Improving dairy ewes resistance to gastro-intestinal parasite infections in natural conditions by selecting rams in artificial infections


GenPhySE – INRA Toulouse
Breeding strategies to select for parasite resistance

- **Resistance measure** = Fecal Egg Count (FEC)

- **Selection of the rams based on the phenotypes of their offspring in natural infections**
  - ✓ only one intervention on the animals
  - ✗ around 30 animals by sire → good accuracy of the index
  - ✗ no control of the number of larvae ingested by the animals

- **Selection of the rams based on their own phenotypes in experimental infections**
  - ✓ pyramidal organization of the population
  - ✓ fewer animals are phenotyped
  - ✗ at least 3 interventions per animal
  - ✗ time consuming
Sheep breeding and parasitism in South-West of France

• **2nd area for dairy sheep production in France**
  a total population of 280,000 Blond-faced Manech ewes in 2015
  28% ewes in selection program
  150 AI progeny tested rams / year

• **Favorable conditions to parasites in this area:**
  flocks mainly raised outside
  mild temperatures (5°C-25°C)
  rainy area (1000-1600 mm of annual rainfall)

• **Anthelmintic resistance in parasite populations:**
  ! only one efficient molecule without any withdrawal time for milk
Two populations to study genetic resistance to parasites

- **603 nucleus rams**
  - 103 rams with phenotyped offspring
  - 2 to 3 years old males
  - Naïve animals
  - Infected with *Haemonchus contortus* only
  - Phenotyped between 2008 and 2016

- **400 ewes on pasture**
  - 2 to 4 years old females
  - 7 flocks
  - Different physiological status (pregnant / milking ewes)
  - Multi-species infections

**FEC**: Fecal Egg Count
Phenotypes in experimental and in natural infections

- **Experimental infection**
  - 603 nucleus rams
  - Infection 1: L3 *H. contortus* (Day 0)
  - Treatment
  - Infection 2: L3 *H. contortus* (Day 45)
  - FEC_inf1
  - FEC_inf2

- **Natural infection**
  - 400 ewes on pasture
  - Infection 1: L3 *H. contortus* (Day 0)
  - Treatment
  - Infection 2: L3 *H. contortus* (Day 30)
  - FEC_inf1
  - Repeated FEC

**Note:**
- FEC : Fecal Egg Count
- Repeated FEC: 1 to 7 measures per ewe

**Duration:**
- Day 0 to Day 75
- 2-3 years

**Institution:**
- INRA
603 nucleus rams

Experimental infection

400 ewes on pasture

Natural infection

Model:
FEC = infectious group + gen_animal + e

Model:
FEC = year × season + age + treatment + permanent environment + gen_animal + e

AIREMLF90
heritabilities and genetic correlations

FEC: Fecal Egg Count
FEC are heritable both in experimental and natural conditions.

- 603 nucleus rams
  - Day 0: Infection 1
    - L3 H. contortus
    - FEC_inf1 $h^2 = 0.14$
  - Day 30
  - Day 45
  - Day 75: Infection 2
    - L3 H. contortus
    - FEC_inf2 $h^2 = 0.35$

- 400 ewes on pasture
  - Natural infection
  - Repeated FEC $h^2 = 0.18$

FEC: Fecal Egg Count
High genetic correlations between nucleus rams FEC and their offspring FEC

603 nucleus rams

Experimental infection

400 ewes on pasture

Natural infection

Day 0

Day 30

Day 45

Day 75

Infection 1

Infection 2

Treatmen

Infection L3 H. contortus

FEC : Fecal Egg Count

FEC_inf1

h² = 0.14

FEC_inf2

h² = 0.35

FEC : Fecal Egg Count

r_g = 0.92

h² = 0.14

h² = 0.35

h² = 0.18
High genetic correlations between nucleus rams FEC and their offspring FEC

603 nucleus rams

400 ewes on pasture

FEC : Fecal Egg Count

603 nucleus rams

Day 0

Day 30

Day 45

Day 75

2-3 years

Infection 1

Experimental infection

Infection 2

Infection L3 H. contortus

Infection L3 H. contortus

FEC_inf1

h² = 0.14

FEC_inf2

h² = 0.35

r_g = 0.92

r_g = 0.71

r_g = 0.56

FEC : Fecal Egg Count
Routine evaluation based on fecal egg count after the second infection

603 nucleus rams

- 2-3 years
- Infection 1: L3 *H. contortus*
- Infection 2: L3 *H. contortus*
- Experimental infection
- FEC: Fecal Egg Count
  - FEC_inf1: $h^2 = 0.14$
  - FEC_inf2: $h^2 = 0.35$

400 ewes on pasture

- Natural infection
- Repeated FEC: $h^2 = 0.18$

Day 0

Day 30

Day 45

Day 75

$\gamma_g = 0.71$

$\gamma_g = 0.92$

$\gamma_g = 0.56$

$\gamma_g = 0.14$

$\gamma_g = 0.35$
Practical demonstration of the efficiency of the selection

Genetic values of the rams based on their own FEC in second infection

FEC corrected for environmental effects

FEC of the 178 females born to susceptible rams

FEC of the 222 females born to resistant rams

FEC : Fecal Egg Count
Practical demonstration of the efficiency of the selection

Genetic values of the rams based on their own FEC in second infection

**FEC corrected for environmental effects**

- **FEC of the 178 females born to susceptible rams**
  - 230 eggs/g on average

- **FEC of the 222 females born to resistant rams**
  - 100 eggs/g on average

FEC : Fecal Egg Count
Practical demonstration of the efficiency of the selection

Genetic values of the rams based on their own FEC in second infection

- **FEC of the 178 females born to susceptible rams**
  - 230 eggs/g on average
  - 12% of high shedders

- **FEC of the 222 females born to resistant rams**
  - 100 eggs/g on average
  - 4% of high shedders

FEC corrected for environmental effects

**FEC : Fecal Egg Count**
Take home message

Selecting rams for resistance in experimental infections is an efficient way to increase resistance to GIN in naturally infected ewes in pastures

✓ Fecal egg counts are heritable
✓ High genetic correlations between fecal egg count of nucleus rams and fecal egg count of their offspring
✓ Practical demonstration of the efficiency of the selection
Thank you for your attention!

Article under review:
S.Aguerre et al.,
2018 Veterinary Parasitology

Acknowledgements

Thanks to the farmers who took part in the study
Thanks to CDEO (breeding organization of Manech Blond-Faced),
the French Livestock Institute
and ENVT (Veterinary School of Toulouse) teams who performed the phenotyping