

Analysis of resistance to gastrointestinal parasites

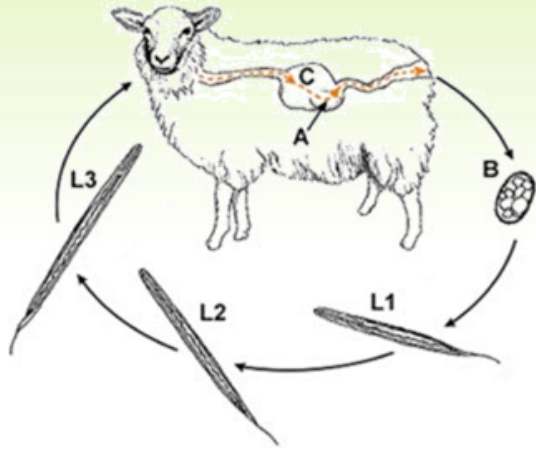
Elly Navajas, Beatriz Carracelas, Gabriel Ciappesoni



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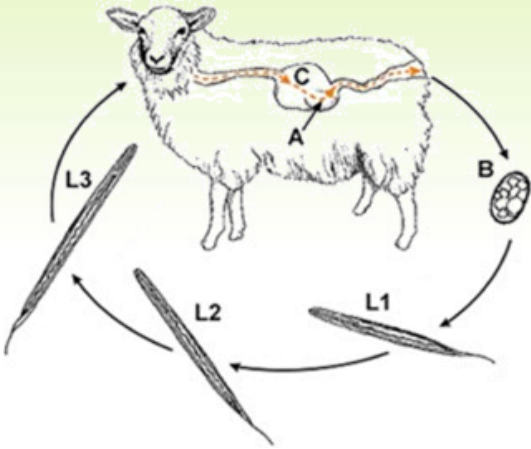
Introduction



- **Gastrointestinal nematodes (GIN) are one of the main constraints for sheep production worldwide**
 - Lambs are the most susceptible category to GIN infection
 - Lambing ewes also experience a phenomenon called periparturient rise (PPR)
- **Faecal worm egg count (FEC) counts the number of worm eggs in faeces**
 - It is used to monitor the worm burden
 - Number of eggs is an indication of the number of adult worms in the gut of the sheep
 - It is the most widely used method to identify resistant sheep
- **FAMACHA®: evaluation of the ocular mucosa when compared with a standardized colour chart** (Van Wyk and Bath, 2002)
 - Clinical identification of anaemic sheep infected with *H. contortus*
 - It can be used to select replacement animals that are resistant and/or resilient to *H. contortus*



Introduction



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- **Faecal worm egg count**
 - It is used to monitor the level of infection
 - Number of eggs per gram of feces
 - It is the most widely used method

Analysis 1- FEC data on Corriedale lambs

- View of structure of data for genetic evaluation
- Fixed effects in the model
- Normalization of FEC

Analysis 2- PPR ewes of different breeds

- Experimental data
- Model definition
- Comparison of breeds

- **FAMACHA©: evaluation chart** (Van Wyk and Bath, 2007)
 - Clinical identification of anaemia
 - It can be used to monitor the level of infection in sheep with *Haemonchus contortus*



GIN infection in lambs

- Genetic selection for resistance to GIN is based on Estimated Breeding Values for FEC
- Individual FEC is recorded in post-weaning lambs of stud flocks
 - Faecal samples are collected directly from the rectum
 - After identification, the samples are refrigerated and sent to the Parasitology Laboratory.
 - Within 72 hours FEC is determined using a modified McMaster technique (Whitlock, 1948).

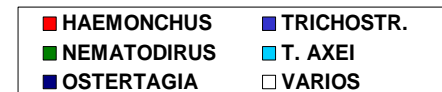
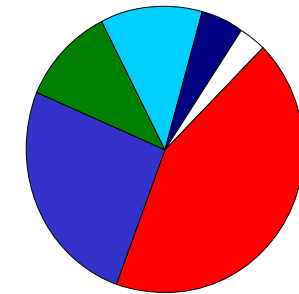


Faecal sampling: FEC1 and FEC2



Lamb Age Month	Lambing			Weaning		Drench		Drench		Drench		Shearing
	s	1	2	3	4	5	6	7	8	9	10	11
		o	n	d	j	f	m	a	m	j	j	a
					1 ^o check FEC=0 in 10 days	1 check each 15 days FEC>500 <20% =0			2 ^o check FEC=0 in 10 days		1 check each 15 d FEC>500 <20% =0	

- Lambs recorded under natural mixed-species challenge on average at 9.5 and 11.6 months of age (FEC1 and FEC2)



FEC of Corriedale lambs - data

- Sample of real data recorded in Corriedale flocks

ID	Animal identification
year	Year of recording: 2008 to 2021
flock	4 flocks (1 to 4)
sex	Sex of lamb: 1= male; 2= female; 3= castrated
TOB	Type of birth: 1= single; 2= twins; 3= triplets; 4= quadruplets
BW1	Body weight recorded at FEC1 (kg)
BCS1	Body condition score at FEC1: 1 to 5
FEC1	Faecal worm egg count at time 1 (eggs/g faeces)
FEC2	Faecal worm egg count at time 1 (eggs/g faeces)

Mandatory for genetic evaluation



FEC of Corriedale lambs – analysis

1. Upload database and check all variables are read correctly
2. Descriptive analysis and distribution
3. Generation of new variables
4. GLM analysis of FEC1 and FEC2
5. Normality tests for FEC



FEC of Corriedale lambs – analysis

1. Upload database and check all variables are read correctly Maximun n = 3,964

2. Descriptive analysis and distribution

```
Title "2. Check for fixed effects";  
PROC FREQ data=WORK.Corr2;  
    tables flock*year TOB*Flock / chisq nopercnt norow nocol nocum  
    plots(only)=(freqplot);
```

3. Generation of new variables

4. GLM analysis of FEC1 and FEC2

5. Normality tests for FEC



FEC of Corriedale lambs – analysis

1. Upload database and check all variables are read correctly Maximun n = 3964

2. Descriptive analysis and distribution

```
TOB3=TOB;  
if TOB=4 then TOB3=3;  
  
/* Transformation FEC : e logarithm */  
LnFEC_1=Log(FEC1+100); LnFEC_2=Log(FEC2+100);  
  
/* Transformation FEC : Cube root */  
cFEC_1=FEC1**(1/3); cFEC_2=FEC2**(1/3);
```

3. Generation of new variables

4. GLM analysis of FEC1 and FEC2

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FEC of Corriedale lambs – analysis

1. Upload database and check all variables are read correctly

Maximun n = 3964

2. Descriptive analysis and distribution

3. Generation of new variables

4. GLM analysis of FEC1 and FEC2

5. Normality tests for FEC

```
Title "3. GLM FEC 1 & FEC 2 logarithm";  
ods graphics off;  
PROC GLM DATA=Corr2 ;  
CLASS TOB3 sex year flock;  
MODEL LnFEC_1 LnFEC_2 =year*flock*sex TOB3/ ss3 ;  
LSMEANS TOB3 /stderr pdiff lines;  
output out=Corr2e RESIDUAL=FEC_1e FEC_2e ;  
  
RUN;  
QUIT;
```



FEC of Corriedale lambs – analysis

1. Upload database and check all variables are read correctly

Maximun n = 3964

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5. Normality tests for FEC

```
Title "4a. Normality Test: FEC1";  
PROC UNIVARIATE data=Corr2e normal;  
    ods select Histogram GoodnessOfFit ProbPlot QQPlot;  
    var FEC1;  
  
    histogram FEC1 / normal(mu=est sigma=est);  
    inset normaltest pnormal std var skewness kurtosis n / position=ne;  
    probplot FEC1 / normal(mu=est sigma=est);  
    inset normaltest pnormal std var skewness kurtosis n / position=nw;  
    qqplot FEC1 / normal(mu=est sigma=est);  
    inset normaltest pnormal std var skewness kurtosis n / position=nw;  
  
run;
```



GIN infection in ewes after lambing

- **Adult categories are more resistant to GIN, higher FEC observed in ewe after lambing**
 - due to temporary loss of acquired immunity is presented in the periparturient period
- **Periparturient rise (PPR) leads to worm eggs being eliminated**
 - Pasture larval contamination, and consequently, GIN infection of newborn lambs

➤ Experimental data recorded in ewes of breeds at INIA Las Brujas

Age	Adult; Hogget
Breed	Creole; EF=East Friesian; Texel
ID	Animal identification
lambs	Number of lambs: 1 to 4
Lamb_date	Lambing date

date_1	Recording date
BW_1	Body weight
BCS_1	Body condition score
FCHA_1	FAMACHA
FEC_1	FEC

1	29/7/2022
2	23/8/2022
3	12/9/2022
4	27/9/2022
5	4/10/2022



GIN infection in ewes after lambing - analysis

1. Generation of new variables

Days in Milk (DIM)

Lambs3

Transformation FEC : e logarithm & cubic root

Means (total & per breed)

2. Check for fixed effects

Lambs3 vs Age vs Breed

3. GLM for FEC 1 to FEC 5 (natural logarithm)

$y = \text{DIM}_1 + \text{Lambs3} + \text{Age} + \text{Breed} + e$

DIM as covariable. Export residuals a test normality.

Describe breed differences (LSMeans)

4. Normality Test: FEC (e.g. FEC 5)

- FEC
- Log FEC
- Residual from GLM Log FEC

5. Alternative models

- FEC adjusted by BW in the model as covariate.
- Number of females: Number of eggs adjusted by g of faeces (3% of BW) and adjusted by biotic potential of *Haemonchus contortus* females.

$\text{FEC}_{1b} = \text{FEC}_1 * (\text{BW}_1 * 1000 * 0.03) / 5000$; Females1=Log(FEC_1b);

$\text{FEC}_{2b} = \text{FEC}_2 * (\text{BW}_2 * 1000 * 0.03) / 5000$; Females2=Log(FEC_2b);

$\text{FEC}_{3b} = \text{FEC}_3 * (\text{BW}_3 * 1000 * 0.03) / 5000$; Females3=Log(FEC_3b);

$\text{FEC}_{4b} = \text{FEC}_4 * (\text{BW}_4 * 1000 * 0.03) / 5000$; Females4=Log(FEC_4b);

$\text{FEC}_{5b} = \text{FEC}_5 * (\text{BW}_5 * 1000 * 0.03) / 5000$; Females5=Log(FEC_5b);

6. Other traits

Explore other traits: FAMACHA, BCS, BW

