

The new infrastructure for beef cattle breeding in Ireland

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Abstract

Ireland has established an integrated cattle breeding information system to underpin the breeding objectives for beef and dairy breeding in Ireland. This system covers birth & calving, reproduction, growth, carcass and maternal traits. It covers all breeds and crosses, including those with dairy breeds, and meets the information needs of Breed Assns, AI Companies, Breeders and Commercial Producers. Ireland is promoting international collaboration in cattle breeding as part of its strategy to improve the profitability of its beef and dairy industry. Two current initiatives are Interbeef and IGenoP. This paper outlines: the benefits of international collaboration, progress and plans for establishing an international beef genetic evaluation service known as Interbeef, and progress and plans for establishing a database of shared cattle genotypes known as IGenoP.

Introduction

Over the last thirteen years Ireland has established a new infrastructure to facilitate the genetic improvement of both dairy and beef cattle. Prime responsibility for leading the development rests with the Irish Cattle Breeding Federation Society Ltd (ICBF) established in 1998 with the objective of achieving the greatest possible genetic improvement in the national cattle herd for the benefit of Irish farmers, the dairy and beef industries and members. This development has been funded by a unique partnership involving farmers, breeders, service providers, service income and Government.

In this paper we outline the major developments that have taken place in Ireland over the past 13 years and illustrate the impact these have had on the breeding of beef cattle. Our focus is on the developments that have impacted on the availability of data for use in creating information essential for effective cattle breeding decisions. These have included: the formation of ICBF, creation of the ICBF Cattle Breeding Database, implementation of the Animal Events data collection system, the creation of linkages with other data collection systems, and the ICBF Genetic Evaluation system.

Irish Beef Cattle Industry

The Irish cattle industry is based on some 2 million calvings per year with 1.1 million in dairy herds and 0.9 million in suckler herds. The industry involves a large amount of cross-breeding with; 38% of dairy cow calvings to beef sire breeds – mainly Angus & Hereford, and 61% of calvings of suckler cows being to a different beef breed to the breed of the cow. The five main beef breeds are Charolais, Limousin, Simmental, Angus and Hereford.

Of the calves born in suckler herds 22% become herd replacements, 16% are exported live and 62% are slaughtered in Ireland almost exclusively for export as cuts to other EU countries.

The suckler herds are small, averaging some 15 cows, not profitable without state support and include many part-time enterprises.

Formation of ICBF

ICBF was established in 1997 and commenced operations in 1998 with its current structureⁱ being finalized in 2000. Its main activities are those associated with: developing the cattle breeding infrastructure in Ireland, operating the cattle breeding database, providing genetic evaluation services, and providing information useful for cattle breeding decisions.

ICBF is owned by the cattle industry with 18% of shares held by each of the Artificial Insemination (AI), Milk Recording (MR) and Herd Book (HB) sectors and the remaining 46% held by the organizations (IFA & ICMSA) representing farmers. The ICBF Board of 16 comprises persons appointed by the shareholders (3 from each of AI, MR and HB, 6 from the farm organizations) and one appointed by the Department of Agriculture Fisheries and Food (DAFFⁱⁱ).

Since its inception, much of ICBF's work has been focused on improving the quantity and quality of data available for cattle breeding. New technologies have been tapped into and business arrangements established, with both shareholders and industry stakeholders alike, with the overall goal of ensuring that Irish farmers have access to high quality information for use in breeding more profitable cattle.

Beef Breeding Objectives & Selection Criteria

A widespread industry consultation supported by extensive research resulted in an agreed breeding objective and selection criteria for beef cattle in Irelandⁱⁱⁱ. The focus of the objective is farm level profitability accounting for the most significant sources of income and cost. Meat income is also considered in the dairy-breeding objective for Ireland. An overall index, the Suckler Beef Value (SBV) is expressed in economic terms (€) and computed from economic sub-indexes for Weanling Export, Beef Carcass, Daughter Fertility and Daughter Milk. These indexes and the evaluations for some of the key component traits are expressed as Euro-Stars on a one to five star scale with each star representing an interval covering 20% of the population. Examples are readily available on the ICBF website^{iv}.

ICBF provides the genetic evaluation system for both dairy and beef cattle breeding in Ireland. This system operates in close association with the ICBF database. ICBF is a full participant in the activities of Interbull, the international dairy genetic evaluation organization and is currently providing leadership for the establishment of Interbeef.

The genetic evaluation system used by ICBF is an across breed system with a single base for each set of traits. For some traits, eg calving and carcass, the evaluation uses data from dairy and suckler herds and the results are comparable across dairy and beef breeds.

With the establishment of clear and agreed breeding objectives the focus ICBF's efforts have moved to improving the availability of relevant data on those animals that are least prone to biases associated with selective recording and selective treatment. That is, commercial producers.

Creation of the ICBF Cattle Breeding Database

At the time ICBF was formed there were a large number of separate computer systems supporting aspects of cattle breeding in Ireland. Each had its own data collection system and supported the information needs of one or other aspect of the cattle breeding industry. For example, each Herd Book (there were 18 at that time) had their own system, each Milk Recording organization (there

were 8 in 1998) had its own system, and DAFF operated separate systems for genetic evaluations and the official calf registration and cattle movement monitoring system (CMMS). These systems used several different animal identifications and held limited cross-references.

ICBF established its cattle breeding database using the IRIS^v software system from the Dutch Cattle Breeding organisation NRS. Creating the database involved an enormous effort to negotiate agreements for the sharing of data, to establish shared data collection systems and to consolidate the existing computer files into a single shared database. The key principles underpinning the agreement between organizations to share data are summarized in table 1.

Table 1. Principles of data and information sharing agreement underpinning ICBF database.

No.	Principle
1	Contributors of data to the creation of the database retain “ownership” and can obtain a copy of their data at any time.
2	All data originating on farm, and known first to the farmer, is captured through “Animal Events” a system controlled by ICBF.
3	ICBF operates an industry wide network of systems to facilitate the electronic sharing of relevant data collected for other purposes. Examples include; inseminations, slaughter data, and sale data.
4	All data in the database is available for research subject to a minimal set of conditions.
5	Genetic evaluations are an integral element of the database.
6	Herd owner’s control service provider access to herd and animal data.
7	Service providers have access to data and information systems needed by their particular businesses for those herds that have granted access.
8	HerdPlus [®] is a service provided by ICBF to the herd owner that facilitates access to all data and information relevant to the herd in the database.
9	Service fees are set on the basis of <i>User Pays</i> and <i>Full Cost Recovery</i> .

ICBF established a team of information technology developers, supported by a number of contractors, to customize IRIS to meet the needs of the Irish breeding industry. This customization has now reached the point where the ICBF database requires no support from NRS. The ICBF cattle breeding database supports, through the use of a range of new technologies^{vi}, the information needs of milk recording, herd books, AI organizations and cattle farmers. Farmers are able to access their own data in the database through the web through the HerdPlus[®] service. Figure 1 illustrates the data sources, information outputs and services that are currently supported by this database.

It is important to note that Genetic Evaluations are a peripheral yet integral element of the ICBF database. All data used in the evaluations is sourced from the database and all results returned to the database from whence they are published and distributed.

Implementation of the Animal Events Data Collection System

The Animal Events (AE) data collection system was developed, as part of the overall database development, to replace the overlapping data collection systems operating in 1998. This system was built to remove duplication in data collection, at farm and organization levels, and to ensure all the data required for cattle breeding and other official purposes was collected efficiently and accurately. The AE system collects data on those cattle breeding events, e.g. calving, birth, identification, mating... which are first known to the farmer. Both paper and electronic systems are supported. The data collected in this way is accessible to those participating organizations that provide cattle breeding services to the herd. The AE system has revolutionized cattle breeding data collection in Ireland.

The ICBF database has been fully operational for dairy, beef, milk recording, beef performance recording, genetic evaluations and herd books since 2005. Some 77,000 herds, with 1.8 million calvings, representing ninety percent of the entire Irish cattle herd, were participating in one or more aspects of the database by the end of 2010.

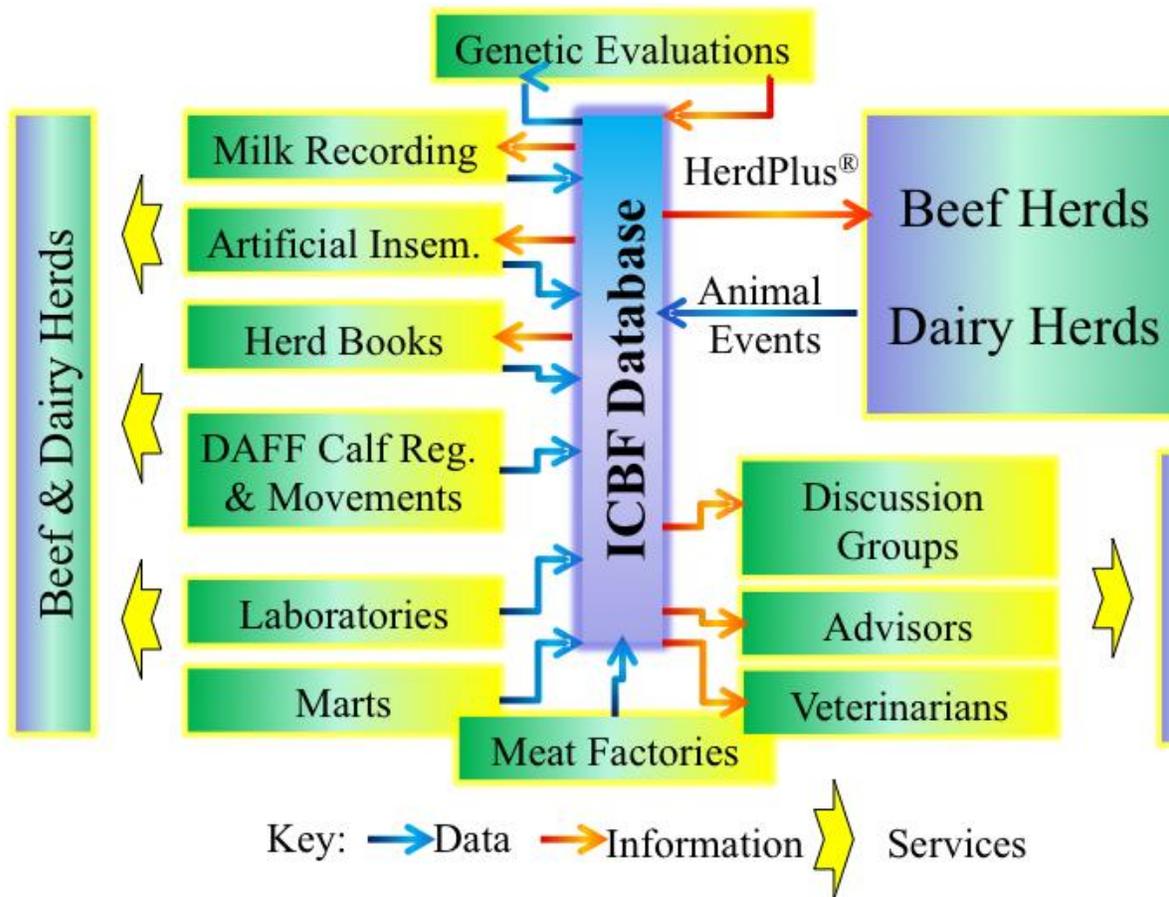


Figure 1. ICBF database showing data sources, information outputs and services to farmers.

LINKAGES WITH OTHER DATA COLLECTION SYSTEMS

The ICBF database has access to data collected by a wide range of organizations for other purposes. The data collected and stored in the ICBF database from these other sources, includes:

- Calf registrations through DAFF – all calves born in Ireland are first registered by DAFF albeit based on data provided by farmers through the AE system, and only then added to the ICBF database. This ensures the official EU identification is available for all calves entering the ICBF database.
- Cattle movements, exports and deaths through CMMS – this eliminates the need for any of the cattle breeding organizations to collect this data. A nightly data feed is provided to ICBF for all movements into or out of herds participating in the database.
- Slaughter data from meat processing plants in Ireland. This includes slaughter date, carcass weight, carcass grade, fat score and, more recently, the two images used in carcass grading.
- Sale data from Marts. This includes dates, weights albeit not always for single animals, and prices.
- Milk records from Milk Recording organizations. The ICBF database is an integral part of the milk recording and result reporting process that operates in Ireland.
- Artificial inseminations recorded by technicians. ICBF has developed a hand-held computer system that links directly to the ICBF database for insemination recording. This system is used by all the main AI field service companies operating in Ireland.
- Linear scoring, dairy and beef, and weight recording services. The same handheld technology used for AI technicians is provided by ICBF for linear scoring and classification services.

These linkages ensure that neither farmers nor organizations are faced with duplicated effort in collecting data that has already been collected for another purpose. The result is a greatly increased availability of data to all participants in the ICBF database.

Animal Welfare, Recording & Breeding Scheme

The Animal Welfare, Recording & Breeding Scheme (AWRBS) was launched in January 2008 by DAFF as a five-year program with the dual objectives of improving animal welfare and improving the scope and quality of data available for beef cattle breeding. Key elements of the scheme included the adoption of best practice animal welfare associated with castration, dehorning and weaning. It was also a requirement of the scheme that ICBF's AE recording system be used for record key events including the sire of calves. In return, the farmer received a payment of, initially €80/cow and more recently, €40/cow. The results of this scheme had a dramatic impact on the availability of sire, calving, weaning and docility data from commercial suckler herds.

Progress

The amount of data collected has risen dramatically as illustrated in table 2. The biggest increase coincides with the introduction of the AWRBS in 2008. The collection of carcass data commenced before 2008 but the advent of the AWRBS has significantly impacted on the number of animals for which the sire is known. This illustrates the benefit and importance of having a database that links animal details recorded at birth with those recorded at slaughter.

Table 2. Progress in data collection. (¹ million, ² thousand)

Year	Births ¹	Animal events births ¹	Pedigree births ¹	Herds ²	Carcass - known sire ¹	Carcass – unknown sire ¹	Docility ¹
2003				12	0.010	0.021	0.006
2004	.73	.47	.09	16	0.184	0.307	0.018
2005	.94	.54	.09	22	0.211	0.385	0.021
2006	1.02	.60	.09	29	0.286	0.711	0.016
2007	1.11	.61	.09	33	0.336	0.924	0.014
2008	1.84	1.25	.10	74	0.355	0.944	0.581
2009	1.82	1.31	.10	76	0.422	0.838	0.679
2010	1.79	1.24	.10	77	0.782	0.679	0.696

Interbeef

The Irish beef breeding population encompasses a substantial number of beef breeds. For all of the beef breeds in Ireland there are populations in other countries with larger numbers of recorded animals. The question then is the best strategy for obtaining access to information from these other populations to enable Irish farmers to make well-informed decisions on the importation of genetic material.

We have addressed this question firstly, by establishing a breeding objective for Ireland and an accompanying genetic evaluation system based on Irish data. This system enables us to identify the bloodlines that have performed well under Irish conditions. Secondly, our strategy is to work with other like-minded countries to establish an international network for sharing beef genetic evaluation information. In this respect we have been building on the Interbull model that operates for some 30 countries, six breeds and six trait-sets for dairy cattle.

Our initial work conducted in partnership with other European & Oceanic countries involved research comparing two main strategies:

- MACE which uses the sire evaluation output of national genetic evaluation systems and is the approach used by Interbull for dairy cattle, and
- Phenotypes where the raw performance data is used in a combined multi-trait analysis with each country treated as a different trait. That is, genetic correlations between countries of less than one.

Research by INRA and AGBU demonstrated the practicality and desirability of the latter strategy. That is, a combined analysis of performance data.

Based on these findings Interbeef is now moving to establish a routine international genetic evaluation service for beef breeds and traits. Key elements of the proposal, which has yet to be finalized, are summarized here.

Structure & Operations: Interbeef is a Working Group of ICAR (International Committee of Animal Recording)^{vii} and is pursuing five objectives relevant to beef cattle:

- a. Provide a forum for sharing knowledge on recording & genetic evaluations.
- b. Maintain guidelines & standards for beef cattle performance recording.
- c. Conduct international surveys relevant to beef cattle performance recording.
- d. Develop international genetic evaluation services.
- e. Facilitate the use of genomic selection.

Interbeef is guided by a Steering Committee appointed by the Board of ICAR and includes a geographical and technical spread of enthusiastic supporters. A scientific advisory committee has also been established to give advice on technical issues. The Secretariat is provided by the Interbull Centre based at the Swedish University of Agricultural Science (SLU) in Uppsala. The current annual budget for Interbeef is €100,000 which is currently funded by a number of European beef cattle performance recording and genetic evaluation interests along with a contribution from ICAR.

Participants in Interbeef include Service Users and Research Providers. Service Users are ICAR members who are organisations able to represent, for country, breed & trait combinations: beef performance recording database operations, beef performance & ancestry recording service provider(s) and genetic evaluation service providers. Research Providers are organizations with the knowledge and expertise to assist with achieving the objectives of Interbeef.

Interbeef services are to be based on a Service Agreement which covers; fees, rules for participation, roles & responsibilities, operating procedures, data flows & interfaces, quality control & query support, data protection and methods & models for international genetic evaluations.

The service includes the creation of a database of pedigrees and performance data to be used in research and in the computation of international genetic evaluations for beef breeds and traits. The evaluations are provided to the Service Users for distribution in their respective country-breed-trait-set combination. Interbeef will not be publishing evaluations. That role rests with the Service Users.

Progress: A prototype database has been established and tested for two breeds, six countries and one trait set. Methods for resolving animal identification conflicts have been developed and tested. A multi-trait genetic evaluation system has been developed and tested by INRA, and transferred to the Interbull Centre where it has been implemented using MIX99 software. A call for further data will be issued as soon as the current negotiations on the Interbeef Agreement has been finalized.

Benefits & Costs: The benefits that Interbeef will provide to Service Users include:

- Improved ancestry information – both in terms of accuracy & completeness.
- Improved access to genetic evaluations of animals in other countries.
- Better ability to target selective imports & exports of breeding stock.

- Improved knowledge of beef cattle performance recording and genetic evaluation practices in other countries.
- Improved international collaboration.
- Improved competitiveness of beef production relative to meat production systems based on other species.

The main costs that have been identified for participation in Interbeef include:

- ICAR membership fee - €545/year.
- Service fees which have yet to be finalized.
- Data provision – primarily time of information systems experts.
- Time & travel cost for attending meetings and participating in conferences.

Summary: Interbeef is facilitating the international genetic evaluation of beef breeds & traits. It has considerable potential to increase the accuracy of evaluation for foreign selection candidates. Further information is available on the Interbeef Website – www.interbeef.org. Ireland is enthusiastically supporting Interbeef because of its potential to improve the profitability of beef production in Ireland through better-informed decisions on selective imports of breeding stock. The main beneficiaries in Ireland are expected to be Irish beef producers.

IGenoP

Ireland, like many other countries and cattle breeding organizations, has identified whole genome assisted selection as potentially a very useful tool in improving the rate of genetic gain, and lowering the cost, for dairy and beef cattle. Again, like many other smaller countries, Ireland has limited capacity to procure training populations of sufficient size with sufficient phenotype data to conduct the research required before genomic selection can be effectively implemented. Part of our strategy to overcome this limitation has been the development of an international **genotype sharing partnership** – IGenoP.

Objectives: The primary driver of IGenoP is a set of objectives that enable national or breed specific genetic evaluation service providers to provide a better service to local breeders. The objectives are:

- To increase the accuracy of local genetic evaluations by enabling the use of genomic information.
- To facilitate the local evaluation of selection candidates from other countries for which genomic data is available.
- To ensure local evaluation systems are free from bias due to genomic pre-selection.
- To facilitate an efficient service by local organizations.

Operational Concept: The operational concept is based on a sharing of genotypes that are able to be used by the partners in both research and the provision of evaluations for selection candidates as follows:

- An international collaboration of animal evaluation units to share genotypes.
- Establishment of a database of shared genotypes at the Interbull Centre.
- Use of shared genotypes and phenotypes for training genomic evaluations for each partner.
- Use of shared genotypes, and local SNP estimates, for evaluation of national selection candidates, both local and potential imports.

Operational Prototype: ICBF has established bi-lateral sharing arrangements with a number of countries and organizations. To support this sharing and to test the practicality of the IGenoP concept it has developed a prototype IGenoP database. This database is now operational within

ICBF and is a key element in its routine genomic evaluation service to Irish dairy farmers and the Irish breeding industry. It uses the Interbull ID for animal all identifications and manages all aspects – from locating animals to be genotyped through sample collection, genotyping, genetic evaluation and provision of results to the person seeking the information. The underlying database has the potential to scale-up and is currently supporting the Illumina 3K, 50K and HD genotypes. It also includes a facility for extracting a sub-set of SNP results that are available to the genotyping laboratories for parentage testing and quality control. Our current focus is on improving access for our bi-lateral partners and in facilitating its transfer to Interbull.

Draft Agreement: In anticipation of the transfer of the IGenoP database to the Interbull Centre we have also developed a draft agreement for participation. Some of the key elements of the draft agreement are:

- **Parties:** ICAR, Interbull, Animal Evaluation Units (Contributors) & Laboratories
- **Purpose:** researching, developing and operating genetic evaluation services in the base and scale of a contributor's own country, breed and trait-set combination
- **Decision making:** Interbull Steering Committee, Annual Meeting in accordance with the rules and procedures adopted by ICAR
- **Contributors (AE Units) must:**
 - a. Provide all genotypes owned or available to contribute & maintain authorisation(s) for other partners to access these.
 - b. Contribute genotypes of bulls (and cows?) exclusively progeny tested in own country.
 - c. Provide genomic evaluations in their base and scale on a non-discriminatory basis.
- **Contributors (AE Units) must not:**
 - a. Provide genomic evaluations in base & scale of any other partner.
 - b. Supply genotypes that they do not own or have the right to supply.
 - c. Pass information obtained through IGenoP to third parties.
- **Interbull Centre:**
 - a. Securely holds the genotypes in a database and ensures they are available.
 - b. Operates a secure website for transfer of genotypes to only those with appropriate authorisation.
 - c. Arranges all meetings and provides administrative support.
 - d. Determine and collect fees to cover the costs of providing the service.
- **Authorised Laboratory(s)** - Upload genotypes & download parentage SNP's.
- **ICAR:**
 - a. Ensures that phenotypic data of relevance to commercial cattle production continues to be collected according to well-defined standards on a worldwide basis.
 - b. Provides administrative support by facilitating membership to organisations wishing to become involved as Contributors or Laboratories.

Summary: IGenoP is a service that will enable national Animal Evaluation Units to provide more accurate genomic evaluations for national and international selection candidates.

The prototype established in Ireland has proven the concept.

Interbull working with interested Animal Evaluation Units could have the service available quickly.

SUMMARY

In the last thirteen years the Irish cattle breeding industry has undergone a complete redevelopment of its data gathering and genetic evaluation infrastructure. The key developments include:

- the establishment of ICBF as a working partnership between the organizations involved in Irish cattle breeding,
- the establishment of a shared cattle breeding database,
- the implementation of a data collection and sharing system that eliminates duplication at farm and organization level,
- development of a genetic evaluation system which identifies, on a worldwide basis, those cattle that are most profitable under Irish conditions, and
- supporting and promoting increased international collaboration in beef breeding and genomics.

Irish farmers, research scientists, Herd Books and AI Companies have responded by making good use of the greatly increased amount of information now available. As a result Irish farmers are now able to better exploit the potential of genetics as a tool for improving the profitability of their enterprises.

i <http://www.icbf.com/aboutus/structure.php>

ii <http://www.agriculture.gov.ie/>

iii Breeding objectives for beef cattle in Ireland. P.R. Amer, G. Simm, M.G. Keane, M.G. Diskin, B.W. Wickham. *Livestock Production Science* 2001 67:223-269.

iv www.icbf.com - choose Active Bull Lists and within that “Beef”. Click on bull identification to see full details.

v A subsidiary of CRV Holdings – website <http://ais.cr-delta.nl/>

vi Cromie A, Wickham B, Coughlan S, & M Burke, 2008. The impact of new technologies on performance recording and genetic evaluation of dairy and beef cattle in Ireland. *Proceedings ICAR Biennial Conference, Niagara, June 2008.*

vii <http://www.icar.org>