Importance of the agricultural sector to NI

- NI covers 14,130km$^2$
  - 46.4% rural (6,560 km$^2$)
- Agriculture core component of NI economy and society: £351m to NI GVA
- “agri-food is our most successful industry” AFSB 2013
- Directly employing 26,000 (3.2% total NI employment)
- The densest poultry population and one of the most dense cattle populations in the UK
- Cattle farming is the main agricultural activity in NI
- Characterised by farm fragmentation and rented seasonal grazing (conacre)
Importance of the agricultural sector to NI

- 25,000 farms: modal size 20-30 hectares. Predominance of ‘very small’ farm businesses in NI
- 88% provide dairy, sheep and/or beef products
- 1,609,000 cattle (2015): average herd size 79
- Beef 15,090 farms (260,325 cattle) and dairy 3,537 farms (311,520 cattle): beef and dairy average 17.3 and 88.1, respectively
- 2015 output £393.8m for beef sector and £479.9m for dairy sector
- Competent Authority DAERA = Department of Agriculture and Rural Affairs
  - Department of Agriculture and Rural Development
  - Department of the Environment
The TB Problem

- The programme is not resulting in a reduction in disease levels
- FVO 2015 - “...but the herd incidence rate has stagnated at levels above 6%, which is not what would be expected with an effective eradication programme in place.”
- Reactor numbers in 2016 highest since 2004
- Many factors influencing spread of infection
- Much is still not understood...
DAERA Veterinary Epidemiology Unit disease statistics

Abernethy and others 2013

DAERA TB Report 2015
The TB Programme

- Detection of infection by live animal or *post mortem* surveillance
  - Annual comparative tuberculin testing and targeted IFN blood testing
  - PME every animal slaughtered for human consumption
- Removal of infected and/or exposed animals
- Controls applied to breakdown herd
- Tracing and risk assessments lead to further testing in other herds
- Approved by EU for co-funding
- Programme costs in excess of £30 million annually
- New Practitioner Contract with enhanced QC
AFBI contribution

The AFBI contribution to the TB programme is continuous

• Histopathology
• Bacteriology
• Molecular Strain typing
• IFNG blood testing
• DNA comparisons
• Post mortem examination
• Forensic Pathology
• Badger Road Traffic Accident Survey
• Specific advice
• Project/Governance Groups
• Collaborations with other scientists
AFBI Contribution

Specific recent projects:

- Literature Reviews - slurry spreading; cattle to cattle transmission; badger to cattle transmission; bTB tests; bTB tests in badgers; International application of the Gamma Interferon test
- TB Biosecurity Study
- Badger Cattle Proximity Study
- Gamma interferon Project
- Badger Sett Survey
- Test, Vaccinate, Remove (TVR) wildlife intervention research
- TB Strategic Partnership Group
AFBI Contribution

Ongoing research:
• Evaluation of multiple reactor and chronic breakdown herds
• TB transmission dynamics using genome epidemiology
• Role of endemic diseases and other factors
• Resuscitation promotion factors enhanced culture
• Optimisation and enhancement of the test format for gamma interferon
• Improve reliability of genomic prediction
• TB molecular epidemiology - analysis of cattle movements and optimisation of epidemiological investigations
Thematic Recommendation Chapters

Chapter 1: Governance. To establish effective governance arrangements to oversee the reduction and eradication of BTB as enabling the farming industry, Government, PVPs, and key stakeholders to work in partnership, with the principle of shared commitment.

Chapter 2: Culture and Communications. To encourage a change in culture and attitude so that all stakeholders understand and accept the part they have to play in achieving BTB eradication and recognise that their contribution will make a difference. To improve communication so that all stakeholders receive relevant, timely and appropriate information.

Chapter 3: Tools and Processes. To minimise the potential for BTB transmission to herds, within herds and from herds, through maximisation and enhancement of the existing tools and processes, and the utilisation of emerging technologies.

Chapter 4: Wildlife. To address the BTB reservoir in badgers to help eradicate BTB in cattle herds and contribute to the health of the badger population.

Chapter 5: Hard Health Management. To promote improved herd health management across all types of cattle holdings, slaughterhouses, and at market points, in order to reduce the risk associated with the spread of disease, and introduce actions and practices that will improve herd health.

Chapter 6: Finance. To re-balance the cost of the disease between the public and private sectors, so encouraging a change in culture and attitude, and a shared commitment to the control and eradication of BTB. To identify new sustainable arrangements which would allow Government to maximise and better deploy resources.

Chapter 7: Research. To ensure that research into BTB is given a priority within the DAERA research agenda. To ensure that the Tuberculosis Eradication Partnership (TBP) has the ability to influence the BTB research agenda, to aware of emerging recommendations from research to inform future reviews of the Strategy and to disseminate relevant research findings to stakeholders.
Badgers: DAERA-led RTA survey and Test, Vaccinate and Remove (TVR) badger study

Population 2012 34,100 (95% CI 26,000-42,000) in 7,600 social groups

- RTA 1998-present
- TB prevalence 15.3% (95% CI 13.1-17.5)

- TVR 100km² with 2km buffer 2014-2019
- Sett side DPP serology test
- BCG vaccinate DPP-, remove DPP+
- TV 2014, TVR 2015-
- Research studies associated with TVR
Molecular typing - bovine TB

- AFBI genome-enabled tools to investigate TB evolution, epidemiology and outbreaks
- What does this tell us about TB? …and how does this help control?
- Deep ancestry shows UK and Ireland dominated by their own TB strain family (EU1)

• TB strains - striking local geographical clustering
  • Locally-driven epidemic: a series of local micro-epidemics
  • Valuable for tracing locally, nationally and internationally
- Cattle and badger TB strains associated at **regional** level
- Lacking direct genetic evidence of transmission chains linking cattle and badgers at **farm** scale
Pathogen WGS - bovine TB

- **Genomic epidemiology** - target one strain
  - Molecular typing, **bacterial WGS** and mathematical modelling (Glasgow)
  - “First direct evidence of ongoing TB transmission between cattle and badgers at the individual farm level”
  - Also signals of cattle-cattle spread (amplification) within some study herds

- Providing insights into disease transmission dynamics which were previously unattainable
Genomics - cattle resistance to bovine TB

- Parallel genetics studies identified heritable genetic variation in risk of TB - exploitable via **selective breeding**
- Industry-led national genetic and genomic evaluations (EBVs) for TB resistance in dairy cows (SRUC and *AHDBDAIRY*)
- **TB Advantage**: new genetic selection trait launched January 2016 - a world first
- NI data being included in EBV estimates
- AFBI key role
Genomics - cattle resistance to bovine TB

- NI case-control genetic association study estimated heritability of 0.23
- Mapped genetic variants associated with TB disease trait
- Demonstrated that **genomic prediction/selection** was feasible for the TB resistance trait

- Disease genetics in the future?
  - Only some diseases amenable
  - Exciting new opportunities to exploit genetic variation in new traits