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Genetics of cost production traits



Key external stakeholders:

Irish sheep, beef and dairy farmers, Irish Cattle Breeding Federation (ICBF), Sheep Ireland, consultancy agencies, international genetic evaluation bodies

Practical implications for stakeholders:

The outcome of this research is most accurate genetic evaluations for beef, dairy and sheep farmers.

- Revised the national dairy cattle, beef cattle and sheep breeding objectives
- Generated novel cattle fertility phenotypes using ultrasound data
- Investigated the genetic factors associated with reproductive traits in nulliparous dairy females
- Revised the national sheep lambing and growth evaluations
- Investigated the role of age at first lambing on subsequent ewe and progeny performance
- Estimated the genetic variation for health traits in cattle and sheep
- Investigated the role of alternative technologies in the recording of health data for cattle and sheep
- Quantified the genetic variation in a range of alternative feed efficiency traits in dairy cattle
- Generated a strategic roadmap on options to increase genetic gain for dairy, beef and sheep

Main results:

- Heritability for the dairy reproductive traits were generally low, regardless if defined traditionally (0.07; calving to first service) or from ultrasound examination [resumed cyclicity at the time of examination (0.07) or early postpartum ovulation (0.10)].
- The direct heritability of dagginess was 0.15, whereas the direct heritability of lameness ranged from 0.06 (ewes) to 0.12 (lambs). The direct heritability of mastitis was 0.04.
- Measurements made using infrared thermography can achieve a high level of precision in an agricultural environment if at least 3 replicate images of the eye, udder, or hooves of cows are captured and averaged.
- The energy sinks (e.g., metabolic live weight) and additional contributors to energy kinetics (e.g., live weight loss) combined, explained 59% of the variation in total net energy intake, implying that residual energy intake (REI) represented 41% of the variance in total net energy intake
- A greater odds of lamb mortality was associated with male lambs (1.31 times more likely of death than females), lambs of very light (2 to 3 kg) and very heavy (>7.0 kg) birth weights, quadruplet born lambs

Opportunity / Benefit:

The overall impact of this research was more accurate genetic evaluations for beef, dairy and sheep thereby reducing fluctuations in animal genetic proofs, as well as, a strategic roadmap on future research and implementation priorities to further improve genetic gain for profitability

Collaborating Institutions:

Irish Cattle Breeding Federation, Sheep Ireland, UCD, DCU and Massey University (New Zealand)

Teagasc project team: Dr. Nóirín McHugh (PI)
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1. Project background:

Genetic evaluations for the foreseeable future, even with genomic selection, will still require routine access to high quality phenotypes. The objective of this project was to develop novel technologies and statistics to aid in the capture of phenotypes and improvement of the genetic evaluations and farm management decision support tools for cost-of-production traits. The principles of genetic improvement across dairy cattle, beef cattle and sheep are similar and therefore, all three sectors are addressed here. This project focused on the development of breeding objectives, new phenotypic tools, genetic evaluations, decision support tools, and dissemination. The three key traits investigated were fertility, health and feed intake/efficiency.

2. Questions addressed by the project:

- Can new novel technologies and statistics be developed to aid in the capture of phenotypes and improvement of the genetic evaluations for cost of production traits?
- Can the current genetic evaluations for fertility be improved and take cognisance of recent developments in statistical methodologies?
- Can new technologies be used to allow for the routine collection of health data in sheep and cattle?
- Should feed efficiency traits be included in the national genetic evaluations for dairy cattle?

3. The experimental studies:

- This study was desktop based and involved the analysis of datasets from ICBF, Sheep Ireland and Teagasc as well as a review on the available literature
- Fertility data for dairy cattle was available through the ICBF database, as well as through individual dairy reproductive ultrasound scanners
- Health data on BVD for cattle and lameness, mastitis, faecal egg counts and dag score for sheep was available through existing datasets stored by ICBF and Sheep Ireland
- A number of experiments were established to quantify the use of novel technologies to generate health data on a routine basis for cattle and sheep
- Feed intake records were available from a range of previous experiments undertaken in Teagasc Moorepark and allowed for the calculation of a plethora of feed efficiency measures
- Selection index methodology was used to calculate the expected genetic gain across a range of traits in sheep, beef and dairy

4. Main results:

- New and novel detailed fertility traits for beef and dairy cattle were identified from the ultrasound examinations including: commencement of oestrous cyclicity after calving and embryonic/foetal death
- Both the additive and non-additive genetic components, as well as the permanent environmental component, contribute to phenotypic variation in the reproductive traits in nulliparous, primiparous and multiparous seasonal-calving dairy females.
- Heritability of the reproductive traits ranged from 0.004 (pregnancy rate to first service) to 0.17 (age at first service in nulliparae), while repeatability estimates for the reproductive traits in cows ranged from 0.01 (calving interval) to 0.11 (pregnant in the first 42 days of the breeding season).
- Lambing performance of a ewe and the growth potential of her progeny differ based on the age of first lambing of the ewe (i.e. lambing for the first time as a ewe lamb or a hogget).
- The genetic variation for health traits in cattle (bovine respiratory disease) and sheep (faecal egg

counts, dag scores and foot lesion scores were investigated. The heritability estimates ranged from 0.04 (ewe mastitis) to 0.15 (lamb dagginess). Genetic correlations between the health traits and other performance traits were also estimated.

- The maximum temperature of sheep hooves proved to be a useful variable to diagnose early onset of infection in individual hooves. This result was the first to suggest that infrared thermography used in agriculture has the best diagnostic capabilities at colder ambient temperatures.
- Exploitable genetic variation was demonstrated to exist for the range of alternative efficiency traits, and the magnitude of this variation was sufficiently large to justify consideration of the feed efficiency complex in future dairy breeding goals.
- High economic weightings must be placed on the cost of production traits to ensure a positive response to selection within the breeding objectives. For example for feed intake in dairy an economic weighting of €0.078/UFL is required for residual energy intake to generate animals with improved REI. Similarly for the sheep breeding objective an economic weighting of -€0.50/ dag score is required for dag score to generate animals with improved dagginess.

5. Opportunity/Benefit:

The results of this study has the potential, if adopted, to increase the rates of genetic gain achievable across the beef, sheep and dairy sectors through the development state of the art statistical tools for implementation in the national genetic evaluations, increase farmers confidence and usage of the genetic evaluations. All research has been incorporated into the national genetic evaluations for beef, sheep and dairy.

6. Dissemination:

Main publications

Byrne, D.T., Berry, D.P., Esmonde, H., and McHugh, N. (2019) 'Sheep lameness detection from individual hoof load' *Computers and electronics in Agriculture* 158:241-248.

McHugh, N., Pabiou, T., Wall, E., McDermott, K., and Berry, D.P. (2017) 'Impact of alternative definitions of contemporary groups on genetic evaluations of lambing traits' *Journal of Animal Science* 95:1926-1938.

Hurley, A.M., López-Villalobos, N., McParland, S., Lewis, E., Kennedy, E., O'Donovan, M., Burke, J.L., and Berry, D.P. (2017). 'Genetics of alternative definitions of feed efficiency in grazing lactating dairy cows' *Journal of Dairy Science* 100:5501-5514.

International conferences

Presented results at numerous conferences such as the European Association of Animal Production, the World Congress on Genetic Applied to Livestock Production and the New Zealand Society of Animal Production.

National conferences and seminars

Presented at national dairy, beef and sheep conferences and at the Agricultural Research Forums throughout the duration of the project.

Open days:

Presented at Moorepark, Athenry and Grange opensdays.

Industry consultation

Project results were presented and discussed at numerous industry meetings with AI companies, breed societies, farming groups, farmers and the Teagasc extension service.

Farmer discussion groups

Results were presented and discussed at many farmer discussion groups and seminars.

7. Compiled by: Dr Nóirín McHugh