CLOChèTE

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTERE DE L'AGRICULTURE ET DE L'ALIMENTATION
avec la contribution financière du compte d'affectation spéciale «Développement agricole et rural »

Evaluation of accelerometer as an effective tool to measure sheep behavior in a pastoral context

GRISOT PG, PHILIBERT A, DROUIN E, DEMARQUET F, AUPIAIS A

INSTITUT DE L'ELEVAGE idele
Montpellier SupAgro
LYCEE Agricole Carmejane
ESTIA INSTITUTE OF TECHNOLOGY
AGUILA TECHNOLOGIES
CERPAM
AGRICULTURES & TERRITOIRES CHAMBRE D'AGRICULTURE OCCITANIE
AGRICULTURES & TERRITOIRES CHAMBRE D'AGRICULTURE PYRÉNÉES-ATLANTIQUES

The « CLOChèTE » project

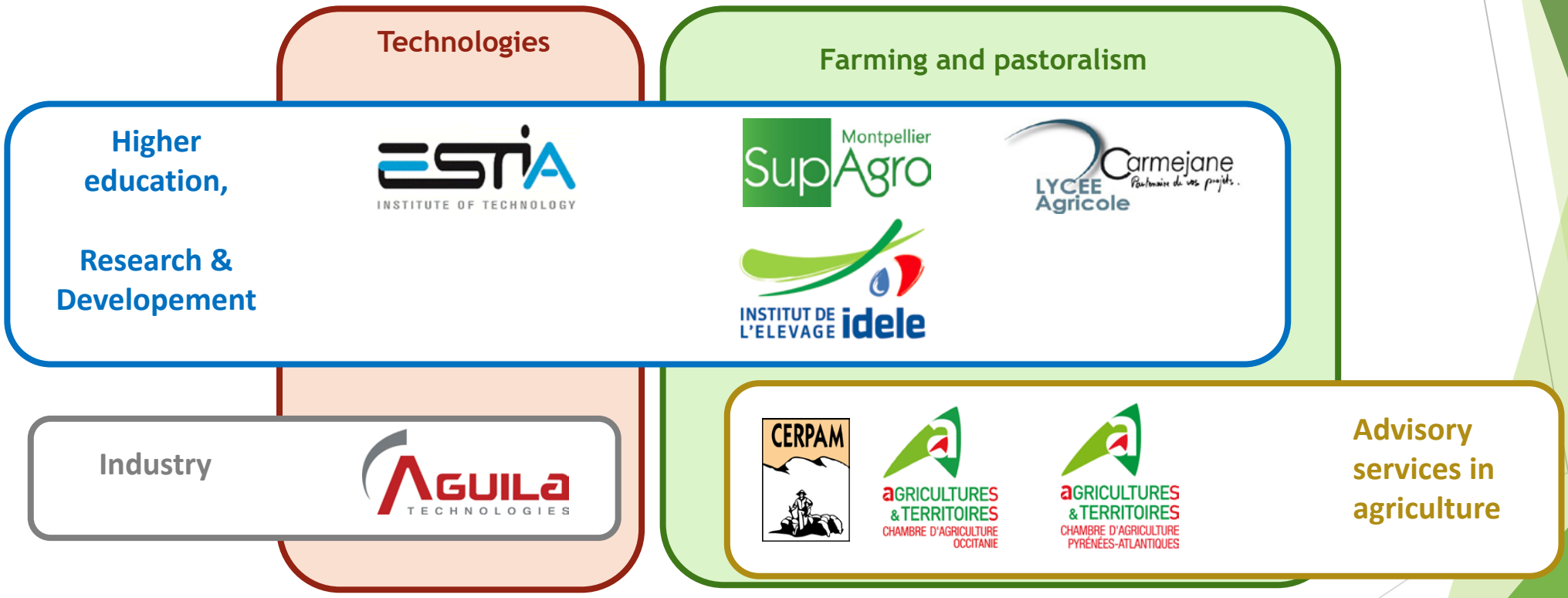
- **Issue** : adapt technologies(GPS, accelerometer) to the needs of pastoral farmers in order to support their activity and improve the utilization of rangelands.
- **Objective** : determine the technical and functional specifications of a tool combining GPS and accelerometer, to be put on the animals
- **In the framework of** : UMT Pasto & RMT Travail en élevage

Context

- Accelerometer technology – not a new tool
  - Since the middle of the 90's, used to characterise animal behavior
  - Different animal species especially since 2000 (Shepard et al. 2008)
  - On sheep in several studies (Mason et al., 2013 ; Marais et al., 2014…) :
    - Up to 5 behavior identified, on grassland

- Pastoral farming issues
  - Efficient pastoral resource management
  - Strong and compact device
  - Good battery operating time
  - Efficient in communications
  - Which individuals to equip?

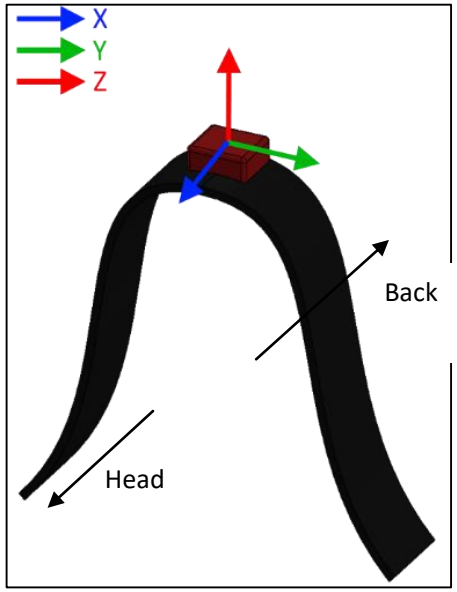
An applied project, with a variety of partners



Pastoral farming issues

- **Efficient pastoral resource management**
- Strong and compact device
- Good battery operating time
- Efficient in communications
- Which individuals to equip?

WPK 2.1 : Evaluation of accelerometer as a tool to characterize animal behavior



Accelerometer

- 3 axis
- g = 9,81m.s^{-2}
- Acquisition frequency : 100Hz

Method: monitoring of ewes at the Carmejane experimental farm

1.5 days on grassland + **1.5 days** on rangeland

3 different animals for each ½ day

Method: monitoring of ewes at the Carmejane experimental farm

Acquisition of data in the field

1.5 days on grassland + **1.5 days** on rangeland

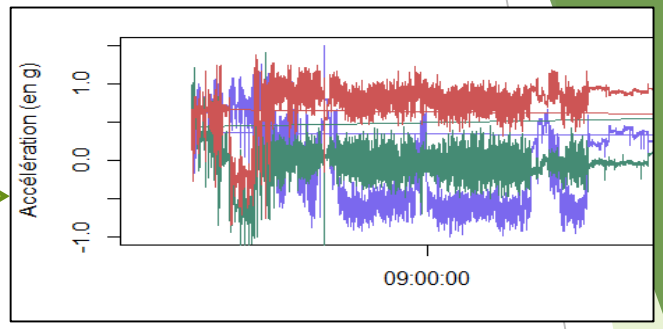
3 different animals for each ½ day

Direct observation of 9 types of behaviors

Lying – Sleeping	Standing – motionless	Standing – ruminating
Lying - motionless	Standing – walking	Standing – eating brush
Lying - ruminating	Standing – running	Standing - grazing

Method: monitoring of ewes at the Carmejane experimental farm

Acquisition of data in the field



1.5 days on grassland + **1.5 days** on rangeland

3 different animals for each ½ day

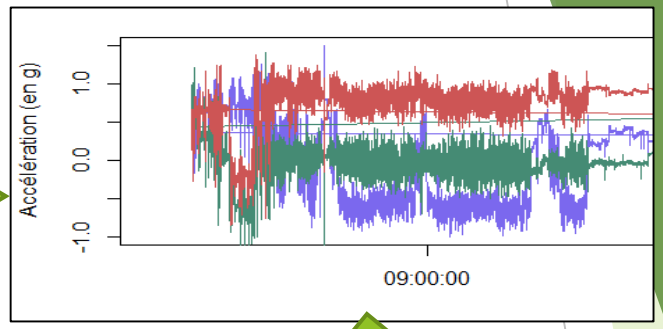
Direct observation of 9 types of behaviors

Lying - Sleeping	Standing - motionless	Standing - ruminating
Lying - motionless	Standing - walking	Standing - eating brush
Lying - ruminating	Standing - running	Standing - grazing

Time	Behavior
09:00:07	Standing - Grazing
09:02:00	Standing - Walking
09:02:10	Standing - Grazing
09:02:38 to 09:03:12	Standing - Walking
09:03:29	Standing - Walking
09:04:03	Standing - Grazing
09:05:15	Standing - Grazing

Method: monitoring of ewes at the Carmejane experimental farm

Acquisition of data in the field



1.5 days on grassland + **1.5 days** on rangeland

3 different animals for each ½ day

Direct observation of 9 types of behaviors

Lying - Sleeping	Standing - motionless	Standing - ruminating
Lying - motionless	Standing - walking	Standing - eating brush
Lying - ruminating	Standing - running	Standing - grazing

Statistical treatments

Time	Behavior
09:00:07	Standing - Grazing
09:02:00	Standing - Walking
09:02:10	Standing - Grazing
09:02:38 to 09:03:12	Standing - Walking
09:03:29	Standing - Walking
09:04:03	Standing - Grazing
09:05:15	Standing - Grazing

Method: combination of Data sets

Time		Acceleration axis x (g)	Acceleration axis y (g)	Acceleration axis z (g)	Behavior
09:00:05	000	0.53125	0.125	0.75	GRAZING
09:00:05	001	0.53125	0.125	0.75	GRAZING
09:00:05	002	0.5625	0.125	0.78125	GRAZING
…	…	…	…	…	…
09:00:05	099	0.5625	0.09375	0.78125	GRAZING
09:00:06	000	0.5625	0.09375	0.78125	GRAZING
…	…	…	…	…	…
09:00:06	099	0.53125	-0.125	0.7735	GRAZING
09:00:07	000	0.53125	-0.125	0.75	GRAZING
…	…	…	…	…	…
09:00:09	099	0.53125	-0.125	0.7735	GRAZING
09:00:10	000	0.53125	-0.125	0.75	GRAZING
…	…	…	…	…	…
09:01:59	099	0.475	-0.09375	0.78125	GRAZING
09:02:00	000	0.475	-0.225	0.75	WALKING
09:02:00	001	0.325	0.375	0.75	WALKING
…	…	…	…	…	…
09:02:09	099	0.5625	0.375	0.75	WALKING

Method: combination of Data sets

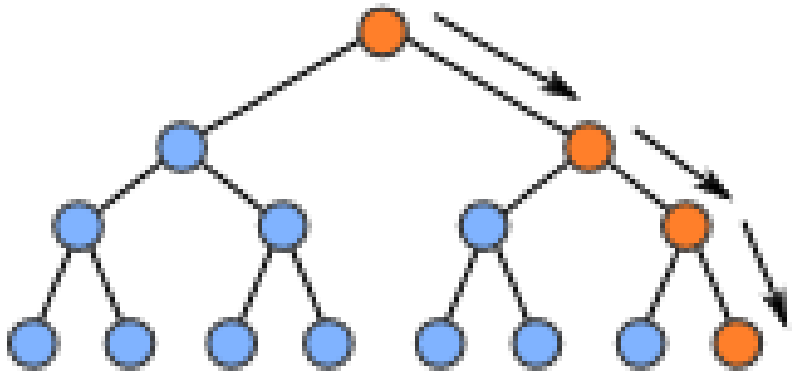
Time		Acceleration axis x (g)	Acceleration axis y (g)	Acceleration axis z (g)	Behavior
09:00:05	000	0.53125	0.125	0.75	GRAZING
09:00:05	001	0.53125	0.125	0.75	GRAZING
09:00:05	002	0.5625	0.125	0.78125	GRAZING
…	…	…	…	…	…
09:00:05	099	0.5625	0.09375	0.78125	GRAZING
09:00:06	000	0.5625	0.09375	0.78125	GRAZING
…	…	…	…	…	…
09:00:06	099	0.53125	-0.125	0.7735	GRAZING
09:00:07	000	0.53125	-0.125	0.75	GRAZING
…	…	…	…	…	…
09:00:09	099	0.53125	-0.125	0.7735	GRAZING
09:00:10	000	0.53125	-0.125	0.75	GRAZING
…	…	…	…	…	…
09:01:59	099	0.475	-0.09375	0.78125	GRAZING
09:02:00	000	0.475	-0.225	0.75	WALKING
09:02:00	001	0.325	0.375	0.75	WALKING
…	…	…	…	…	…
09:02:09	099	0.5625	0.375	0.75	WALKING

5-second segment

Method: Statistical treatments with the Random Forest algorithm

- ✓ Treatment of a pool of 3500 x 5-second segments with only 1 behavior
- ✓ Data analysed: 100Hz and 25Hz

- ✓ CART method: Classification and Regression Tree
  - ✓ Classifies segments in subsets to discriminate them
  - ✓ At every node of the tree, the algorithm looks for the best statistical variable to discriminate segments and to divide them in 2 subsets (according to this variable)



Method: Statistical treatments with the Random Forest algorithm

- ✓ Treatment of a pool of 3500 x 5-second segments with only 1 behavior
- ✓ Data analysed: 100Hz and 25Hz

- ✓ CART method: Classification and Regression Tree
  - ✓ Classifies segments in subsets to discriminate them
  - ✓ At every node of the tree, the algorithm looks for the best statistical variable to discriminate segments and to divide them in 2 subsets (according to this variable)

- ✓ Random Forest:
  - ✓ 500 regression trees, 3500 segments per tree (sampled with replacement), 6 variables per tree
  - ✓ 18 variables to discriminate segments (median, average, standard deviation, min, max, …)

- ✓ **Output: rate of success in segment classification**

Results: rate of success in segment classification

Grassland and rangeland data, 25Hz frequency

Behavior observed	Number of analysed segments	% of good predictions	Confusions with
Lying – sleeping	1415	94.8	Lying - motionless
Lying - motionless	2362	92.9	Lying – ruminating
Lying - ruminating	1658	90.7	Lying - motionless
Standing - grazing	5024	98.0	
Standing – ruminating	292	67.5	Lying - ruminating
Standing – eating brush	9	0.0	Standing – grazing
Standing – motionless	244	28.7	Standing – grazing and Lying – motionless
Standing – walking	132	62.1	Standing – grazing
Standing – running	117	73.5	Standing - walking

→ **92.4** % of segments correctly predicted
→ Confusions between some behaviors

Results: rate of success in segment classification

Grassland and rangeland data, 25Hz frequency

Behavior observed	Number of analysed segments	% of good predictions	Confusions with
Lying – sleeping	1415	94.8	Lying - motionless
Lying - motionless	2362	92.9	Lyin… …g
Lying - ruminating	1658	90.7	
Standing - grazing	5024	9…	
Standing – ruminating	292		Lying - ruminating
Standing – eating brush			Standing – grazing
Standing – moti…		28.7	Standing – grazing and Lying – motionless
Standing – wa…		62.1	Standing – grazing
Standing – run…	117	73.5	Standing - walking

Similar results with 100 Hz Frequency
92.5 % of segments correctly predicted

Conclusions

- 25 Hz vs 100 HZ: same results → reduce the data volume
- 92.4 % of good prediction → very good prediction for **lying** and **grazing** behaviors

- To be done next:
  - Improvement of the algorithm with new sequences (rangeland pasture)
  - Validation of the algorithm on other flocks and other kinds of pastures
  - Determination of the number of segment per minute (or per hour) necessary to predict correctly the behavior

Perspectives

- **Efficient pastoral resource management**
  - For pastoral farmers, combined to GPS data:
    - Better rangeland management
    - Alerts: dangerous areas or abnormal behavior (predator attack)

- Strong and compact device
- Good battery operating time
- Efficient in communications
- Which individuals to equip?

Thank you!