

**Project number:** 5499  
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## Genetics of predisposition to tuberculosis in Irish dairy cattle



### Key external stakeholders:

The Irish Cattle Breeding Federation (ICBF); breeding industry; dairy farmers

### Practical implications for stakeholders:

The results show that susceptibility to bovine tuberculosis (TB) is under genetic control. Twelve to eighteen percent of the variation in susceptibility to TB among animals is due to their genetic makeup which is passed on from one generation to the next. Therefore breeding for resistance to TB is feasible if sufficient information is available to accurately identify genetic differences among animals.

The results suggest that selection for improved survival may indirectly reduce susceptibility to TB infection, while selection for reduced somatic cell count and increased fat production and body condition score may increase susceptibility to TB infection.

### Main results:

- Twelve to eighteen percent of the differences among animals in susceptibility to TB due to differences in their genetic makeup which are passed on from one generation to the next. This means that breeding for TB resistance is possible.

### Opportunity / Benefit:

- Breeding for resistance to TB is possible
- Estimates of genetic merit for TB derived that could be used in subsequent genomic research

### Collaborating Institutions:

UCD, ICBF, DAFM

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### 1. Project background:

*Mycobacterium bovis*, the causal organism of bovine tuberculosis (TB), remains an important infection of cattle in many countries. A TB eradication programme has been operating in the Irish cattle herd since the 1950s, with control costs being borne by both government and industry. There is a large gap in knowledge on genetic predisposition to TB and how current breeding programs may be affecting this. There are several large animal- and herd-level datasets (animal breeding, disease control) in Ireland which represent an opportunity, unique internationally, to address some of these gaps in knowledge. Results from this study will provide an initial understanding of the genetics behind susceptibility to TB, and has the potential to identify Irish and foreign animals with relatives in Ireland that are genetically predisposed to infection with TB. An outcome of this study will also be measures of genetic merit for TB that can be used by other scientists in the discovery of regions of an animal's genome (i.e., DNA) associated with TB susceptibility/resistance.

### 2. Questions addressed by the project:

Can we alter susceptibility to TB using animal breeding and if so what is the impact of current breeding goals on genetic susceptibility in the national herd?

### 3. The experimental studies:

Data from the national tuberculosis database (held at CVERA, dating back to the early 1990s) was used along with performance and pedigree data from the ICBF. Only data from herds that experienced some degree of infection were included in the analysis. Within the CVERA database, individual animal records on the result of the tuberculin test as well as a lesion score were available for herds that had a positive case of TB. Different statistical approaches were undertaken to quantify the contribution of genetics to TB susceptibility.

### 4. Main results:

- The heritability of responsiveness to the tuberculin test was 0.14 in cows and 0.12 in heifers; the heritability of confirmed TB infection based on carcass lesions in cows was 0.18. This means that 12% to 18% of the differences among animals in susceptibility to TB was due to differences in their genetic makeup which are passed on from one generation to the next. It also implies that breeding for TB resistance will be fruitful.
- A very strong positive genetic correlation ( $r_g=0.999$ ;  $SE=0.0024$ ) was estimated between responsiveness to the tuberculin test and confirmed *M. bovis* infection in cows, indicating that they are genetically very similar traits, and that genetic selection to reduced responsiveness to the tuberculin test will also reduce genetic susceptibility to TB.
- Responsiveness to the tuberculin test was significantly positively genetically correlated with fat production (0.39) and body condition score (0.36), and negatively correlated with somatic cell score (-0.34) and survival (-0.62). Hence, these results suggest selection for increased survival may indirectly reduce susceptibility to TB infection, while selection for reduced somatic cell count and increased fat production and body condition score may increase susceptibility to TB infection.
- Large emphasis on TB within breeding goals needed to increase resistance to TB infection.

### 5. Opportunity/Benefit:

- We now know that breeding for resistance for TB could form an integral part of a national strategy against TB infection in cattle
- Estimates of genetic merit derived using the statistical methodology developed in this study should be used to identify regions of the genome associated with TB to help understand the genetic architecture of the trait and develop the necessary tools to help eradicate TB

### 6. Dissemination:

Papers were presented at the European Association of Animal Production; British Society of Animal Science and the World Congress on Genetic Applied to Livestock Production. Papers were also presented at the Agricultural Research Forum and results presented at the Moorepark Open Day 2009.

**Main publications:**

Bermingham, M.L., S.J. More, M. Good, A.R. Cromie and D.P. Berry (2009) Genetics of tuberculosis in Irish Holstein-Friesian dairy herds. *Journal of Dairy Science* 92, 3447–3456.

Bermingham, M.L., S.J. More, M. Good, A.R. Cromie and D.P. Berry (2010) Genetic correlations between measures of *Mycobacterium bovis* infection and economically important traits in Irish Holstein-Friesian dairy cows. *Journal of Dairy Science* 93, 5413-5422

Bermingham, M.L., S. Brotherstone, D.P. Berry, S.J. More, M. Good, A.R. Cromie, I.M.S. White, I.M. Higgins, M.P. Coffey, S.H. Downs, E.J. Glass, S.C. Bishop, A.P. Mitchell, R.S. Clifton-Hadley, and J.A. Woolliams. (2011) Evidence of genetic variance in resistance to tuberculosis in Great Britain and Irish Holstein-Friesian populations. *BMC Proceedings*. 5: 515

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