Using extension to progress genetic improvement on Irish dairy farms

George Ramsbottom, Teagasc Oak Park, Carlow, Ireland

The Economic Breeding Index (EBI), developed by the Irish Cattle Breeding Federation (ICBF), is now widely used by Irish dairy farmers in selecting sires for their dairy herds. Teagasc's advisory service has incorporated EBI targets into it's advisory programme and employed a wide variety of extension methodologies to promote it. The result has been its widespread acceptance which in turn has resulted in a doubling of the proportion replacement heifers sired through AI and a rapid increase in their genetic merit.

Background

Teagasc is a "semi-state organisation" which provides integrated research, advisory and training services for the agriculture and food industry in Ireland. One third of its budget supports Teagasc's advisory service, which has both a farm business and a national social policy remit. The organisation employs approximately 80 Business and Technology dairy advisers and five dairy specialists who directly support almost two thirds of Ireland's 18,000 dairy farmers.

For full time, commercially viable farms, the focus is on improving business efficiency to generate higher profit. Analysis of on-farm genetic and financial data from over 1,100 dairy herds has shown that EBI is associated with an increase in profit per cow (Ramsbottom, 2011). Thus EBI targets are included as key performance indicators in Teagasc's dairy advisory programme.

Dairy production systems in Ireland are seasonal (Berry et al., 2006) and highly dependent on achieving high fertility levels in dairy cows (Shalloo et al., 2004). When EBI was developed, the Irish dairy industry was ready for change. Over the previous 20 years, the Relative Breeding Index (RBI) which focused on genetic improvement for milk production had delivered on its objective - to produce milkier cows. However it underestimated the antagonistic genetic relationship between milk production and fertility resulting in a less fertile national herd (Evans et al., 2002; Berry et al., 2003). Indeed research showed that 'medium' RBI dairy cattle were more profitable than 'high' RBI stock when their higher fertility performance was accounted for (Veerkamp et al., 2000). When modelled, farm profit was most sensitive to changes in milk price followed by replacement rate (Evans et al., 2006).

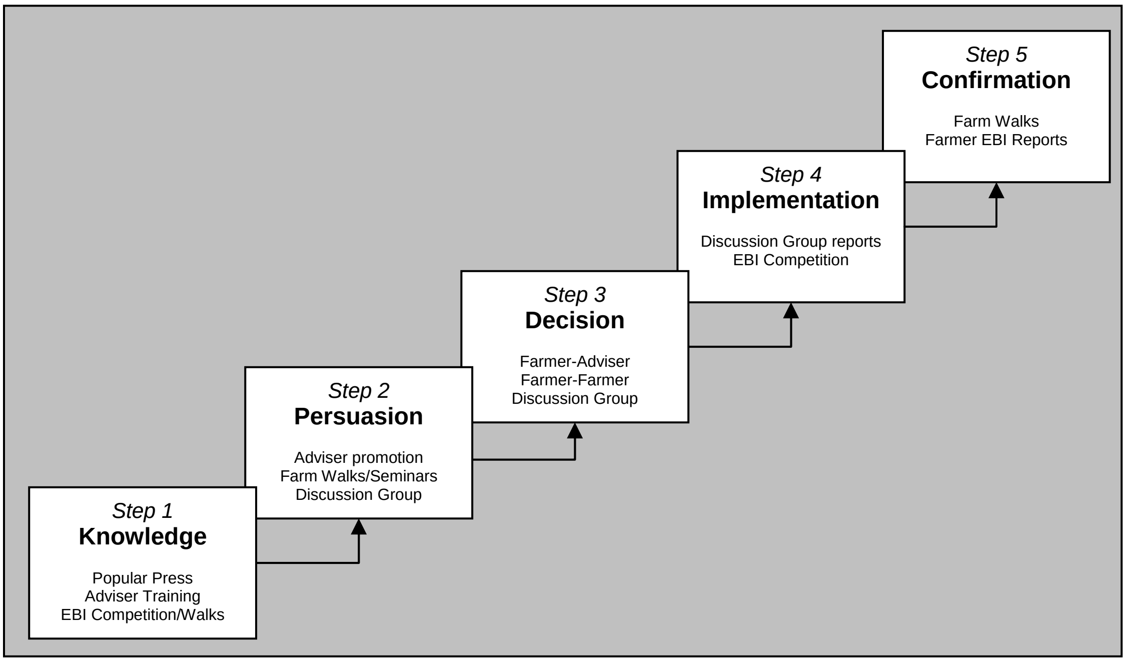
The use of AI was falling in tandem with the decline in fertility of the national dairy herd, most dairy replacements were sired by stock bulls and genetic merit of the replacement heifers entering the national dairy herd had stagnated (Wickham et al. 2012).

Starting in the late 1990's Teagasc and ICBF developed strong developed strong collaborative linkages in education, research and advice. These linkages continue to this day. From a Teagasc advisory perspective, one of the earliest initiatives was the large-scale series of meetings for farmers run by Teagasc and ICBF which promoted the use of animal events recording – primarily focusing on recording the sire of replacement heifers (ICBF 2002). The number of heifers with such information increased from 109,000 to 252,000 between 2000 and 2011 (see Table 2). This link underpins all further sire evaluation and is of crucial importance to developing a robust EBI.

Key principles of technology transfer and their adaptation by the advisory service

Rural sociologist Everett Rogers characterised adoption of an innovation as a five-step process as outlined in Figure 1. The following paragraphs detail how Teagasc advisers and others co-operated to ensure that this five step process functioned efficiently in the adoption of the EBI.

Figure 1. The five step EBI adoption process (adapted from Rogers, 2003).



Rogers characterises the first step of this process as the knowledge stage - here the individual is first exposed to an innovation and becomes inspired to seek further information about it. By 2005 the first of a series of annual breeding competitions with a prize fund provided by Rabobank and publicised heavily by the Irish Farmers Journal, was launched promoting the concept of EBI. Initially an individual farmer competition, huge publicity was achieved with over 2,000 dairy farmers attending the inaugural Open Day and over 1,000 dairy farmers attending each of the following two national events held in 2006 and 2007. A feature of these early events was presenting the 'High EBI cows' as a separate group for farmers to see – very quickly extension of EBI was moving, for some farmers at least, from the knowledge step to the persuasion step.

Step two in the process of adoption of an innovation is persuasion – at this stage the farmer is interested and actively seeks information/detail about the innovation. This was extended through the farming press, farmer meetings and walks and through farmer – adviser contacts. Research on practice adoption by Irish dairy farmers found that Teagasc advisers and discussion groups significantly influenced the adoption of newer technologies (Kelly, 2011).

Step three is the decision step – the farmer weighs up the concept and decides to adopt or reject it. In making the decision, a range of people 'closest' to the farmer are often hugely influential in making this decision. These people change depending on the technology involved. For breeding decisions, these people tended to be the farmer's Teagasc adviser, their AI company representative and their farmer peers – most often members of their own discussion group. Each year in advance of the breeding season, Teagasc advisers meet with ICBF personnel and Teagasc dairy specialists and researchers to ensure that consistent EBI messages were promoted. In the early years, such meetings were held with AI representatives as well.

Step four is the implementation stage. Here the individual employs the innovation to some extent on their own farm. Teagasc specialist staff and ICBF personnel developed a suite of discussion group reports, available to their advisers, that allowed group members to compare their breeding information with that of other members of their group. Peer pressure was employed to ensure that EBI was being implemented on individual's farms.

Step five is the confirmation stage. Here the individual finalises the decision to continue using the innovation and may end up using it to its fullest potential. Between 2008 and 2011 the breeding competition changed from being an individual farmer competition to a discussion group competition. During the three years 2008 to 2010 approximately 75 dairy discussion groups met a team of experts each year and had their breeding performance critiqued. The impact of this on members' performance both in terms of the number of heifers born in the following years and the average EBI of the bulls used was hugely significant. Winning groups hosted breeding events where most of the information was presented by group members rather than 'breeding experts'. Farmers attending the events observed that hearing the messages from other farmers was hugely effective in confirming the EBI message. To support farmers at this stage, Teagasc and ICBF personnel prepared tables showing the milk production and fertility performance of 'high EBI' and 'low EBI' cows from wining group members' herds at the national and regional events that took place from 2008 to 2011.

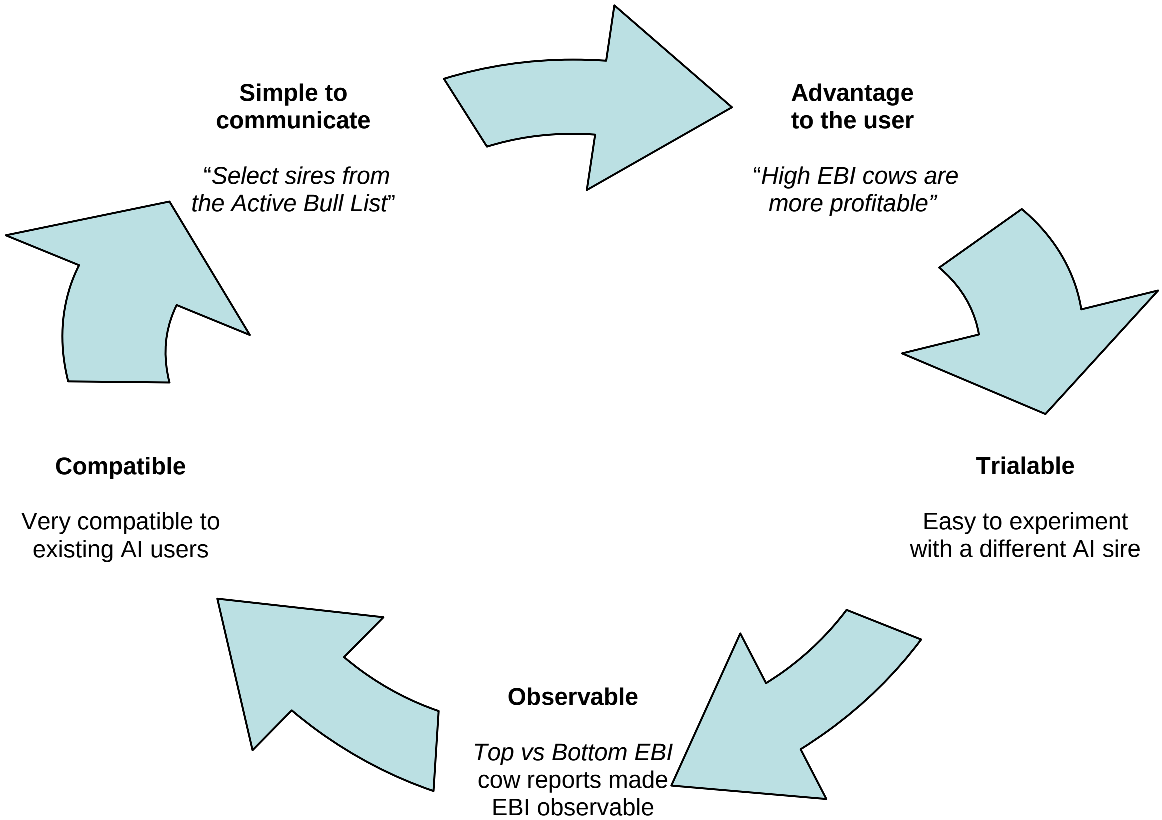
Promotion of EBI is ongoing. Improving herd EBI continues to be a Teagasc dairy programme target.

- Teagasc continues to promote the index through the usual communication channels including the popular press, promotion by advisers at individual farm visits and at farm walks and meetings.
- A Department of Agriculture scheme, the Dairy Efficiency Programme commenced in 2010. This scheme funds participation in discussion groups and membership has doubled since then. The scheme supports EBI as participants must engage in recording sires of calves, cow temperament and on-farm lameness and mastitis events.
- Farmer reports have been developed by Teagasc specialists and ICBF personnel. These allow individual dairy farmers to compare genetic and cow performance data from their own farm with that of similar farmers within their own region.
- The EBI is not a 'finished product' and undergoes continual adjustment and refinement so ongoing modification of Teagasc's advice and guidance is required.

Factors that facilitated EBI adoption

According to Rogers (2003), five intrinsic factors influence an individual's decision to adopt or reject an innovation. All of them were adapted in Teagasc's extension of the EBI message as outlined in Figure 2.

Figure 2. Intrinsic factors that made EBI easier to adopt (adapted from Rogers, 2003).

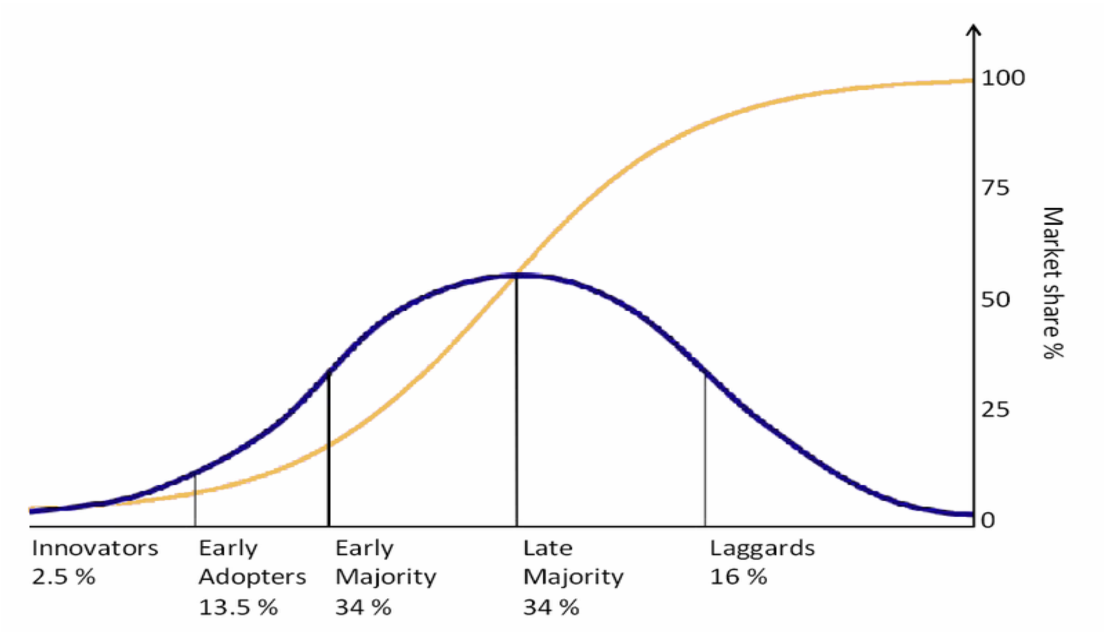


People factors also influence the rate of adoption.

- As outlined already a 'team' approach was being employed by service providers from ICBF, Teagasc and the main breeding organisations. This was further enhanced by the development of an AI partnership supported by the Irish Department of Agriculture in 2007-2008. Such a unified approach meant that a consistent EBI message was extended by all of the parties involved.
- Discussion groups have been a major conduit for the extension of EBI. Their efficacy was confirmed with research by Hennessy and Newman (2010) which showed that a higher percentage of group members used AI and genomic sires in 2009 compared with non-group members.

Within the rate of adoption there is a point at which an innovation reaches critical mass. This is a point in time within the adoption curve that enough individuals have adopted an innovation, critical mass has been achieved, and the continued adoption of the innovation is self-sustaining. Figure 3 presents the successive groups of consumers adopting the new technology (shown as a 'bell curve'). The market share (shown as an 's shaped' or logistic curve) ultimately approaches 100%.

Figure 3. The diffusion of innovations (adapted from Rogers, 2003).



Innovation is a two-way process

One of the cons of the Diffusion of Innovation model is that the communication process involved is a one-way flow of information. This was not the case with EBI. Early adopters of EBI very quickly challenged the limited range of AI sires available to them to ensure a continued rapid pace of genetic improvement.

- The ICBF and the breeding organisations responded with GeneIreland, a programme to progeny test young bulls in a much more organised and systematic way that was done heretofore. Teagasc advisers promoted the GeneIreland programme in the initial years.
- Genomic testing of Irish dairy sires began just before the start of the spring breeding season in 2009. This new technology was developed by Teagasc researchers and ICBF personnel and supported by the breeding companies. Consultation between all of the parties ensured that a simple consistent message regarding the use of genomic sires was developed and extended. Teagasc advisers were cited by over one third of dairy farmer users as the main influence of their use of genomic sires in 2009 (Kelly, 2011). The widespread use of these genomic sires ensued as presented in Table 1. This in turn has contributed to the rate of heifer genetic improvement observed in recent years as detailed in Figure 4. On average the EBI of sires used nationally in 2011 increased by €37 compared to 2009 due to the use of an increasing proportion of high EBI genomic AI sires.

Table 1. EBI and percentage of AI sires used in Ireland that were either genomically proven or daughter proven (2009-2011).

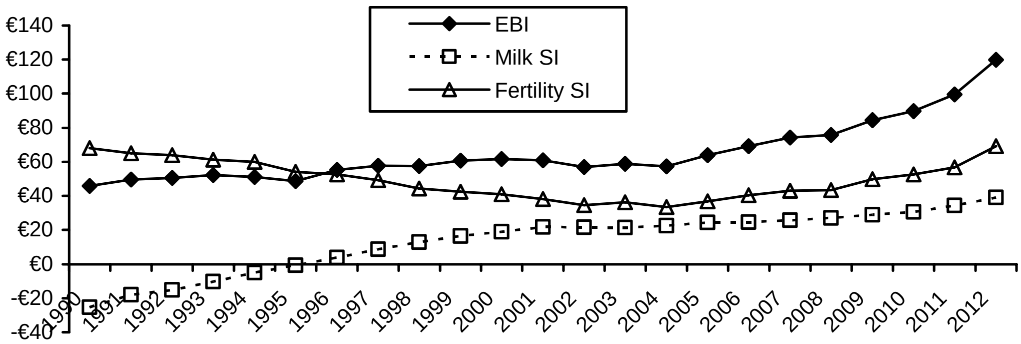
	2009	2010	2011
Genomic AI sires			
EBI (€)	€179	€211	€218
% of total AI used	34%	40%	47%
Daughter proven sires			
EBI (€)	€126	€151	€148
% of total AI used	66%	60%	53%
Weighted EBI of all AI sires used	**€144**	**€175**	**€181**

Data for 2009 and 2010 adapted from Wickham (2011); data for 2011 from spring calvings only (ICBF, 2011)

Results

The average EBI and milk and fertility sub-indices of heifers born since 1990 are presented in Figure 4.

Figure 4. EBI (€) of heifers born in Ireland between 1990 and 2012.



The data in Figure 4 show that over this 22 year period, the EBI of dairy replacement heifers born on Irish dairy farms has almost trebled. The rapid rise observed in the last couple of years reflects the trend to using more genomic sires (which are higher EBI) as detailed in Table 1. This improvement in genetic merit of the heifers born is associated with the improvements observed in heifer fertility and milk production performance as outlined in Figures 5 and 6.

Figure 5. Calving interval (days) between first and second calving.

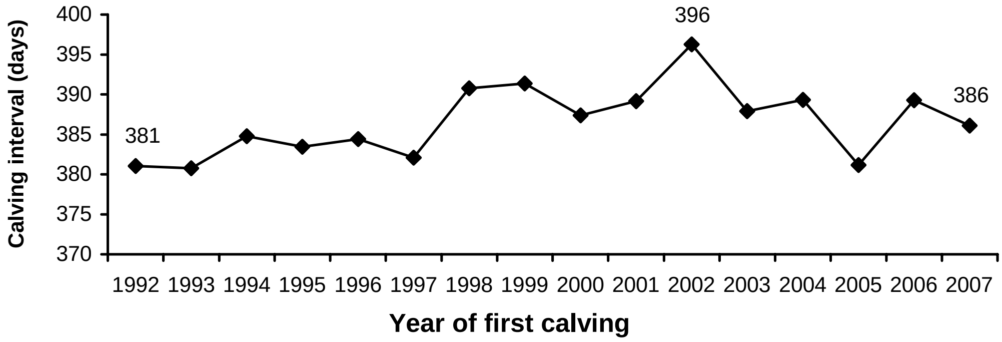


Figure 5 records the rise in calving interval between the early '90's and 2002 of the national dairy herd reflecting the decline in fertility sub-index of the herd over the period. Since then a trend towards a shorter calving interval has been observed in tandem with the improvement in genetic merit for fertility nationally. The calving interval for dairy cattle that calved for the first time in 2007 is 286 days. These animals were primarily born in 2005 when the average fertility sub-index was €37. Further improvement is expected over the next number of years as the fertility sub-index has risen substantially since – that of the 2012 born heifers is €69.

Figure 6. First lactation milk yield (kg milk solids) of dairy cattle by year of birth.

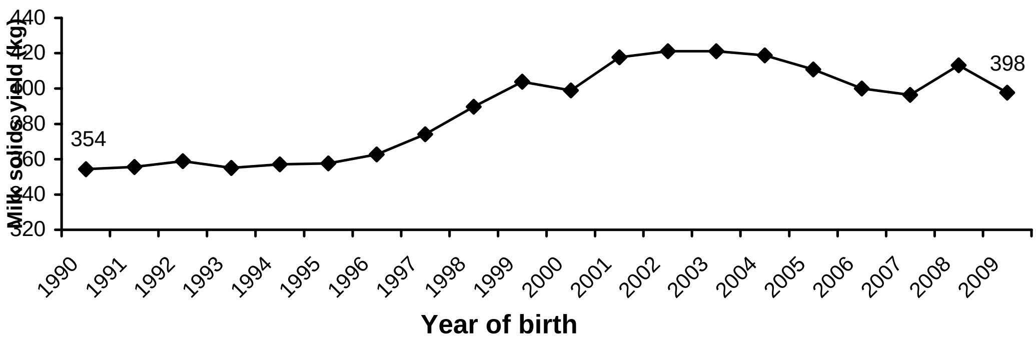


Figure 6 documents the trend in first lactation milk solids yield in milk recorded herds by year of birth. Milk solids production of the 2009 born heifers was over 40 kg higher than the yield achieved in 1990. In the intervening period milk sub-index had increased by over €50 to €29. Further increases in milk solids production are expected in the coming years. The milk production sub-index of 2012 born heifers is €39.

The number of replacement heifers born on Irish dairy farms since 2000 is presented in Table 2.

Table 2. Number of dairy replacement heifer calves born on Irish dairy farms between 2000 and 2011.

Year of birth	Dairy heifer calves	No. with sire information (no. with AI sire)
2000	209,579	108,264 (93,880)
2001	234,830	115,884 (100,642)
2002	255,669	135,206 (105,904)
2003	284,116	150,086 (113,393)
2004	282,440	153,175 (111,945)
2005	265,749	148,547 (108,570)
2006	248,510	145,795 (107,742)
2007	254,626	158,958 (122,351)
2008	269,064	174,905 (132,529)
2009	309,712	199,119 (153,475)
2010	319,072	209,157 (158,426)
2011	360,368	252,947 (184,014)

Significant changes have occurred in the both number of heifers born and the number of AI bred heifers born annually. The number of dairy replacement heifers born annually has increased by over 70% since 2000. In addition there has been a 133% increase in the number recording sire information. The number with a known has increased by almost 150% and with a known AI sire has effectively doubled over the period.

Summary

The results of the collaborative approach taken to the extension of the EBI message have included:

- A rapid rise in the EBI of sires used on Irish dairy farms;
- The widespread use of genomic sires;
- A rapid increase in both the number and EBI of replacement heifers born in the national herd.

References

Berry, D.P., Buckley, F., Dillon, P., Evans, R.D., Rath, M. and Veerkamp, R.F. 2003 genetic parameters for body condition score, body weight, milk yield and fertility estimated using random regression models Journal of Dairy Science 86, 3704-3717

Berry, D.P., O'Brien, B., O'Callaghan, E.J., O'Sullivan, K. and Meaney, W.J. 2006 Temporal trends in bulk tank somatic cell count and total bacterial count in Irish dairy herds during the past decade Journal of Dairy Science 89, 4083–4093

Evans, R.D., Buckley, F., Dillon, P. and Veerkamp, R.F. 2002 Genetic parameters for production and reproduction of spring-calving upgraded Holstein-Friesian dairy cows in Ireland Irish Journal of Agricultural and Food Research 41, 43-54

Evans, R.D., Wallace, M., Shalloo, L., Garrick, D.J. and Dillon, P. 2006 Financial implications of recent declines in reproduction and survival of Holstein-Friesian cows in spring-calving Irish dairy herds Agricultural Systems 89, 165-183

Hennessy, T. and Newman, C. 2010 The Benefits of the Membership of a Dairy Farm Discussion Group: Evidence from the National Farm Survey Paper presented at the Teagasc National Dairy Conference 17th-18th November Teagasc, Carlow, Ireland

ICBF 2002 ICBF Annual Report – February 2001 to January 2002 ICBF, Bandon, Co. Cork 24th May 2002 Available online at http://www.icbf.com/publications/files/Annual_Report_for_2002.pdf

ICBF 2011 ICBF Annual Report 2011 ICBF, Bandon, Co. Cork Available online at http://www.icbf.com/publications/files/Annual_Report_2011.pdf

Kelly, T.G. 2011 Teagasc influence on best practice and adoption on Irish dairy farms Best-Practice Knowledge Transfer British Society of Animal Science Knowledge exchange between providers of KT to farmers, Thursday 3 March, Sixways Stadium, Warriors Way, Pershore Lane, Hindlip, Worcester, WR3 8ZE

Ramsbottom, G., Cromie, A.R., Horan, B. and Berry, D.P. 2011 Relationship between dairy cow genetic merit and profit on commercial spring calving dairy farms Animal doi:10.1017/S1751731111002503

Rogers, E. M. 2003 Diffusion of Innovations (5th Edition) Glencoe: Free Press, New York

Shalloo, L., Dillon, P., Rath, M. and Wallace, M. 2004 Description and validation of the Moorepark Dairy Systems model Journal of Dairy Science 87, 1945–1958

Veerkamp, R.F., Meuwissen, T. H.E., Dillon, P., Olori, V., Growen, A.F., van Arendonk, J.A.M. and Cromie, A.R. (2000) Dairy Breeding Objective and Programs for Ireland : Final Report Available Online at ICBFhttp://www.icbf.com/publications/files/Final_RBI_report_25_11_2000.pdf

Wickham, B.W. 2011 How genomic selection is increasing the profitability of the Irish dairy herd SMO Conference – Melbourne, Australia, Thursday 5th May Available online at http://www.icbf.com/publications/files/SMO_Wickham_3rd_May_2011.pdf

Wickham, B.W., Amer, P.R., Berry, D.P., Burke, M., Coughlan, S., Cromie, A., Kearney, J.F., McHugh, N., and O'Connell, K. 2012 Industrial perspective: capturing the benefits of genomics to Irish cattle breeding Animal Production Science 52:172-179