

Project number: 6450
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Deep phenotyping for reproductive performance in dairy and beef cattle



Key external stakeholders:

The Irish Cattle Breeding Federation (ICBF)
Reproductive tract ultrasound technicians
Scientists
Irish breeding industry

Practical implications for stakeholders:

This study

- The incidence of multiple ovulations in Irish dairy cattle is less than most other populations but is likely to be increasing given the positive genetic correlation with milk yield identified
- Multiple ovulations is both heritable and repeatable
- The size of the growing conceptus relative to the expected size for a given age could be used as a predictor of conceptus viability

Main results:

- Multiple ovulations is heritable and is positively genetically correlated with milk yield implying that breeding programs that select for increased milk yield alone will, on average, increase the incidence of multiple ovulations – this is the likely rationale for the observed trends in increasing twinning rate globally in Holstein-Friesian dairy cows
- In the absence of service dates, reproductive tract ultrasonography can be a very accurate tool to predict calving dates

Opportunity / Benefit:

The possibility exists for selection for multiple or single births
Reproductive tract ultrasonography may be useful to diagnose the likelihood of embryo loss
Predicted calving dates from reproductive tract ultrasonography can be very accurate

Collaborating Institutions:

Irish Cattle Breeding Federation
Reprodoc Ltd.

Teagasc project team: Donagh Berry (PI)
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External collaborators: Andrew Cromie (ICBF),
Dan Ryan (Reprodoc Ltd.)

1. Project background:

Reproductive traits included in international breeding programs are almost exclusively producer-recorded traits such as calving interval or days open. Such traits are subject to considerable error or unrecorded animal-specific management decisions; the impact is low heritability and the necessity for large datasets to achieve high reliability and genetic gain. Moreover, such complex traits are a culmination of several underlying more detailed reproductive traits. Calving interval for example is a function of post-partum interval to commencement of luteal activity, sufficiently obvious expression of oestrous for detection in AI breeding programs, conception and establishment of pregnancy, and gestation length. Therefore two cows could achieve the same calving interval through very different underlying physiology (i.e., quick return to oestrus and poor pregnancy rate ν late return to oestrus and excellent pregnancy rate). What is not clear is the impact on detailed reproductive phenotypes from current breeding strategies that select on traditional, macro-level, reproductive phenotypes. Also not clear is the impact of selection on other traits (e.g., milk production) on these underlying phenotypes and the extent of genetic variation in these underlying reproductive phenotypes.

2. Questions addressed by the project:

- The usefulness of reproductive tract ultrasonography to generate useful phenotypes for inclusion breeding programs
- Quantification of the genetic variability in these derived phenotypes, especially multiple ovulations
- The impact of current breeding programs on incidence of these reproductive phenotypes
- The usefulness of reproductive tract ultrasonography to predict future embryo mortality but also expected calving date

3. The experimental studies:

- This study was desktop based and involved the analysis of datasets collected by Reprodoc Ltd. as well as ancillary data from the ICBF database
- A total of 65,030 transrectal ultrasound observations of the reproductive tract from 41,582 dairy cows in 828 Irish dairy between March 2008 and October 2012 were available
- Ancillary information such as herd, cow parity number, calving date, breed composition and pedigree information were also available
- Data were analysed using mixed models and generalized estimating equations where appropriate

4. Main results:

- Multiple ovulations were lowly heritable (0.028), but repeatable (0.326); moreover considerable genetic variation existed
- A moderate genetic correlation (0.66) existed between multiple ovulations and twin births.
- There was a greater likelihood of multiple ovulations in cows with greater phenotypic yields (odds ratio: 1.53–1.81) and greater genetic merit for yield (odds ratio: 1.31–1.59) relative to lower performing contemporaries. After adjustment for genetic merit, a similar trend of increased odds (odds ratio: 1.29–1.87) of multiple ovulations in higher yielding cows was observed compared with the lowest yielding category.
- No association existed between either phenotypic milk composition or genetic merit for milk composition with the likelihood of multiple ovulations.
- The likelihood of cystic ovarian structures was greatest in cows with greatest phenotypic milk yields (odds ratio: 2.75–3.24), greater genetic merit for milk yield (odds ratio: 1.30–1.51), and even after adjustment for genetic merit there was a greater likelihood of cystic ovarian structures in cows with the highest milk yields
- Genetic predisposition to higher somatic cell score was associated with a reduced risk of multiple ovulations (odds ratio: 0.69; 95% CI: 0.55–0.87)
- There was a lower likelihood of multiple ovulations, cystic ovarian structures, and poorer uterine health and an increased likelihood of CL presence in cows with superior genetic merit for reproductive performance and survival
- Predicted calving date calculated from ultrasonography was 1.41 days (SD: 5.97 days) later than the

actual subsequent calving date, and was, on average, 0.52 days (SD=5.47 days) later than predicted calving date, assuming a gestation length of 282 days.

- Predicted gestational age relative to actual gestation age based on service data was associated with an increased likelihood of pregnancy loss

5. Opportunity/Benefit:

- Confidence that current breeding programs that select for calving interval are actually improving all of the underlying detailed reproductive measures investigated in the present study
- Predicted gestational age relative to actual gestation age based on service data could be used as a predictor of future pregnancy loss

6. Dissemination:

Main publications:

Fitzgerald, A.M., Ryan, D.P., Carthy, T.R., Evans, R.D. and Berry, D.P. (2014). Ovarian structures and uterine environment are associated with phenotypic and genetic merit for performance in lactating dairy cows. *Theriogenology* 82: 1231-1240

Fitzgerald, A.M., Berry, D.P., Carthy, T., Cromie, A.R and Ryan, D.P. (2014). Risk factors associated with multiple ovulation and twin birth rate in Irish dairy and beef cattle. *Journal of Animal Science*.92:966-973

Fitzgerald A.M., D.P. Ryan, D.P. Berry. (2015). Factors associated with the differential in actual gestational age and gestational age predicted from transrectal ultrasonography in pregnant dairy cows. *Theriogenology*, In Press

International conferences

Presented at the World Congress on Genetic Applied to Livestock Production

National Conferences and seminars

Presented at the Agricultural Research Forums through the duration of the project

7. Compiled by: Dr. Donagh Berry
