Adaptative traits for sheep selection in harsh environment

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Abstract
Session 24: Selection in harsh environments: methods and results

Adaptive traits for sheep selection in harsh environment

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An experiment has been conducted about selection of sheep in dry environment on the Larzac plateau (South of France).
The Romane (INRA 401) flock has been raised outdoors all along the year and fed on rangelands. Adaptive abilities have been investigated following behavioural and fleece traits.
Genetic effects have been estimated on three crops of 1111 lambs issued from 15 sires.
The survival rate has been related to fleece composition collected on lambs at birth.
Hairy birth coat influenced favourably birth survival rate from 3 points to woolly one (93 % vs 90 %),
Heritability of birth coat type was 0.56.
Behavioural traits have been measured in weaned lambs (i.e. 75 day-old) during two standardised tests assessing attractiveness to social partners and to human (conflict test and corridor test).
The 30 original variables have been synthesised into 8 behavioural traits from PCA.
Heritability estimates ranged from 0.04 (social attraction) to 0.41 (high bleats after isolation), avoidance of human estimate being medium with 0.29.
A preliminary primo-detection of QTL with 72 microsatellites markers on 4 families of 361 lambs led to 7 QTL on 6 chromosomes for 5 traits.
Favourable genetic correlations between the 8 behavioural traits and weak phenotypic correlations with growth and carcass traits have been found.
Genotype by Environment Interaction has been estimated from outdoors and indoors lambs both issued from same sires, it seemed weak since sires ranged similarly for 6 of the 8 traits.
Despite a need for additional investigations, hairy birth coat, reactivity to human and social attractiveness could be included in selection program in the purpose of improving the adaptation of farm animals to harsh environments.
Low GxE to be confirmed allows selection in better environment.

Harsh: dry or wet or hot or cold or/and unhealhty …
Our experiment
in dry environment (Larzac plateau, south of France)
with a Romane (INRA 401) flock raised outdoors
and fed on rangelands
(with complements when needed i.e. lambing)

Adaptative traits investigated:
behaviour, fleece,survival,body condition…

Sheep behaviour in relation to harsh environment

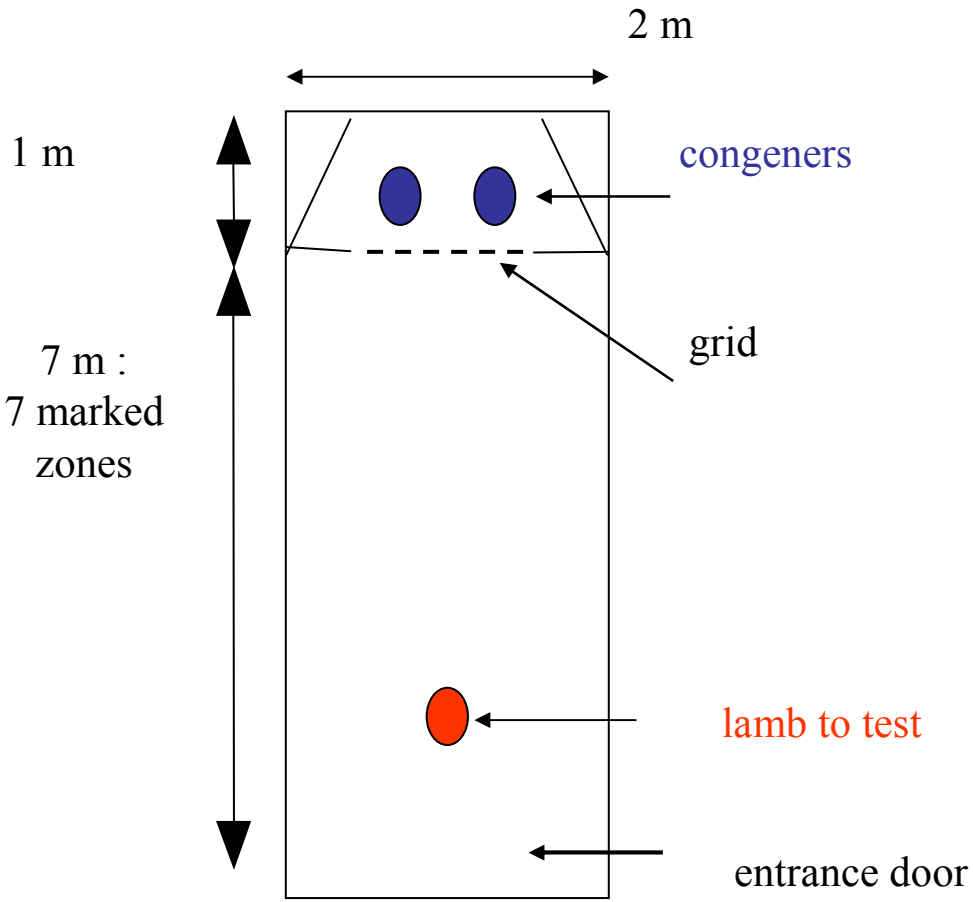
- high maternal behaviour
  influences survival and growth of outdoors lambs
- good flock acceptance
  to ease social learnings
- low avoidance to human despite decreasing shepherd contacts
  to ease breeding acts

How to measure ?

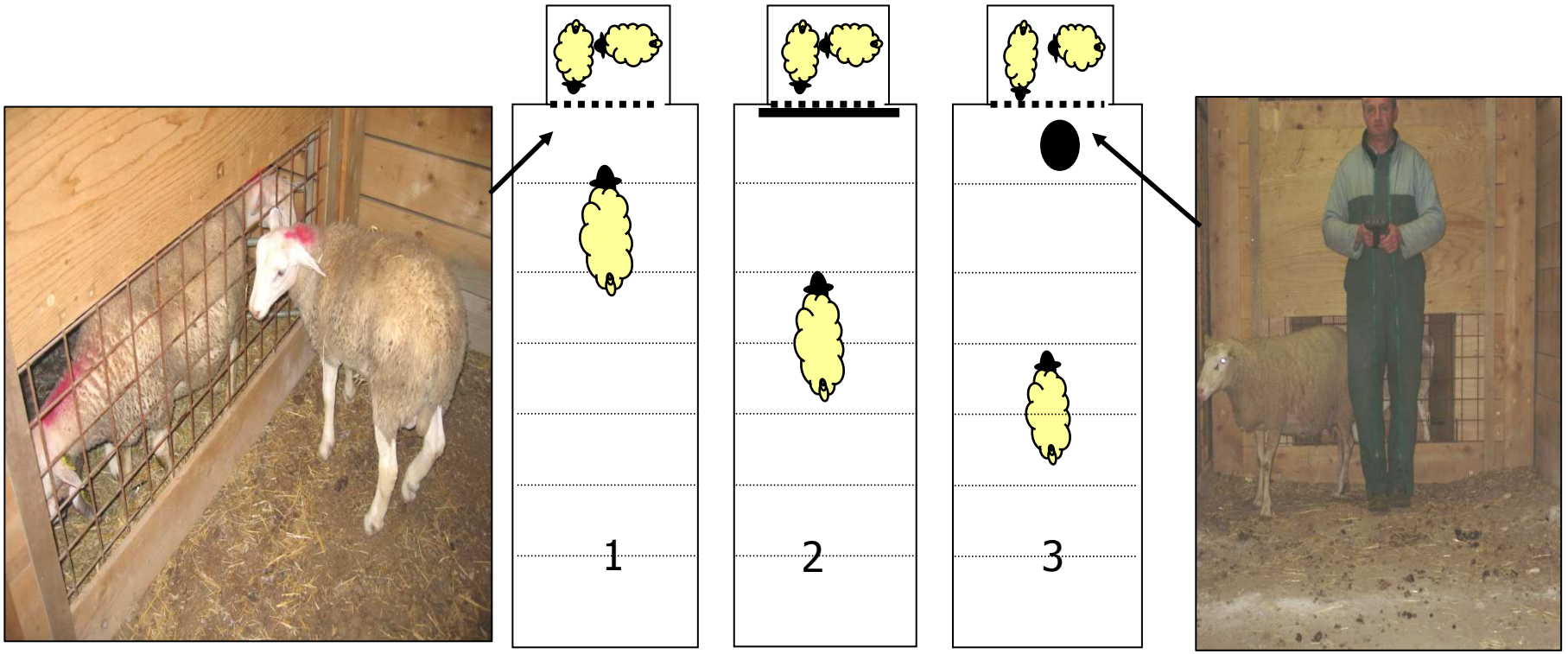
- Collaborative research with ethologists

  INRA-URH-ACS Clermont-Ferrand (Theix)
- Plenty of behaviour tests
- Selection of tests performed at weaning
  - Conflict test
  - Corridor test
- + Connexion tests
  - 2 australian teams: CSIRO Armidale & UWA Perth

Conflict test



3 steps :
1- congeners behind the grid (1/2 mn)
2- grid closed by a board (1 mn)
3- conflict with human (1 mn)

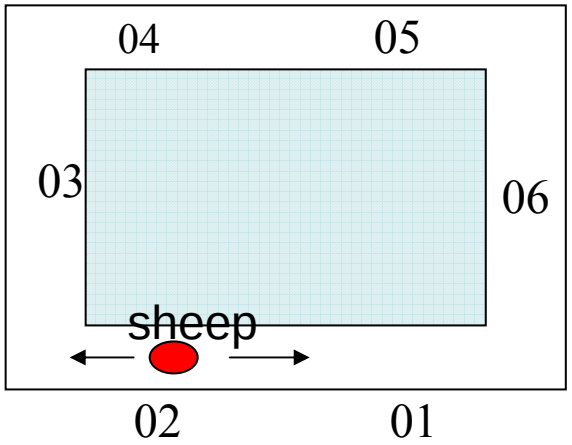


- Bleats (high & low)
- locomotion activity
- distance to congeners or human

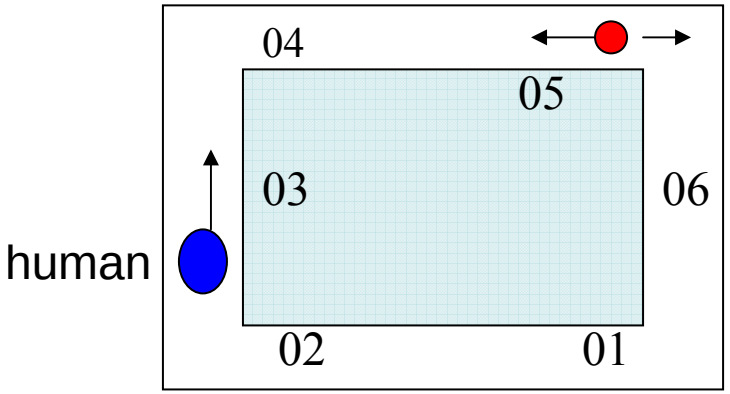
- looks / congeners or human
- vigilance behaviour

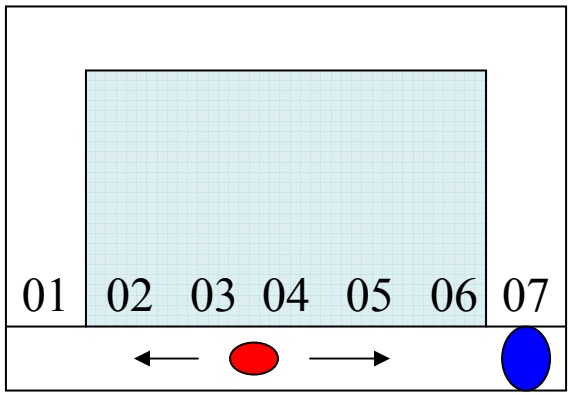
Corridor test

1st step



2nd step





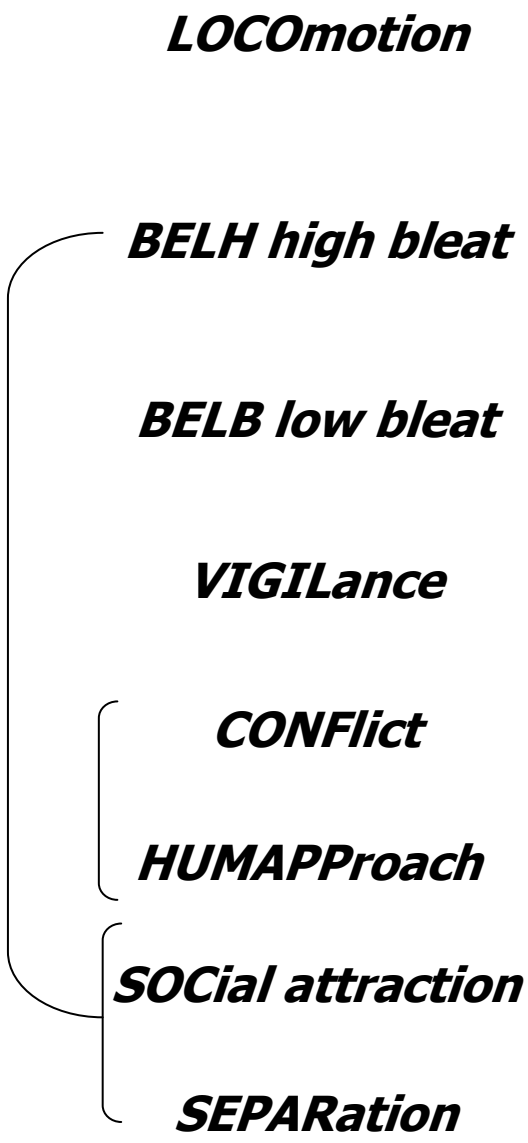
3rd step

design size: 6 m x 4 m

Test in 3 steps :

1. Social isolation (1/2 mn)
2. pursuit by human (1 mn)
3. approach to human (1/2 mn)

More than 30 measurements synthesised by Principal Component Analysis in 8 traits



Estimation of genetic parameters (rP \h²\ rG)

	LOCO	*BELH*	*BELB*	*VIGIL*	*SOC*	*SEPAR*	*CONF*	*HOMAP*
LOCO	**0,25**	0,20	-0,35	-0,47	-0,30	0,32	0,24	-0,21
BELH	0,18	**0,41**	-0,18	-0,46	-0,10	0,70	0,61	0,31
BELB	-0,13	-0,25	**0,28**	-0,38	0,40	0,48	0,12	-0,10
VIGIL	-0,30	-0,20	0,01	**0,10**	-1,00	-0,88	-0,67	-051
SOC	0,31	-0,08	0,03	0,01	**0,04**	0,84	-0,18	-0,11
SEPAR	0,19	0,28	0,15	-0,29	0,16	**0,17**	0,40	0,33
CONF	0,14	0,18	-0,02	-0,22	0,04	0,17	**0,10**	0,75
HOMAP	-0,19	0,13	-0,02	-0,11	-0,15	0,05	0,24	**0,29**

Lambs n=1111, Sires=15,Pedigrees n=3632

- Heritability coefficients low to consistent
- Coherent genetic correlations :
  - positive between 3 sociability variables
  - positive between 2 human avoidance variables
  - opposite for vigilance and sociability/human avoidance

→ possible to co-select different behaviour traits

Searching for predictors : QTLs

✓ QTL Primo-detection : 72 microsatellite markers (average distance : 38 cM)

✓ 4 families , 361 lambs (± 90 / ram)

QTL	OAR chromosome	Variable
-	1	BELH
-	2	BELH
-	2	SEPAR
-	6	LOCO
-	13	SEPAR
-	21	BELB
-	22	CONF

☛7 QTLs detected on 6 chromosomes for 5 traits

✓ in progress: QTL detection on 10 families by SNPs

Genetic x Environment Interaction

Same Romane (INRA401) rams with progeny
in an outdoors flock (INRA-la Fage) and in an indoors flock (INRA-Sapinière)

- ✓ lambs weaned at 75(± 5) days and tested at 85(± 5) days
- ✓ 5 rams per year, 5 years

G x E interaction (first results: 1yr, 5 sires, 532 lambs)

Traits	***Sire effect*** *(n=5)* *P* value	***Environment effect*** *(n=2)* *P* value	**Indoors - Outdoors**	***Sire * Environnment*** *P* value
LOCO	<0,001	<0,001	2.21	<0,05
BELH	<0,001	<0,001	2.49	ns
BELB	<0,001	ns	-0.01	ns
VIGIL	<0,001	<0,001	-1.28	<0,05
SOC	<0,05	<0,001	-0.87	ns
SEPAR	<0,01	<0,01	-0.49	ns
CONF	0.07	0.05	-0.27	ns
HOMAPP	<0,01	<0,001	-0.70	ns

- sire effect confirmed
- environnment effects :
  indoors lambs react more and avoid more humans
- low Gx E interaction (if confirmed, possible to select in indoors flocks)

Other adaptative traits

- Fleece composition (hair vs wool) traits & survival traits (Allain *et al, this session*)
- Body condition
  - Scores all over the year (mating, lambing, weaning,…) in connexion with liveweights and production traits
  - Ability to use body reserves and to recover good condition after harsh period
    - Project in order to identify fine phenotypes