mated and their progeny run together until slaughter and grading, the results are the same – EBVs work!

EBVs can create new business

A Hereford 'case-study' from a recent assignment in China is probably relevant to what I consider is the importance of EBVs.

I recently visited a vertically integrated (one of few) operation with feedlots and a meatworks in Inner Mongolia. In that part of the world the Simmental breed is the dominant breed or cross breed. The company I visited showed me some nicely marbled steaks from Simmental cattle. The manager of the works told me that he had actually given away 16,000 free straws of Hereford semen to potential suppliers of feeders the year before.

His logic was quite appealing. The farmers are accustomed to the red and white of Simmental so the colour of Herefords would be acceptable. He wanted easy calving (for heifers), early maturing cattle with better fat cover and marbling for the premium 'hot pot' market, where cattle are fed longer, up to 200 days on feed. I asked him for details on the Hereford bulls in question. His reply through a translator was "they must have been good ones because I paid top money". As I reflected later on his words it came to mind that the possible future of the Hereford breed in that part of the world will depend strongly on the performance of the few chosen bulls, for the economically important traits i.e. calving ease, birth weight, gestation length, fat cover and marbling.

It would have been much better if the selection of the semen had been made using EBVs or EPDs.

b. Life after EBVs - \$ Index Values

How do you deal with 20+ EBVs, how do you keep all those numbers in your head when you want to devise a mating for instance? There is often talk of 'EBV overload'.

That's where the \$Index comes in. It gives a single \$EBV or Index Value that gives a bull's potential genetic contribution to profitability in a particular production system or specific market.

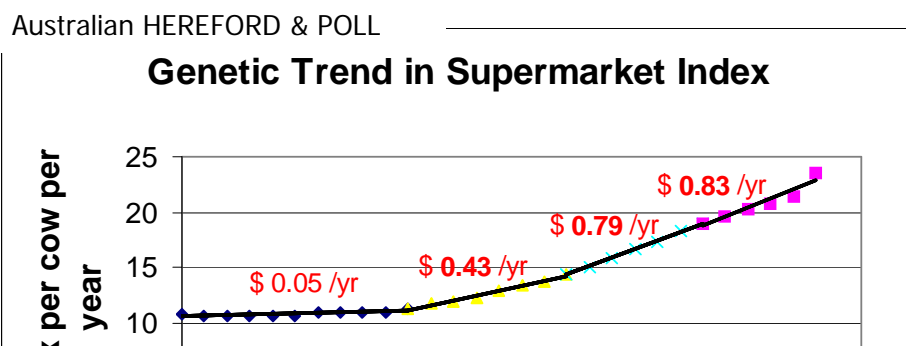
It balances and sums all the EBVs relative to their economically weighted emphasis for a nominated production, turn-off system.

In Australia we have some 'best-in-class' software, a system called BREEDOBJECT, devised by the same researchers that brought you BREEDPLAN.

A commercial producer can buy a bull based on one EBV that details all the elements of genetics impacting paddock performance, backgrounding and feedlot phase finishing plus market specifications.

The effect of \$EBVs on improved profitability in the Hereford breed in Australia is shown in the following figure.

Figure 1. Australian Hereford & Poll Hereford genetic trends for Supermarket \$Index



BREEDOBJECT – How it works

BREEDOBJECT formalises the breeding objective of a herd. For any production/market system target, the first stage is an economic analysis of what effects profit in that particular herd.

Then BREEDOBJECT determines what emphasis or weighting should be put on the different EBVs that are available on animals. The different weighting is then distilled into the \$Index Value or \$EBV calculated for each animal.

What emphasis on what EBV?

At each step in beef production, different genes impact on the performance in that phase. Different owners in the beef chain therefore put different emphasis on different EBVs. The \$Index brings all these phases together and ranks an animal for its genetic potential to deliver profitability to the whole chain.

Think about it:

The **cow-calf producer** is interested in the following EBVs.

Reproductive Performance: Days to Calving, gestation Length, Calving Ease and Birth Weight
Growth: Growth to weaning and milk production, mature Cow Weight.

In future I believe they will be very interested in Net Feed Intake (NFI) EBVs too.

The **backgrounder** is interested in the following EBVs.

Growth: 400 Day and 600 Day weight

The **lot feeder** is interested in the same growth EBVs as the backgrounder plus NFI EBVs when they become available.

The **processor** is interested in the following EBVs

Carcase: Carcase Wt, Fat, EMA, Yield % and Intra muscular fat (Marbling EBV). Where there is a strategic business relationship between the processor and the lot-feeder, the lot feeder must also take interest in these EBVs

Will a meat processor be interested in calving difficulty on your farm? Of course he won't. Will the backgrounder be interested in the Milk EBVs of the bull you use? It is unlikely, because until more integrated supply management systems develop, the individuals in the beef supply chain will place most emphasis on the part that is important to them.

Control of beef chain genetics

At present, the commercial producer controls the genetics that affects the whole beef chain. In these days when many day-to-day actions are now covered by Quality Assurance terminology, we can say that in putting a bull out with some cows the commercial producer is determining the **genetic critical control point** of the whole beef chain. That is why the development of the \$Index had to cater for the whole

chain. Of course it assumes that the backgrounder, lot-feeder, processor will pass back to the cow-calf producer some of the benefits from animals they buy that have higher performance. Other views can be held eg the producer could select only for in-paddock performance and ignore later growth and carcass traits. As cost of production (CoP) comes under more and more focus many will decide to place more emphasis back on the farm and nothing further up the chain.

This is the way in the Argentinean Pampas for instance where under their intensive rotational grazing systems they currently pay scant attention to carcass traits and much more on fertility, calving ease and maternal traits. That's because all the market wants is a 400 kg steer with reasonable fat coverage.

Evolution of \$Indices in Australia

The development of breed-level \$Indexes has been the key to awareness and uptake of \$Index Values in Australia in the last decade. The development of breed specific indexes for a range of production/market scenarios created strong awareness of this new tool. That development was a joint venture between AGBU scientists, ABRI and the technical advisers of breed associations.

When those indices became part of the on-line services (to be covered by Murray Scholz) then especially commercial producers accelerated the level of uptake of this set of new tools and the use of the tool was expanded widely in Australia.

Today's sale catalogues from leading studs invariably feature EBVs plus \$Indices.

Customised \$Index

After a number of years of breed indexes there is a deal of discussion going on amongst producers if the breed index is really how they want to breed their cattle. This discussion is healthy. From day 1 in BREEDOBJECT the parties involved in development have always agreed that customisation to the individual breeding objective was integral and this ability has been maintained. Foremost amongst discussion at present is if the current type of Hereford being bred is that suitable for grazing systems running the cow-calf operation at high density, rotational grazing systems? These are good questions.

In Argentina where my clients run Angus at heavy stocking rates they breed a small-framed (<4) cow and put a lot of emphasis on early conceptions, calving ease and scrotal size in bulls, positive external fat and holding milk moderate. As mentioned before, the market there pays little or no premium for marbling, but wisely they are maintaining some higher marbling lines. Who knows what the future will bring?

I suspect as these discussions progress in Australia, EBVs from frame score and mature cow condition score (if sufficiently heritable) will need to be produced and included in the index. Customised Indexes for commercial producers, high density, rotational or cell grazing systems may require a different biotype of Hereford, and the producer may have to choose the balance of emphasis between on-farm performance and post-farm traits. It is an interesting time ahead for the international seedstock producer.

International \$EBVs

As genetic evaluation moves to international developments with a number of same-breed association in different countries participating, the question could be asked, will International \$EBVs be in common use soon?

Each country has different market specifications, different climate and resources and those different situations really demand that each country or zone develop its own suite of \$Indices.

For instance some countries have to house their cattle while others can leave them out year-round. Some countries run their beef cattle very intensively while other like Australia run them relatively extensively. In some countries the cost of labour is low and the cost of calving difficulty, because of that is lower and the required emphasis less.

What I suspect will happen is that \$Indexes will be developed within each country by local economists and producers and breed associations, but they will include the EBV profiles of International AI sires and rank them for their \$ value. They will 'import' the data from 'international EBVs' into the software eg BREEDOBJECT and compare what international sires have to offer that particular production/market system.

c. DNA-based Gene Marker Tests

A relatively new technology for the Hereford breeder is the DNA diagnostic test. Genetic Solutions in Australia released GeneSTAR Marbling in 2000 and since then has sold the test to many countries. That company now sells 2 DNA marker tests: GeneSTAR Marbling – a direct test for the thyroglobulin gene, one of the genes for marbling; GeneSTAR Tenderness 2 – a combined DNA test for 2 important genes associated with beef tenderness, namely calpastatin and calpain.

The value of these tests is the simplicity of getting a result for a trait that is normally difficult or costly to obtain eg carcass traits and in future net feed intake or parasite resistance. The test is done on a hair sample, a tissue sample eg a sliver of beef, or blood.

The major benefit of these direct tests is that they provide precise genotype information based on differences in DNA sequence unlike EBVs that, as the name implies, 'estimates' breeding value. At this point the current tests explain only part of the genotype for the polygenic traits of interest and so the research in Australia and around the world seems to be committed to develop new tests.

More tests will be developed (faster) in future for marbling and tenderness and other traits e.g. Net Feed Efficiency, external and internal parasites and fertility. A \$71.5-million international project to sequence the cattle genome was launched in December in USA.

Since a tail hair can be collected at an early age, important information can be gained earlier in life than other methods.

There are other DNA markers called Linked markers but their use will be restricted to very large breeding programs because utilisation of them is more complex and requires a lot of information on performance and pedigrees of families.

The genes in GeneSTAR tests behave like the poll gene in transmission. A 2-STAR animal is the homozygote (two copies of the favourable form of the gene), the 1-STAR is the heterozygote (1 copy) and the 0-STAR has no copies of the favourable form of the gene.

The best way to use the test is to use it to identify sires or semen that are 2-STAR for the gene required. The 2-STAR bull will always pass on 1 copy of the favourable form thus increasing the frequency of that in the herd.

The size of the effect on GeneSTAR Marbling is 10% for the 2-STAR and of the two-gene Tenderness 2 test is c. 18%, for animals that are 2-STAR for each of the tenderness genes. It has been calculated that 5 direct markers could explain about 50% of the variance for a trait of interest.

The price of these tests is such that the producer has to be careful which animals to test. Testing sires is the key to practical use of the tests.

The advent of these test means a whole beef chain approach is now possible on beef tenderness and eating quality. Of course the end result on the plate depends on much more than the genetics but now the commercial beef producer can ensure a good start to beef consistency and eating quality. By using a double 2-STAR bull for tenderness the producer 'puts a tick' on the critical control point in the beef chain for eating quality. The success of premium brands will be greatly enhanced if the source animal has a tender genetic profile.

In time there will be multi-gene tests that will be used at the commercial herd and feeder level to sort cattle pre-feeding. When the volume of commercial cattle testing increases, the test prices will reduce.

At this stage however the key to success is at the seedstock level by breeding carriers of the good forms of the genes and in risk mitigation by ensuring that herd bulls you use are not carriers of the tough or unfavourable forms of the genes of interest.

d. Incorporation of DNA marker Information in EBVs

DNA tests add more genetic information for cattle breeding and selection.

Where there is already an EBV for the trait it is important to incorporate the DNA result to add to accuracy of the EBV and reduce future changes in the EBV.

The geneticists that are constantly enhancing BREEDPLAN are already working on the procedures to enable the maximisation of information from both sources as well as how to incorporate them in the \$Index.

Wouldn't an EBV for tenderness that included results from DNA marker tests combined with data or measures of flight-speed or temperament scoring be helpful in the challenge to produce better, more consistent beef?

It is important that breed associations work towards getting DNA marker results 'on file' to add to the genetic information of the breed.

Thinking into the future, it may also be important for the Hereford breed to consider gene banks and tissue banks.

Summary on the international impact of these technologies

Internationally, other meats produced intensively at a high level of efficiency, are challenging beef. We have to lower our costs of production. We have to get more consistency into our beef.

Genetic information is one of the key weapons in this fight. Genetics are a low cost or 'no-cost' means of improvement of the beef supply chain. Of course you also need appropriate feeding and management pre and post slaughter to produce a consistent or high quality product.

If you follow my thread in the second part of this talk you will note I am really suggesting there is no 'perfect' Hereford for the world. Within each country, within each ecological and climate zone, within each end-market segment a different animal with different EBV or EBV + DNA profiles is needed. A bull that suits one commercial producer will not suit (be profitable for) another producer from somewhere else, producing something else.

That's why I often describe the \$EBV as the "no-cost" tool to improve beef production. Assume the average price of bulls in public sales is \$4000. If one commercial producer buys a \$4000 bull with a high \$EBV for his production/market system and another commercial producer producing for a completely different system pays \$4000 for a bull with a high \$EBV for his production system/market then this improvement is essentially at 'no-cost' since both these producers had to buy bulls and they both got high value herd/improvers for an average cost.

Industry profitability is fundamentally linked to the rate of genetic improvement. Hereford associations and their members can have a significant influence on the rate of genetic improvement in their respective beef industries as long as the breed retains a strong market share and its breeders are committed to genetic gains, particularly in carcass traits which determine the acceptance of your product by consumers.

My hope for Herefords

It's simple! The vision I have is based on word association.

You know how it goes; you are asked what is the first phrase that comes into your head when a word is mentioned.

My hope is that when you say Hereford – the phrase Worldwide **Genetic Information** is the first thing that comes to mind.

That's not the way it is today with the Hereford breed. The mission is to get it done and internationally and quickly.

There is an opportunity for Herefords on a world basis to summarise its key genetic information on one web-based portal, to educate and to inform commercial producers worldwide where the leading genetics are for a wide range of traits and from a diverse range of pedigrees. You will then have to coordinate internationally in marketing and dissemination of the information.