The Theory of Genetics Applied to Livestock Production; Some Experiences from Ireland.

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Introduction.

The objective of a theory is to provide a model and/or framework to answer a question of importance. For example, in his Theory of Evolution, Charles Darwin attempted to answer the important question *"what is the origin of species"* by developing important concepts such as natural selection, genetic variation, mutation and extinction. Using these various concepts and his own life experiences (including over 20 years of observational data), he was able to construct a credible perspective of how all life-form existed and evolved over time.

In this paper, we will attempt to answer a question of particular relevance for this conference that is, how do we achieve genetic gain in livestock production? Our observational data (or life experience) will be based on 10 years of cattle breeding data from Ireland, since the formal establishment of Irish Cattle Breeding Federation (ICBF) in 2000. It is hoped that the framework provided will be of value to other people/countries as they endeavor to return increased profit from cattle breeding for their respective farmers and/or industries.

Materials & Methods.

An overview of the key elements of the theory, are given in Figure 1. These include the issue question, the dynamic principle, and the main concepts and sub-concepts. For each we will present the key components based on experiences from Ireland, together with a discussion on how these have been created and/or evolved over the past 10 years.

Results & Discussion.

The Issue Question: How do we achieve genetic gain in Cattle Breeding? ICBF was formally established in 2000 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. Prior to 2000, cattle breeding in Ireland was made up of some 30 different cattle breeding entities, each with their own data recording system and perspective on cattle breeding, with the Department of Agriculture, Fisheries and Food (DAFF) providing a co-ordinating role.

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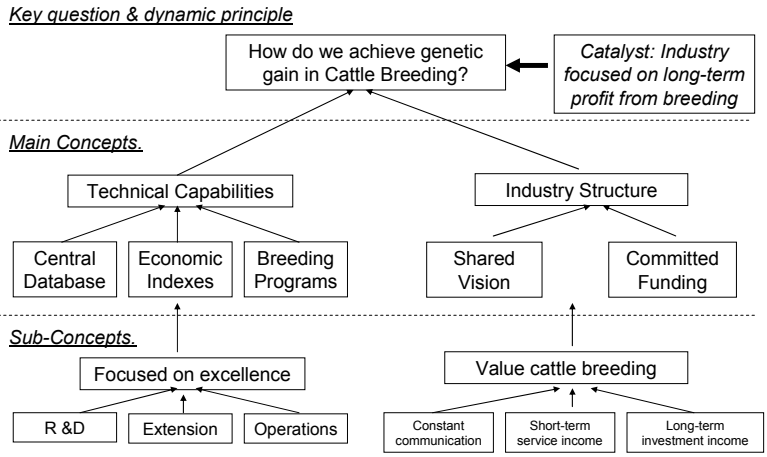


Figure 1: A model for achieving genetic gain in cattle breeding

The net effect of greater industry alignment, has been much imporved effectiveness and efficiency, as evidenced by increases in data recording and genetic gain (ICBF 2008). For example, some 90% of total calf births on a National basis (2.2 million per year) now reside in the cattle breeding database. Similarly levels of milk recording (+5%/year), dairy AI births (+11%/year) and beef recording (+40%) have all increased since the mid-2000's, demonstarting the value of greater industry co-operation.

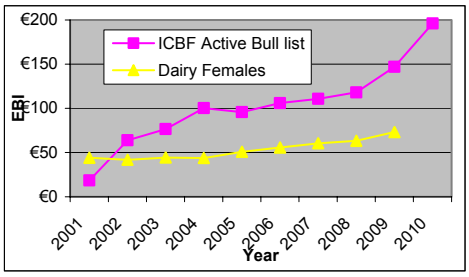
The Dynamic Principle: Industry focused on long-term profit from breeding. The key catalyst (or dynamic principle) in helping achieve genetic gain in Ireland, has been the long-term perspective that industry stakeholders are prepared to take regarding the value of cattle breeding (e.g., DAFF, Teagasc, farmer bodies, milk recording organizations, AI organizations and herdbooks). A good example of this, is the excellent commitment that ICBF receives from both DAFF and farmers (via their purchase of calf tags), with some 70% of our total budget (€5.8 million in 2008) coming from these sources, with the remainder coming service income (ICBF, 2008). Similarly our interaction with Teagasc (the state research and advisory organization) is a rich relationship focused on farmer and industry profitability. The net effect of each of these relationships is an appreciation that initiatives taken today, will not bear fruit tomorrow, but instead will take 5-10 years to realize their return on investment. A good example of this is genetic gain in our dairy Economic Breeding Index (see Table 1 and Figure 2).

Since the initial research work in 2000 (Veerkamp et al, 2002), there has been a steady increase in EBI, as evidenced by increases in index for the top 75 active AI sires, and the female population. Linked to this initial research work, have been two further initiatives, the launch of the G€N€ IR€LAND dairy breeding program in 2005 (with a target of progeny testing 100 bulls each with 100 daughters) and the implementation of genomic selection methodolgy in our routine evaluations in 2009 (Berry et al., 2009). Each of these pieces of

work were funded from "industry-good" monies, with the net effect being a €10 increase in profit/lactation (in Predicted Transmitting Ability terms) for females born in 2009, compared to 2008. The increase in EBI of sires on our ICBF Active Dairy Bull List is even more dramatic (+€49 in PTA terms for 2010 compared to 2009), reflecting the economic consequences of genomic selection, as we endeavour to return bulls at younger age into widespread AI. Given these trends, ICBF are now confident that optimal gains identified by Sonesson et al, (2008) of €35/lactation (in breeding value terms) can be realised over the next 5-10 years. Indeed we are confident that by 2020, the value of cattle breeding, through the use of the EBI, will have returned over €200 million in net profit for Irish dairy farmers.

Table 1 & Figure 2. Genetic Gain in Dairy Economic Breeding Index (2001-2010).

Year	ICBF Active Bull list	Dairy Females
2001	€18	€44.20
2002	€64	€41.70
2003	€76	€44.30
2004	€100	€43.90
2005	€96	€50.80
2006	€106	€55.70
2007	€111	€60.50
2008	€118	€63.30
2009	€147	€73.10
2010	€196	



Whilst most of ICBF's initial focus work has been on dairy breeding, similar initiatives are now underway in beef, with the launch of the Suckler Beef Value in 2005 (Amer et al., 2000), the G€N€ IR€LAND beef breeding program in 2007 (Meuwissen et. Al., 2006) and our genomics research program in 2009. Levels of genetic gain are currently some €5/year (in PTA terms), with an optimal gain of €20 achievable in the longer term. Again each of these initiatives are funded from "industry-good" income.

The Main Concepts & Sub-concepts: Technical capability and Industry Structure. In reviewing genetic gain in Ireland over the past 10 years, two main concepts (technical capability and industry structure) and two sub-concepts (focused on excellence and value cattle breeding) are apparent.

Technical capability and Focused on Excellence. ICBF are small team of some 35 people spread across 3 areas; (i) database and IT, (ii) Services and (iii) Genetics, with the genetics group consisting of 5 people (ICBF, 2008). One of the key factors in the successful development of our technical infrastructure and capabilities has been the establishment of strong relationships with other cattle breeding groups, most notably Teagasc, Wageningen, Abacus Bio, Novima, CRV Arnhem, SAC-Edinburgh, LIC and the Interbull Centre. Each of these groups provides an important resource in knowledge building within ICBF, as we endeavor to create a world-class cattle breeding system in Ireland. The constant focus on excellence is also critical, as we seek to improve on an annual basis. New projects are submitted to research and development, with the best making it through the funnel into

operations and then into program extension, with the latter work facilitated by our industry partners, most notably Teagasc and our AI, milk recording and herdbook members.

Industry Structure and Value Cattle Breeding. Whilst almost all of the discussion at this conference will be on the technical aspects of livestock breeding, it is the issue of industry structure and commitment to the value of cattle breeding that has perhaps reaped greatest dividends in Ireland over the past 10 years. The ability to set aside short term commercial gains and/or allegiances, to instead focus on long-term profit from breeding is a powerful driving force within the Irish cattle breeding industry. Keeping the wants and needs of commercial farmers at the fore, is important in this process, as without farmers, we would have no industry. This is a salient point for all people to reflect on. Of course such initiatives are not without their difficulties, with a supportive government (DAFF) and constant communication (e.g. industry meetings and our weekly update) being key facilitator's in the process of ensuring greater industry engagement and support.

Conclusions.

Genetic gain is most often associated with technical developments and capabilities, e.g., efficient data recording systems, economics indexes that are focused on profit and a well structured breeding program. Whilst each of these issues is important, the role of industry structure and support, including the need to have a shared vision focused on long-term profit is equally important. Since its inception in 2000, Irish Cattle Breeding Federation (ICBF) has focused most of its efforts on both these areas (technical capabilities and industry structure). The result has been increased genetic gain and profit for Irish dairy and beef farmers and the wider industries in Ireland. It is hoped that this paper will provide readers with a framework for effecting similar improvements in other countries as they endeavor to return increased profit from cattle breeding for their respective farmers and/or industries.

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