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Resistance to Gastrointestinal Nematodes in Hill Sheep

Key external stakeholders:
Sheep producers, Sheep processors, Sheep meat consumers, Anthelmintic drug trade, Department of Agriculture, Food and the Marine

Practical implications for stakeholders:

- Gastrointestinal nematodes (gut worms) are the most serious cause of disease in Irish sheep. The most common infective species are *Teladorsagia*, *Trichostrongylus* and *Nematodirus.* Infection can lead to clinical disease and ill-thrift.
- There is variation among lambs in their ability to resist gastrointestinal nematode infection.
- Resistant Scottish Blackface lambs could be reliably identified using faecal egg counts from two independent natural infections.
- Resistant lambs had lower faecal egg count than susceptible lambs and this was a result of lower worm fecundity in resistant lambs rather than a lower worm burden.
- Resistant lambs produced more anti-nematode Immunoglobulin A than susceptible lambs and attracted immune cells to the site of infection faster than susceptible lambs
- A panel of genetic markers showed some promise in identifying resistant lambs

Main results:

- Resistant and susceptible lambs were identified using two faecal egg count (FEC) measurements from each of two independent natural infections.
- Resistant lambs had a lower FEC than susceptible lambs. There was no difference in worm burden between resistant and susceptible lambs but worms from resistant lambs were shorter and produced fewer eggs.
- The anti-nematode response in resistant lambs was mediated by Immunoglobulin A (IgA), with resistant lambs having higher levels of serum and abomasal mucosa IgA. This may be a useful marker of gut worm resistance.
- Resistant lambs mounted a faster immune response than susceptible lambs and attracted immune cells to the site of infection more quickly.
- Heritability of gut worm resistance in Scottish Blackface lambs was 0.27 indicating that there would be a good response to genetic selection.
- A panel of genetic markers in genes associated with gut worm resistance was developed.
- The panel of markers explained approximately 50% of the phenotypic variation in nematode resistance.

Opportunity / Benefit:

Nematode resistant Scottish Blackface lambs can be identified using faecal egg counts. Resistant lambs have lower faecal egg count due to lower worm fecundity. Resistant lambs also produced more anti-nematode Ig A than susceptible lambs and this may be a useful marker or resistance. A panel of genetic markers also showed some promise in identifying resistant lambs.

Collaborating Institutions:

Dublin City University and University College Dublin

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1. Project background:

Irish lamb production is predominantly grass-based and 80% of all lamb produced is exported. The Food Harvest 2020 report targets a 20% increase in Irish sheep output value by 2020. The technical efficiencies required to meet this target will include improvements in animal health and reducing losses due to animal diseases. Gut worms can cause ill-thrift and disease, and good worm control is currently highly dependent on effective worming products. However, a direct and unavoidable result of continuous use of wormers is the development of drug resistant worms. Therefore, alternative methods of gut worm control are required. One such alternative is the development of worm resistant flocks through genetic selection.

2. Questions addressed by the project:

- Can we reliably identify worm resistant and susceptible Scottish Blackface lambs?
- What is the mechanism by which Scottish Blackface lambs manifest resistance?
- Are there gene expression differences between resistant and susceptible Scottish Blackface lambs?
- Can we use genetic markers to identify worm resistant lambs?

3. The experimental studies:

Three separate studies were carried out.

1. The objective of the first study was to develop a method to reliably identify resistant and susceptible Scottish Blackface lambs and to validate this selection method. This study also looked at the parasitological parameters and the immunological response to infection in resistant and susceptible lambs.
2. The objective of the second study was to examine gene expression in gut immune tissue in order to determine what genes were activated in resistant lambs compared to susceptible lambs.
3. The third study tested a panel of 1000 genetic markers as a tool to identify resistant lambs.

4. Main results:

- Resistant and susceptible lambs were identified using two faecal egg count (FEC) measurements from each of two independent natural infections.
- Resistance and susceptibility was validated by challenging the lambs with 30,000 *Teladorsagia circumcincta* infective larvae.
- Resistant lambs had a lower FEC than susceptible lambs. There was no difference in worm burden between resistant and susceptible lambs but worms from resistant lambs were shorter and produced fewer eggs.
- The anti-nematode response in resistant lambs was mediated by Immunoglobulin A (IgA), with resistant lambs having higher levels of serum and abomasal mucosa IgA. This may be a useful marker of gut worm resistance.
- Gene expression in the abomasal lymph nodes was examined at 7 and 14 days post-infection with gut worms. Resistant lambs mounted a faster immune response than susceptible lambs and attracted immune cells to the site of infection more quickly.
- Heritability of gut worm resistance in Scottish Blackface lambs was 0.27 indicating that there would be a good response to genetic selection.
- A panel of genetic markers in genes associated with gut worm resistance was developed.
- No individual marker was significantly associated with gut worm resistance, however, the panel of markers explained approximately 50% of the phenotypic variation in nematode resistance.
- A panel of genetic markers may be more useful for predicting nematode resistance than individual markers.

5. Opportunity/Benefit:

Nematode resistant Scottish Blackface lambs can be identified using faecal egg counts. Resistant lambs have lower faecal egg count due to lower worm fecundity. Resistant lambs also produced more anti-nematode Ig A than susceptible lambs and this may be a useful marker or resistance. A panel of genetic markers also showed some promise in identifying resistant lambs.

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6. Dissemination:

- McRae K. M., Good B., Hanrahan J.P., Glynn A., O'Connell M.J. and Keane O.M. (2014) Response to *Teladorsagia circumcincta* infection in Scottish Blackface lambs with divergent phenotypes for nematode resistance. *Veterinary Parasitology*. 206(3-4):200-207
- McRae K. M., Good B., Hanrahan J.P., Sweeney, T., O'Connell M.J. and Keane O.M. Gene expression in abomasal lymph node of Scottish Blackface lambs challenged with *Teladorsagia circumcincta*. Proceedings of the 24th International Conference for the World Association for the Advancement of Veterinary Parasitology. Perth, August 25th – 29th
- McRae K. M., Good B., Hanrahan J.P., Cormican, P., Sweeney, T., O'Connell M.J. and Keane O.M. (2014) Differential gene expression in Scottish Blackface lambs with divergent phenotypes for resistance to gastrointestinal nematodes. Proceedings of the Agricultural Research Forum, Tullamore March 11th.

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