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Genetics of improved health, fertility, grass intake and feed efficiency in Irish dairy cattle



Key external stakeholders:

The Irish Cattle Breeding Federation (ICBF)
Breeding industry
Dairy and Beef Farmers
AI technicians
Farm Relief Service

Practical implications for stakeholders:

This study has

- Shown significant differences between Jerseys, Jersey crossbreds and Holsteins in their ability to convert feed into milk solids
- Developed the data editing, statistical models and genetic parameters for female fertility traits in dairy and beef animals which has been disseminated at many industry meetings and has been implemented into national genetic evaluations
- Developed the data editing and statistical models for evaluation of bull fertility and performance of AI technicians in cattle which are now routinely used by the industry to monitor performance
- Provided genomic data for inclusion in genomic selection evaluations which are now implemented in national evaluations
- Revised the health sub-index of the dairy EBI to include actual mastitis and lameness data with the appropriate economic weights (to be implemented into national evaluations in 2011)
- Generated scientific knowledge (in collaboration with other projects) of the associations between variation at the level of DNA and performance in Holstein-Friesian cattle
- Shown that Johne's disease is under genetic control and significant differences exist among sires in the daughters' susceptibility to Johne's disease, which are not strongly related to current breeding goals
- Shown that antibody immune response and cell mediated immune response in Norwegian Red and Holstein cattle were not consistent indicators of udder health
- Shown that dry matter intake, energy balance and digestibility is under genetic control, the extent of which varies across the lactation

Main results:

- Clear and exploitable genetic variation in male and female fertility traits in dairy and beef cattle
- Clear and exploitable genetic variation in mastitis and lameness data collected by Irish farmers
- Considerable exploitable genetic variation in dry matter intake, energy balance and the digestibility of feed.

Opportunity / Benefit:

Greater accuracy of genetic selection for a comprehensive suite of important traits is now possible

Collaborating Institutions:

University College Dublin, UCD
Irish Cattle Breeding Federation, ICBF

Teagasc project team:	Dr. Donagh Berry (PI) Dr. Frank Buckley
External collaborators:	Drs. A.R. Cromie, S. Coughlan, J.F. Kearney, R.D. Evans and B. Wickham, ICBF B. Eivers NCBC G. Ryan Dovea T. Baker, Eurogene P Bryne, FRS

1. Project background:

Although the economic breeding index (EBI) and suckler beef value (SBV) exist to improve health and fertility in dairy and beef cattle, the approaches used can be improved through the development of new phenotypes (e.g., mastitis, lameness) and redefinition of phenotypes based on now routinely available data (e.g., new fertility traits). Additionally, a key requirement of sustainability is efficient production from a pasture based system. High grass intake per unit size/production will likely result in cows more suited for grazing systems. High feed conversion efficiency (FCE) is desirable. However, data underlying the genetic variation in grass intake and FCE in grazing dairy cattle has yet to be quantified.

2. Questions addressed by the project:

The objective of this study was to quantify the genetic variation in a number of key traits that will aid the development of improved selection strategies for increased health, fertility, and efficiency, for Irish pasture-based systems. Traditional genetics and state-of-the-art genomic approaches were to be used.

3. The experimental studies:

- Most of the tasks were based on mining of the Irish Cattle Breeding database or collecting additional data (e.g. lameness) to supplement the database.
- Genomic associations in this project were based on 848 Holstein-Friesian AI sires representative of those used in Irish dairy herds in recent years.
- Research on the antibody and cell mediate immune response in the Norwegian Red and Holstein-Friesian cattle was based on 648 second-lactation cows (274 Holstein-Friesian, 207 purebred Norwegian Red and 167 crossbreds) from 30 commercial Irish dairy herds.
- The study on the breed differences in feed efficiency was based on 110 cows (37 Holstein-Friesian, 36 Jersey and 37 crossbreds) from one research farm at Moorepark.

4. Main results:

- New fertility phenotypes, defined using routine service and pregnancy diagnosis data, are under genetic control and are better early biological genetic predictors of fertility than milk yield (which is currently used in the national genetic evaluations for dairy cattle). Greater accuracy of selection for fertility was shown to be possible using this new approach.
- Clear and exploitable genetic variation in fertility (including age at first calving) exists in beef cattle.
- Large differences exist among bulls and technicians in their ability to get cows in calf.
- Mastitis and lameness data collected by Irish farmers is suitable for inclusion in national genetic evaluations for health. The incidence rate of mastitis and lameness in the data was 11% for both. 4% to 5% of the differences among animals in the incidence of mastitis and lameness were due to their genetic makeup, which can be exploited in breeding programs.
- It is possible to improve resistance to Johne's disease through breeding; the heritability (i.e., proportion of variation observed on farm due to differences in genetics of the animals) for susceptibility to Johne's disease varied from 7% to 15%. Genetic correlations between Johne's disease and milk, fat and protein yield were negative, although not always statistically significant; stronger negative genetic correlations were evident in older animals.
- Considerable exploitable genetic variation exists within the Holstein-Friesian breed in dry matter intake, energy balance and the digestibility of feed. The heritability (i.e. proportion of variation observed on farm due to differences in genetics of the animals) varied from 10% to 30% for dry matter intake, from 9% to 35% for energy balance, and from 8% to 45% for diet digestibility.
- The Jerseys have better gross feed efficiency (i.e., higher milk solid output per unit intake) compared to the crossbreds which in turn had better gross efficiency than the Holstein-Friesians.
- The Norwegian Reds had a greater primary antibody mediated immune response compared to the Holstein-Friesians and the Norwegian Red × Holstein-Friesian crossbreds. No difference was observed among the breed groups in cell-mediated immune response. While differences in mean

breed group somatic cell count values were in line with group mean antibody mediated immune response values, no association was found among the traits.

5. Opportunity/Benefit:

- The results from this study have been used in the revised national genetic evaluation for female fertility in dairy cows and in beef cows and have been used for the first ever national evaluation of male fertility and AI technician performance
- New genetic evaluation for mastitis and lameness are being developed

6. Dissemination:

International conferences

Presented at many international conferences, invited and contributed, such as the European Association of Animal Production, British Society of Animal Science, British Cattle Breeders Conference, INTERBULL, ICAR, American Dairy Science Association Annual meeting, New Zealand Society of Animal Production, International Society of Animal Genetics, Recent Advances in Animal Nutrition Annual Conference (Nottingham), and the World Congress on Genetics Applied to Livestock Production.

National Conferences and seminars

Presented at the Agricultural Research Forums through the duration of the project and at national farmer conferences (e.g., Irish Grassland Conference).

Open Day

Presented at all Moorepark open days.

Breeding industry consultation days

Presented and discussed at several industry meeting days with representatives from the different AI organisations, breed societies, Teagasc extension service, farmer groups and farmers.

Farmer discussion groups

Discussed at many farmer discussion groups and seminars.

Press

Results regularly presented in the Irish Farmers Journal, Farming Independent, Today's Farm, TResearch, and Moorepark News.

Main publications:

Berry, D.P., J.F. Kearney, and J.R. Roche. (2011). Evidence of genetic and maternal effects on secondary sex ratio in cattle. *Theriogenology*. (In Press)

Berry, D.P. R.D. Evans, S. McParland. (2011) Evaluation of bull fertility in dairy and beef cattle using cow field data. *Theriogenology* 75: 172-181.

Berry, D.P., M. Good, P. Mullooney, A.R. Cromie, and S.J. More. (2010). Genetic variation in serological response to *Mycobacterium avium* subspecies *paratuberculosis* and its association with performance in Irish Holstein-Friesian dairy cows. *Livestock Science* 131 : 102-107

Popular publications:

Buckley, F. and Berry, D.P. (2010). Bull Selection 2010 - Achieving improved herd fertility:- Moorepark Dairy Levy Research Update-Series No. 14 on 6th May. Teagasc IE

Buckley, F. and Berry, D.P. (2009). Genetics for grass-based systems - Irish Dairying New Thinking for Challenging Times (Moorepark Open Day 2009). Teagasc IE pp. 41-46

Buckley, F. and Berry, D.P. (2010). Breeding and Management Technologies to Increase Farm Profit: Bull selection 2010- Moorepark Dairy Levy Research Update: Ballydague Research Farm, Series No. 13, 23rd March. Teagasc.

7. Compiled by: Dr. Donagh Berry