Submission to National Farmed Animal Health Strategy Consultation (NFAHSC)

Irish Cattle Breeding Federation

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1 Background

ICBF has one of the largest animal related databases in the world, with a particular focus on using genetics to improve dairy and beef cattle, as well as sheep to increase profitability and sustainability at farm level.

Every day, a variety of health related data is submitted into the ICBF database by farmers, veterinarians, laboratories, factories, DAFM, and farm software companies. The ICBF database holds over 100 million records on nearly 30 million cattle making us a key supplier of health related data to various stakeholders. ICBF is known globally for its innovation in cattle genetics and the large scale genotyping occurring in the Irish population. ICBF, in conjunction with Teagasc, are leading the field of animal genetics by developing a comprehensive genetic index which aims to increase an animal's resistance to disease. In recent years, we have helped support AHI in its roll out of national programs for non-regulatory diseases. ICBF is in a position to play a major supporting role in the national farmed animal health strategy due to the extent of its collaboration with industry partners and research institutions and the comprehensive database we are entrusted with.

In 2002, already aware of the importance of collecting health data, ICBF sent out the first event recording book to dairy farmers encouraging them to record health events such as mastitis, lameness, and various reproductive disorders. This system was rolled out to beef farmers in 2008, and in 2013, our online reporting screen for health events was updated and implemented to allow farmers to record 33 individual diseases and also record unlisted diseases which allows us to monitor when or if new diseases need to be added to the list. 2014 saw the roll out of our genetic defect recording survey which has allowed farmers and veterinarians to record incidence of genetic defects on their farm in the hopes of identifying both lineages and the causative mutations for diseases found in Ireland. All of these advances have placed ICBF in a unique position of holding a large number of useful farm reported data which can be used to support research and health initiatives by different industry partners.

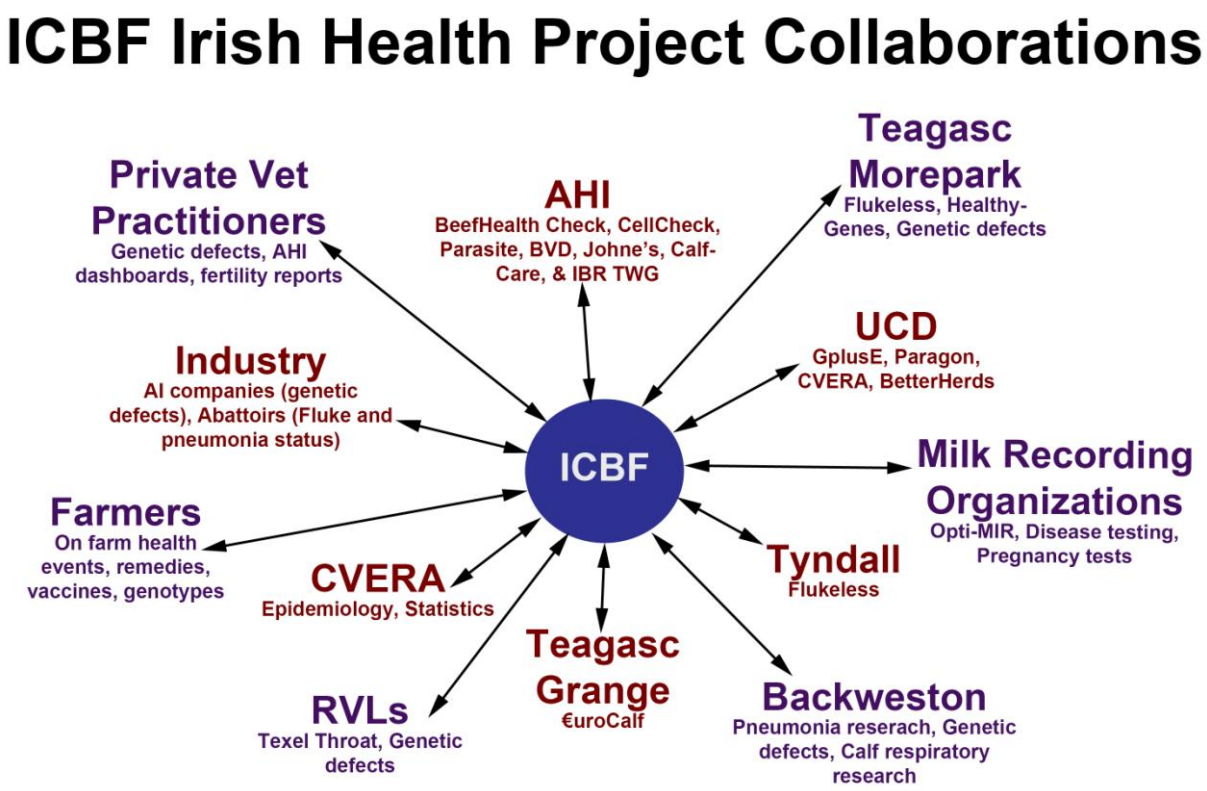
In addition to farmer and veterinary recorded data we have a strong track record of working with milk recording organizations (MROs) to report health and SCC data back to farmers, collaborating with AHI's CellCheck program, and collecting disease test results from both organisations. In 2013 we began collaborating with abattoirs to bring in liver fluke data from animals processed in factories in addition to the carcass data that was already being transferred to the database. These relationships were furthered by work with AHI on the Beef HealthCheck program and the number of abattoirs participating has increased dramatically with this collaboration along with them collecting data on pneumonia in slaughtered cattle.

ICBF has had an excellent working relationship with AHI since its inception in 2009. In addition to the work with Beef HealthCheck and CellCheck, ICBF staff contribute to a number of AHI technical working groups, also provide backend computer support, and design the various AHI dashboards that farmers and veterinarians interact with.

Heath data from the ICBF database has been used for numerous research projects by different research institutes across Ireland such as CVERA, UCD, Teagasc (Grange and Moorepark), CIT, Tyndall, and veterinarians in the Regional Veterinary Laboratories and Backweston. By fostering these relationships we have also encouraged and sought out more data to be entered into our database. Collaborations with these institutes have contributed to ICBF's core concept of developing genetic evaluations to help farmers be more efficient and profitable.

Having a database like ICBF's is a unique situation, globally. Most often data is fractured between breed associations, milk recording organisations, veterinarians, various farm

software companies, and government agencies. This uniqueness is what will help ICBF support many of the initiatives described in the National Farmed Animal Health Strategy, and also be a research leader in the sections on genetic solutions to health problems.



Graphic representing the different projects and collaborators ICBF works with to bring health data into the database.

2 ICBF contributions towards the animal health strategy framework

The 4 primary concepts of 'prevention is better than cure', 'animal health in the concept of one health,' 'animal health as a key contributor to animal welfare,' and the 'all-island animal health and welfare strategy,' are ones ICBF has the potential to support through genetic indexes, genetic disease research, and database support.

Prevention is better than cure. ICBF has a strong track record in providing genetic indices to increase farmer profitability. One measure that will be included in future indices is a health robustness index where we take into account the heritablility of various diseases to select for healthier animals. We will implement the concept of prevention is better than cure by targeting the genetic components of disease susceptibility. Previous research by Professor Donagh Berry, has demonstrated that some lineages are more susceptible to bovine tuberculosis (TB) than others. For many years, we have been aware of the heritable element of disease resistance. This information can be incorporated into a genomic index where farmers can choose animals that have offspring which remain healthy when faced with pathogens. While it seems like a magic bullet to select on TB resistant animals, we are conscious that selecting on only one health trait may have consequences on susceptibility to other pathogens so we are developing a robustness index which will cover resistance to multiple pathogens and offer immunologically balanced animals.

A farmer would be able to look at individual traits and select for animals that have higher resistance to key pathogens, such as TB, BVD, or IBR, and tailor their breeding strategies towards diseases their herd may be more likely to encounter. In addition to support on the genetics front, we are working towards bringing in vaccine and remedies records so that

vaccine failure and anti-microbial resistance (AMR) can be examined in detail alongside the health and remedy data from the ICBF database. This data will also be useful to researchers to help put an economic index on the cost of prevention verses cure.

Animal health in the concept of one health initiative. While ICBF is well aware of this concept, we foresee having a smaller supporting role, as we have not yet established collaborations with human health practitioners. Data concerning zoonotic pathogens such as Salmonella, and Neospora are routinely added to the ICBF database by MROs. *Mycoplasma avium* subspecies avium, the causative agent of Johne's disease, is not classified as a zoonotic pathogen though correlative work has shown a link between it and chron's disease in humans, and therefore data provided by the MROs and AHI are of great interest to everyone as this story continues to be explored. With the current data in our database, we envision being able to support this concept through tracking of zoonotic diseases, future collection of remedies, and making the data available to research centres such as CVERA and Backweston who are in a better position to identify the epidemiological importance of the data. Additionally some of the genetic diseases we are targeting in cattle have analogous conditions in humans. Once causative mutations are identified we envision publishing this work and making it available for human researchers to test whether the same affected gene or biochemical pathway causes similar genetic diseases in humans as in livestock.

Animal health as a key contributor to animal welfare. Healthy, well looked after animals are key to the Irish brand. In an unofficial survey of 376 people from various states across the USA, they described grass fed beef and Irish products as, 'healthy,' 'natural' and 'environmentally friendly/green.' To maintain this positive view, animal welfare is a key component. Animals that are treated well will be less stressed and therefore more immunocompetent. Furthermore, animals that are immunologically robust from superior genetics will stay healthier when stress is unavoidable. In hopes of decreasing stress in both the animals and farmers, ICBF accounts for docility in our genetic indexes.

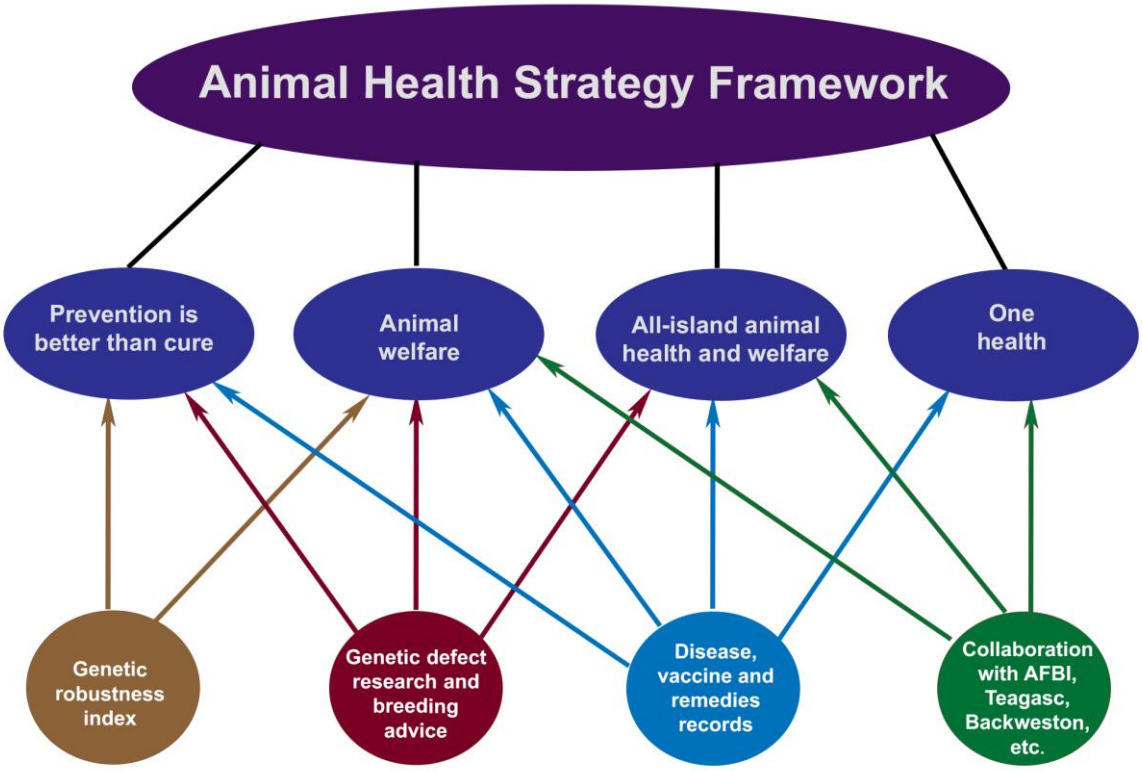
The Scientific Advisory Committee for Animal Health and Welfare recommended that research into the polled trait of cattle be explored to potentially eliminate the dehorning of cattle. The IDB chip developed by ICBF contains tests for 2 separate polled alleles, the celtic and friesian alleles, making this more likely to happen in the near future as an animal's genetic poll status can be determined. This genetic information will allow ICBF to advise farmers to breed polledness into their population while continuing to improve production traits. From our analysis we know that more polled alleles exist in the bovine population. Due to the high level of genotyping in Ireland and our whole genome sequencing work we are in a unique position to identify more of these poll alleles and then apply them in Ireland. Two examples of this are that some polled Shorthorn and Irish Maol cattle do not contain the poll celtic or friesian alleles according to their genotypes.

Another measure we have begun to explore in earnest with help from veterinarians, the RVLs, farmers, Teagasc, UCD, and international collaborators is tackling genetic diseases. Many of these diseases can cause unwanted suffering in animals because they are not immediately lethal. ICBF has set up a genetic disease survey which is available to everyone and allows us to monitor what defects are showing up in the national herd every year. The project started very small, but each year the number of submissions has doubled. An example of one disease we're collaborating on with Teagasc is Atresia. Dr. John Mee (Teagasc) has been studying this for many years and has compiled an amazing repository of animal tag numbers associated with the disease and has provided tissue for us to work towards finding the gene or genes involved in the disease. This particular disease is hard for farmers because the animal seems fine when it is born, but then quickly deteriorates and can suffer for up to 48 hours unless humanely euthanized due to a constriction or blockage in the calf's digestive track. By finding the genes responsible for this disease and others like it we will be able to devise mating strategies for farmers to eliminate the risk of having an affected calf born. We

are also creating the framework to begin offering a genetic disease survey to sheep breeders as well as cattle breeders.

The IDB chip, developed by ICBF, tests for nearly 100 specific genetic diseases covering 140 specific mutations in the cattle genome. Many of these diseases cause pain or suffering in the affected animals and therefore having these tests available will decrease the number of animals suffering from these painful and often fatal diseases.

All-island animal health and welfare strategy. Through grants and previous collaborations we are in contact with AFBI in Northern Ireland. This connection in addition to the ones in the Republic of Ireland, could allow ICBF to receive and supply data towards and all-island health and welfare strategy. We currently support the backend development of AHI programs and data collection, this service could be extended to AHWNI. Mart data is transferred via software that is commonly used in Marts across the island which would make incorporating it into our database easy. In addition to the mart data, many of the same companies have abattoirs in both NI and ROI which could lead to health data from NI coming into the database and go towards and all-island strategy. Due to experience with international grants, we have familiarity with taking in data, genotypes, and pedigree information from multiple countries, and collating it for investigation by appropriate research institutions.



3 ICBF support of the animal health strategy framework and systems

The national farmed animal health strategy (NFAHS) framework outlines 15 infrastructure and systems that are essential to the success of the NFAHS. As mentioned in the background: the database, genetic indexes, genetic disease research, and personnel at ICBF will be a useful support tool to nearly all systems mentioned. This next section will cover how we can support these infrastructures and systems to help the NFAHS succeed.

Animal Health Surveillance

- As a central database for many aspects of health and disease, ICBF is in an excellent position to provide support towards any surveillance system wanting to capture on farm health events in cattle.
- In addition to traditional health and disease recording (mastitis, lameness, scour, etc) we also collect congenital defect information. While many of these diseases are genetic, some may be due to environmental or introduced toxins. Having this system available to all farmers and veterinarians allows ICBF to identify birth defects from all anyone wishing to report them.
- Both of these systems will be extended to sheep in the future.
- ICBF collaborates with MROs, AHI, abattoirs, laboratories, farm software providers, veterinarians, RVLs, and Backweston to collect the widest range of health data available while maintaining the highest level of data protection for our farmers.
- Data from MROs extend beyond the traditional SCC and production data. Tests are available for Johne's, *Fasciola hepatica*, *Ostertagia*, Neospora, BVD, and Leptospirosis to name a few. All of these tests can be done simply on milk samples already taken for the traditional milk analysis making them more readily available than more invasive sample collection techniques.
- Decreases in production traits such as milk production from MROs or weights at marts could be indicators of health problems in a herd. ICBF receives this information on a regular basis and therefore it can be used for early detection of an outbreak or as an indicator for underlying subclinical disease in a herd.

Contingency Preparedness and Emergency Response:

- Because health and production data are transferred into ICBF on a regular basis, our database would be a useful support tool for DAFM when dealing with sudden outbreaks.

Laboratory Services:

- ICBF is currently taking in data from laboratories for the BVD and Johne's programs. This service could be expanded to other pathogens of interest. Through this expansion we will be better able to serve Ireland's scientific community by providing a clear picture of animal health, remedy usage, and animal movements. We also collaborate with the Weatherby's Genotyping lab receiving approximately 500,000 genotypes per year.
- MRO laboratories supply ICBF with a variety of disease records in addition to SCC, and production records. The disease data can be used directly in surveillance and genetic indices, while the production records can be used to identify subclinical infections or the onset of infection through decreased milk production. We also receive pregnancy diagnoses from the MROs which can be used to assess reproductive health.

Epidemiolical and Risk Analysis & Animal Health/Animal Disease Statistical Modelling:

- As stated above, the integrated ICBF database for cattle and sheep (in the near future) will give researchers a "one stop shop" to collect data for epidemiological studies. We have measures in place that allow us to distribute anonymised data to researchers which lets them to do their research while still providing data security to Irish farmers.

Economics of Animal Health

- Dr. Bernie Earley of Teagasc Grange is working on the grant funded €uroCalf project which focuses on the economics around calf rearing. ICBF has supplied supplemental data towards this project which has allowed the researchers to look at topics more in-depth than they would have without the additional data. We foresee a similar role in any departmental initiatives on cattle economics.
- ICBF receives data on carcass traits and prices from abattoirs, prices and weights from the marts, and supports the Teagasc profit monitors which all can be used towards identifying economic advantages and deficits in animal economics.
- MROs send in a variety of health and production traits which can be used as economic indicators of dairy profitability when taken in conjunction with current prices for remedies and milk.
- ICBF is in the process of developing a health robustness index which could reduce the amount of losses from disease in a herd. This index would also most likely reduce the number of antimicrobials used on farm which is another cost saving measure for farmers.
- The USA dairy herd, with approximately 9 million cattle, experiences estimated $11 million yearly losses from 15 lethal and unwanted genetic diseases due to the mating of 2 animals that carry the same genetic disease. Currently there are 140 known lethal and unwanted genetic mutations covering 93 specific diseases in beef and dairy cattle worldwide. We could estimate similar economic losses across the 6.7 million cattle in Ireland for the 140 lethal and unwanted mutation tests found on the IDB chip. Each new version of the IDB chip will contain new genetic disease SNPs identified by ICBF or other researchers so that we can be assured we are making the best breeding decisions for the Irish population. It is estimated that every animal carries 3-4 lethal genes in its genome, if were only to mate animals without these lethal genes, we would not have a population to breed from. This is why ICBF is pushing for selectively choosing animal matings using the information from the IDB chip to decrease the likelihood of mating 2 animals carrying the same defective genes.
- This is especially poignant given the current frequency of Holstein Haplotype 3, a genetic disease which causes early embryonic death, is **8.2%** in the nearly 90,000 tested Irish dairy cattle. As the name implies, it is a disease of Holstein cattle, but it can be passed onto any progeny from Holstein or Holstein cross animals.

Traceability Systems and Supporting Access to International Markets

- Currently, Ireland has one of the most comprehensive animal movement tracking systems in the world. The next step in traceability will be to bring in DNA based registration for all Irish livestock. Animal tags can be lost or removed whereas an animal's DNA does not change. This would be the ultimate in traceability because all DNA would be on file for every animal in the country. A person buying a steak in New York or Japan would be able to take a sample of that steak and validate that it is exactly the Irish animal and breed that it is marketed as. Alternatively, if an animal is found to be harbouring any sort of pathogen but missing tags, it would be very easy to identify that animal through its DNA. This national DNA database would also decrease the ability of animal theft, and simplify any animal forensics that might need to be undertaken.
- The large scale genotyping initiatives in Ireland also give us an advantage in international markets as the IDB chip developed by ICBF has more genetic disease

diagnostic probes than any commercial chip on the market. This gives our farmers a unique advantage when selling breeding animals in local and international markets.

ICT Developments and Data Management:

- The NFAHS outlines some of the relevancies of ICBF's database but we are interested in expanding our collaborations with DAFM so that more kinds of information flow between us. Through these collaborations more health data can contribute to genetic breeding values and the robustness index mentioned above. With so much data being collected by various entities it would be ideal to collate it in one place to increase efficiency and data management. Currently ICBF holds over 100 million records for nearly 30 million animals. Every year we receive approximately 1 million AI records, 700,000 milk recording records, 1.6 million carcass records, 7 million movement records, 2.5 million birth records, 2.5 million BVD records, and 500,000 genotypes which makes us very good at handling and storing large quantities of different types of data.
- In the last 12 months ICBF has invested heavily in building the capabilities of our database infrastructure and the Oracle Exadata technology deployed is the same technology used by Oracle in its overall Global Cloud offering. We currently have some of the fastest computing power in Ireland due to server upgrades in the last year.

Veterinary Medicinal Products:

- Antimicrobial resistance (AMR) is a huge topic right now, and with the addition of remedies and vaccination data capture, ICBF will be strategically placed to help researchers identify areas where antimicrobial usage can be reduced.
- In addition to our plans for collecting remedies and vaccine data, ICBF currently collects health data. These three pieces of the puzzle can be used to monitor for AMR in herds.

Independent Scientific Advice:

- ICBF is an organisation owned by no one and everyone all at the same time. There is not one stakeholder who holds more sway than another which makes us a good candidate for independent scientific advice. In addition, we collaborate with multiple national and international research institutions which permits us a unique perspective on cutting edge scientific research around the world.
- There are currently 7 staff members who hold PhDs in genetics, 1 holds a PhD in bioinformatics, and another has a PhD in veterinary pathobiology with BSL-3 laboratory training and previous experience in parasitology, microbiology, and epidemiology. This collaboration of scientists with various specialties in a single company is a great advantage to ICBF's role as scientific advisors.

Education, Training, and Communication:

- ICBF's customer support section, HerdPlus, is in constant communication with farmers making them an excellent resource for communication.
- In collaboration with AHI we have developed the BVD, Johne's, and Beef HealthCheck dashboards to deliver health information in easily understandable graphics to farmers and veterinarians.
- In an effort to educate and reach more farmers, our health and disease page is available to everyone. This page contains information on why health recording is important, how to record genetic defects, information on genetic diseases and traits

found on the IDB chip, a genetic disease picture gallery so farmers can put a name to what they may have seen on their farm, and information on common cattle health problems. The page also links up to AHI pamphlets as they are the most comprehensive Irish produced documents on many of these diseases. By allowing everyone access to this page we are able to capture genetic defects on any farm in the country if a farmer or vet want to report it.

Research and Innovation:

- ICBF's development of the IDB chip and the affordability of the chip have given Ireland a strong advantage in the field of genetics and genomics, resulting in the worlds largest beef genetic database. We are the first in the world to offer genomic evaluations to the commercial beef industry.
- We have developed a report detailing the genetic disease status of beef and dairy animals for all validated genetic diseases and traits on the IDB.
- Through collaboration with international researchers, and independent research here in Ireland, we have added new diseases to the list of known unwanted and lethal genes on the IDB chip each year and will continue to do so. The national genetic disease survey system we developed and collaborations with Teagasc, UCD, and the RVLs help us select what diseases to target for causative mutation research.
- While causative mutation identification is a lengthy process, we can identify lineages that carry genetic diseases and recommend strategic mating to farmers to decrease the likelihood they will have negatively affected offspring, but this is only a temporary solution until the causative mutation(s) are found. Since every animals is a carrier for multiple genetic diseases, if we were to eliminate all carriers of lethal mutations and unwanted genes we would have no animals left. Therefore the research above is very important so that we can identify what genetic defects an animal carries and then encourage farmers to selectively breed for the good traits and not cross animals carrying the negative traits.
- ICBF is developing a health robustness index with the aim to produce healthier animals for farmers. In this index we will take into account the heritability of an animal's susceptibility to a suite of diseases. This development will lead to more economical cattle due to reduced health costs, and a reduction in antibiotic usage.

4 Conclusion and contributions towards the strategic outcomes

The key to making progress in any program is to be able to collect measurable data on a large number of animals for a multitude of traits. Without this, it is not possible to quantify the difference before, during, and after a program has been implemented. ICBF has been collecting data on Irish cattle since 2002, and through collaborations with many industry and research partners we have developed a large database that has been and continues to be vital to Irish cattle research.

The NFAHS contains 5 strategic outcomes, most of these are core to ICBF's values of applying science and technology to ensure our farmers and industry make the most profitable and sustainable decisions. The first strategic outcome is: **Increased farm level productivity, delivered in a sustainable way.** We have found that even with just a 3% genetic heritability level we have been able to make great strides in improving the fertility of the Irish dairy population. The introduction of the EBI which takes into account fertility has resulted in about €750 million additional profit to the industry over 20 years.

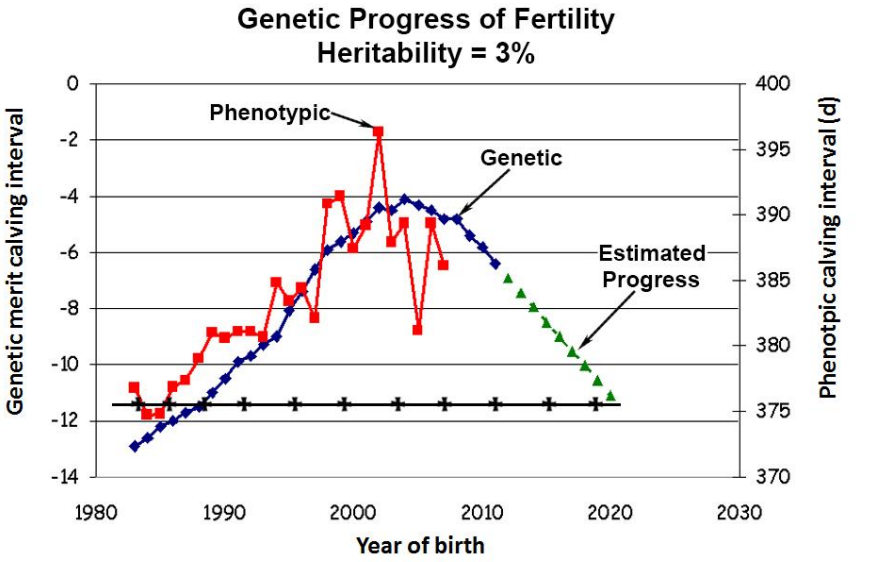


Figure kindly provided by Donagh Berry

Some diseases have genetic heritabilities as high as 15% which makes us confident that we will be able to improve the health of the national Irish cattle population through genetic gain and add additional profit to farmers similar to what was seen with the EBI. Genetic gain is permanent and cumulative; which means that with each successive generation we can make additional strides towards creating genetically robust animals that will stay healthier when faced with pathogens. We have also learned from the past mistakes of selecting on a single trait and therefore will be recommending farmers select on a robustness index which will contribute to overall immune-competence of the herd, and not just resistance to single pathogens.

Research done by Dr. Andrew Cromie of ICBF, using the Bord Bia Carbon Navigator has identified a strong correlation between our current economic breeding values and cattle that are more carbon efficient. Therefore, just by using our current breeding indices we are producing more efficient cattle. Along with this work, ICBF is interested in collaborating on projects to explore the genetics of the cattle microbiome which is hypothesised to also play a role in reducing CO_2 emissions from cattle.

In addition to genetic evaluations, we have introduced a national genetic defect survey which is available for all cattle farmers and vets, and will soon be available for sheep as well. This initiative will put Ireland at the forefront of defect causative mutation discovery. While a similar system has been running in France for a number of years, identification of causative mutations has not been the focus and this is where Ireland will shine due to the large scale genotyping we are doing. Ireland is currently genotyping 500,000 animals per year, at this rate we will soon have the largest genotyped cattle population in the world. With the current set of SNPs on the IDB chip we will be able to suggest smarter mating to farmers so the number of animals carrying lethal defects will not be mated to other carriers thus decreasing the likelihood of the cow losing her calf or requiring multiple serves.

The second strategic outcome is: **Improved processor outcomes**. As previously mentioned, ICBF receives a large volume of health and production data from MROs. This data can be used to assist farmer selection of healthier and more efficient cattle. These cattle will be less costly to maintain which will result in dairying be more sustainable to both the farmer and the processors. ICBF receives health data as part of AHI's Beef HealthCheck program, and carcass data from nearly all abattoirs in Ireland. The health data will feed back to both dairy and beef producers helping them monitor fluke burden and subclinical pneumonia in slaughtered cattle. This data along with the production data allows us to help farmers breed and maintain animals that will be more efficient and economically relevant. In addition to efficiency, we are working towards creating a meat eating quality index to make

Irish cattle the best in the world in terms of taste and tenderness. This will both benefit the processors and also help with **improving market access** which is strategic outcome 3. The national movements database, provided through AIM also plays a role in improving market access as consumers are wanting to know more and more where their groceries are coming from. If this current system were supplemented with DNA based registration, Ireland would be the first in the world where a consumer would be 100% sure where their meat or dairy products have come from. With the BDGP scheme and the large volume to genotyping involved in this scheme, we are closer to this being a reality. ICBF also serves as a central database for many health traits from various industry partners and is linked in with DAFM's animal movement system which may give comfort to international markets.

While ICBF will play a smaller supporting role in the 4th strategic outcome: **Improved capacity to protect public health**, we foresee contributing to the research in zoonotic diseases and once the remedies and vaccine capture system is available, we will be able to contribute to on-farm AMR research which could be a factor in human AMR. Through the work done on our robustness index we believe antimicrobial usage on farms will decrease because we will recommend farmers start breeding animals with resistance to multiple pathogens.

The final strategic outcome: **Improved capability to anticipate threats, take proportionate actions to mitigate risk and improved response capacity** fits well with the variety of data coming into the ICBF database which could act as an early warning system for outbreaks, and indicate trends in disease reporting. The congenital defect survey could also serve as an alert system for abortion storms and deformed animals being born. This system could be helpful during an outbreak like the 2013 Schmallenburg epidemic if combined with increased public awareness and usage. As with all programs, uptake has been slow, but we are hoping to increase awareness this year through a series of discussions with farmers and industry partners.

The database and our genetic research will be ICBF's biggest support for the National Farmed Animal Health Strategy. As outlined in the above sections there are many portions of the framework, systems, and strategic outcomes which ICBF is in a position to support and we are looking forward to the new and continued collaboration this will bring.